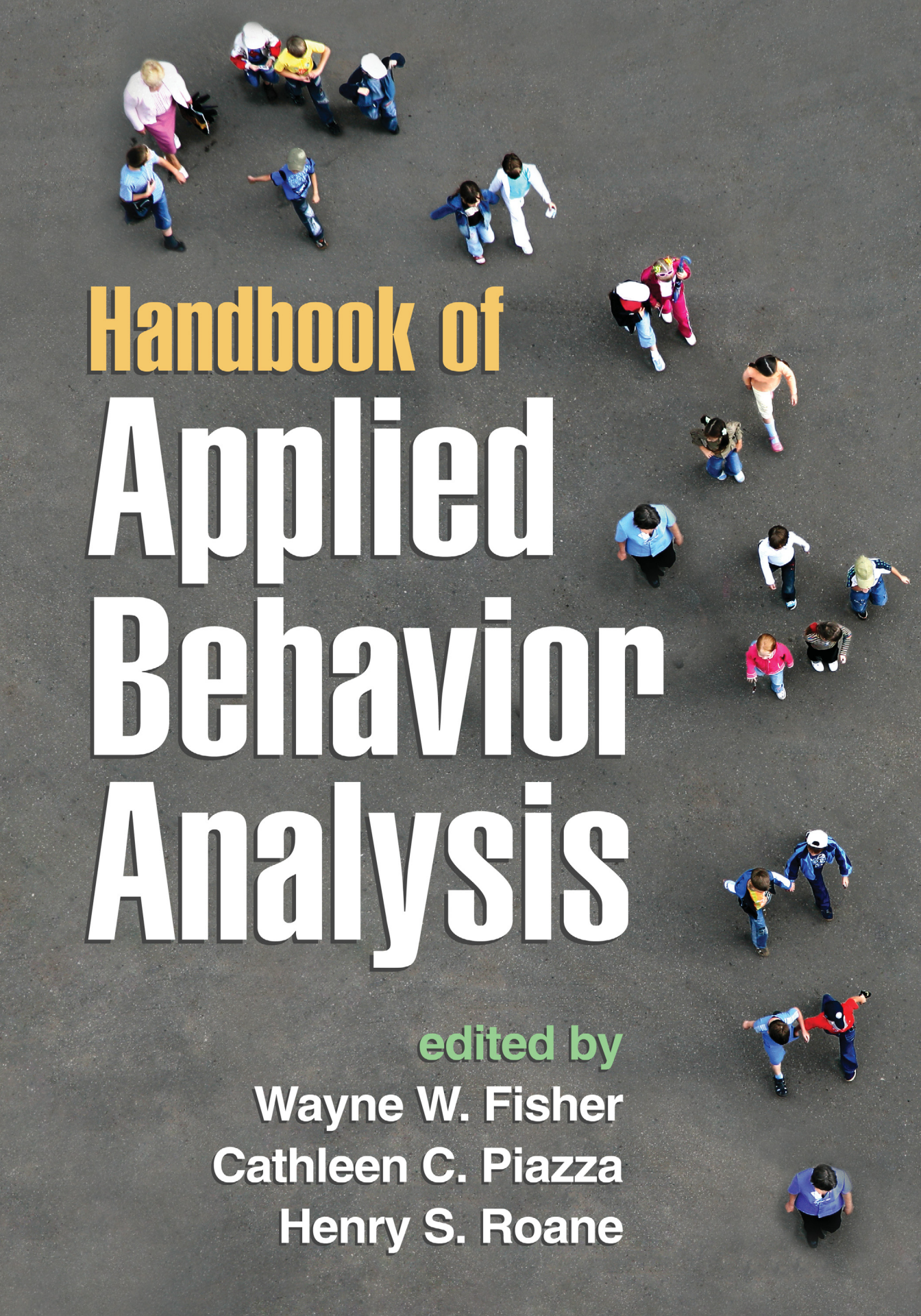


Handbook of Applied Behavior Analysis

edited by

Wayne W. Fisher

Cathleen C. Piazza

Henry S. Roane



THE GUILFORD PRESS

HANDBOOK OF APPLIED BEHAVIOR ANALYSIS

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About the Editors

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Cathleen C. Piazza, PhD, is a Professor at the Munroe–Meyer Institute and the Department of Pediatrics at the University of Nebraska Medical Center, where she is also Director of the Pediatric Feeding Disorders Program. Dr. Piazza and her colleagues have examined various aspects of feeding behavior and have developed a series of interventions to address one of the most common health problems in children with disabilities.

Her research in this area has been among the most systematic in the field and has firmly established behavioral approaches as preferred methods for assessment and treatment. In her roles as clinical, research, and training director, Dr. Piazza has mentored a large number of interns and fellows who have gone on to make significant contributions to the field. Highly regarded for her general expertise in research methodology, she is a former editor of the *Journal of Applied Behavior Analysis*.

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Preface

I never teach my pupils; I only attempt to provide
the conditions in which they can learn.
—Albert Einstein

No book can substitute for the learning that occurs from the ongoing contingencies of reinforcement present in one's natural environment. Behavior analysts may identify and understand the contingencies present in our own settings better than most laypersons, but that knowledge does not immunize us from the potent effects those prevailing contingencies have on our behavior. Applied behavior analysts, in particular, often find themselves in environmental contexts involving strong social contingencies in which we are expected to solve complex and socially important behavior problems. Such powerful contingencies are likely to shape and hone one's behavior-analytic skills much more so than reading this or any other book. Nevertheless, an informative book can provide a roadmap that helps us respond to those social contingencies more effectively and rapidly, and this book was developed specifically for that purpose.

As we conceived and developed this book, it occurred to us that there was no single source that we would consistently go to when faced with a particularly challenging clinical or applied research problem. Rather, we might start by going to any one of a number of different sources, including (1) consulting with in-house colleagues or ones at other institutions, (2) conducting computer searches of the *Journal of Applied Behavior Analysis* (*JABA*) or the *Journal of the Experimental Analysis of Behavior (JEAB)*, or (3) reading sections of the many books covering behavior-analysis topics relevant to the specific clinical or research challenge before us. Thus, a central goal of this book was to develop a resource for those behavior analysts working in service and applied research settings that (we hope) would be the first source they would turn to when presented with a unique or difficult clinical or applied research problem. In fact, in selecting the authors for each of the chapters, we spent a considerable amount of time asking ourselves whom we would call upon as a first choice for a consultant on the specific topic, and then we invited that person to be the senior author for the chapter. It was exceedingly reinforcing when our first choice accepted our invitation to author the chapter on his or her specific area of expertise in almost every case. Thus, if you peruse the table of contents, you will

see that each chapter in this book is authored by one or more internationally renowned experts in the topic area covered in that chapter.

The quality of the authors is reflected by the fact that seven have been or currently are editors of major behavioral journals such as *JABA*, *JEAB*, and *The Behavior Analyst*. Another 11 authors have been associate editors of these or other respected journals. In addition, the book has been edited to improve its overall quality and cohesiveness. Thus, this book is the first comprehensive and authoritative handbook of *applied behavior analysis*, written and edited by leading experts in the field.

The book provides the reader with the basic foundations of behavior analysis in the early chapters and then ties these basic concepts to application in subsequent chapters. As such, it strikes a balance between emphasis on research and application. The book provides a detailed level of analysis for both general and specialized areas of behavior analysis. Its contents reflect the breadth of behavior analysis and the expansion of applied behavior analysis into mainstream domains such as pediatrics, psychology, management, psychiatry, and drug treatment.

The book begins with, and devotes its first six chapters to a concise, yet detailed review of the history, philosophy, and basic principles that provide the foundation on which the subfield of applied behavior analysis is based. The next part of the book is devoted to *measurement*, *experimental design*, and related *methodological issues*. The fourth part consists of five chapters that discuss *stimulus preference assessments*, *functional and structural approaches* to assessing problem behavior, as well as specific chapters on indirect, direct, and controlled *functional assessments*. The fifth part of the book describes a variety of concepts and procedures relevant to interventions for increasing *desirable behavior*. The four chapters in this section cover topics such as *differential reinforcement procedures*, building complex repertoires and establishing *stimulus control*, teaching *verbal behavior*, and *staff training and management*. Part VI includes five chapters covering issues related to developing interventions for decreasing *problem behavior*. Topics in this section include developing *antecedent interventions*, designing *function-based extinction*, *reinforcement*, and *punishment* interventions, and developing *token economies*. The seventh part of the book describes several important and emerging subspecialties within the field of applied behavior analysis, including behavioral approaches to *education*, treatment of *autism*, establishing *safety skills* in children, *behavioral pediatrics*, behavioral treatment of *drug addiction*, and *behavioral gerontology*. The eighth and final part of the book focuses on *professional issues* in applied behavior analysis, and includes chapters on *ethics* and *training and professional certification*. Of interest to the reader is that, though the topics of each chapter are specific to that content area, there are several overlapping themes across chapters. The discussion of specific principles across different content domains is representative of the breadth of the basic tenets of behavior analysis.

This book can be used as a core or primary textbook for courses in psychology, education, or behavior analysis. The target audiences for the book are practicing behavior analysts and students in graduate classes in psychology, education, or other related fields, and it could serve as a primary source for preparing for professional certification. The quality and comprehensiveness of the book make it a "must-have" for any behavior analysis library. We hope the reader will find this text as informative as it was enjoyable for us to edit.

Wayne W. Fisher
Cathleen C. Piazza
Henry S. Roane

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PART I

INTRODUCTION

CHAPTER 1

Applied Behavior Analysis

History, Philosophy, Principles, and Basic Methods

Wayne W. Fisher, Rebecca A. Groff, and Henry S. Roane

Behavior analysis is a discipline with three primary branches (Morris, Todd, Midgley, Schneider, & Johnson, 1990): (1) behaviorism, which focuses on the worldview or philosophy of behavior analysis; (2) the experimental analysis of behavior, which focuses on identifying and analyzing the basic principles and processes that explain behavior; and (3) applied behavior analysis (ABA), which focuses on solving problems of social importance using the principles and procedures of behavior analysis. Although this third branch of behavior analysis is the primary topic of our text, a basic knowledge of the other branches is necessary to appreciate fully the development and dimensions of ABA.

Behavior analysis began as a school or subfield within the discipline of psychology. Some still view behavior analysis as a subspecialty within psychology,whereas others believe that the basic tenets of behavior analysis and traditional psychology are so fundamentally at odds that the two cannot coexist within a single discipline (e.g., Fraley & Vargus, 1986). The basic tenets that distinguish behavior analysis from other areas of psychology include its emphasis on (1) behavior as the basic datum for the field rather than the *psyche*, the *self*, or other internal mental or metaphysical structures or phenomena; (2) continuity between publicly observable behavior and private events (e.g., thinking, feeling); (3) prediction and control of the behavior of individuals (rather than groups); (4) environmental explanations of behavior; and (5) the study of behavior as a natural science. We discuss each of these tenets before turning our attention to the dimensions that specifically define ABA.

Behavior as Subject Matter

Behavior analysts believe that the appropriate subject matter for our field is behavior. We define *behavior* quite broadly to include anything an individual does when interacting with the physical environment (Catania, 2007; Skinner, 1938), including crying, speaking, listening, running, jumping, shifting attention, and even thinking. This behavioral philosophy is in contrast to the beliefs of mentalists or cognitive psychologists, who view thinking, feeling, and other internal events as activity that occurs within metaphysical entities such as the *self*, the *psyche*, or the *mind*, and consider these entities to influence or control outward behavior. Mentalists observe behavior in order to

draw inferences about these hypothetical structures, which they view as the appropriate subject matter for the field of psychology. They believe that understanding these inner constructs help to explain observable behavior. Behaviorists believe that behavior itself is the appropriate subject matter for our field, and that it should be studied directly, without references to internal causes. They view the brain as real but the mind as an invention, something thought up rather than something that thinks and controls behavior.

Although people in all walks of life talk about the mind as if it were a real entity, when questioned about its location and its characteristics, they find that the mind is difficult (if not impossible) to locate or describe in precise terms. Another problem that arises when one attempts to explain outward, observable behavior by appealing to causation via internal events is that one then has to explain what causes the internal events. Two philosophical arguments illustrate this problem: One is called Ryle's regress, and the other is called the homunculus fallacy.

Ryle (1949) identified a logical flaw in the traditional (dualist) view of intelligent behavior. The dualist position (i.e., viewing the mind and body as two distinct entities) is that when an individual displays an intelligent act (i.e., an observable response), it must have been preceded and directed by internal (mental) reflection on how to act intelligently. Ryle pointed out that if the logic of the dualist view were accurate, then it would follow that the internal operation of "reflection" would also be an intelligent act (albeit an internal one) that would need to be preceded and guided by reflection about various alternative ways of reflecting, thus creating a potentially never-ending succession of reflecting about reflecting about reflecting, and so forth. The endless need for a predecessor and director of every intelligent act has been labeled *Ryle's regress*.

The homunculus fallacy is analogous to Ryle's regress except that it is focused on the topic of how visual stimulation is interpreted. A mentalist viewpoint is that light is projected onto the back of the retina, and the mind views these images similarly to the way an individual views a motion picture. The mind is thus akin to a little man (or homunculus) who is metaphorically sitting inside of the brain viewing the movie. The question then arises as to how the mind (or the homunculus) sees and interprets the motion picture playing inside the human brain. In keeping with the mentalist hypothesis, there would have to be another, smaller homunculus inside the first one, which would in turn need to have an even smaller homunculus inside of it to interpret its movie. The endless need for another homunculus to explain the visual interpretations of the prior one is known as the *homunculus fallacy* (Uttal, 2000).

These arguments help to illustrate that it is impossible to prove or disprove the existence of the mind, much the way it is impossible to prove or disprove the existence of ghosts. Modern day mentalists (e.g., cognitive psychologists) do not often talk about the mind per se, but they are much more likely than behaviorists to look to internal variables (e.g., thoughts and feelings within the individual that cannot be observed) to explain behavior, and similar logical problems arise; that is, observable behavior (e.g., preparing a sandwich) is used to formulate hypotheses about internal constructs (e.g., the individual is hungry), which are then used to explain the observed behavior (e.g., the person prepared a sandwich because of the hunger). Skinner (1953) pointed out that the two statements, "He eats" and "He is hungry," describe a single set of facts; thus, one statement, "He is hungry," cannot be used to explain the other, "He eats" (p. 31). Skinner also argued that appeals to such inner causes impede scientific inquiry because once a (supposed) cause of behavior is identified (i.e., "He eats because he is hungry"), there is no reason to continue to search for an explanation of the behavior.

By contrast, B. F. Skinner's approach to explaining behavior represents a constantly evolving one in which experimental findings guide theory much more than theory guides experimentation. In fact, revisions and updates of behavior analytic explanations of behavior are often based on new experimental findings—an approach that has been referred to many times as "a work in progress" (e.g., Catania, 1988, p. 279). One notable example of the way our conceptualizations of behavior have been updated as result of new experimental findings has been the way we define our subject matter "behavior."

Early definitions of *behavior* focused on its physical or topographical characteristics, such as "thought processes are really

motor habits in the larynx, improvements, short cuts, changes, etc." (Watson, 1913, p. 177). Skinner (1938) provided a much broader definition of *behavior* and introduced the concept of the three-term contingency (antecedent–behavior–consequence) that defines "operant behavior." That is, *operant behavior* is defined by not only its topographical features but also its functional properties, namely, the environmental antecedents and consequences that are functionally related to the specific response topography. The topographical features of a person running to catch a bus may be similar to those of someone running out of a burning building, but the two forms of running are distinctly separate operant responses because they are under the control of different environmental antecedents and consequences, and it is these environment–behavior relations that define operant behavior (Donahoe, 2004).

More recent empirical findings have led to additional refinements regarding what constitutes behavior. For example, research has shown that that operant behavior is sensitive to both molecular and molar patterns of reinforcement (e.g., Herrnstein, 1969). Based in part on this empirical finding, teleological behaviorism attempts to explain complex behavior (e.g., building a house, falling in love) through the identification of organized patterns of environment–behavior relations that involve both proximal and ultimate causes (or consequences). Rachlin (1995) explains that hammering a nail is a function of not only the immediate consequence of fastening two boards together but also the larger task of constructing a floor, which in turn is a function of the task of building a house, and all of these nested responses are a function of the ultimate consequence of sheltering and protecting one's family.

Our conception of what constitutes behavior has also expanded as a result of research on stimulus equivalence and relational frame theory (Hayes, Barnes-Holmes, & Roche, 2001; Sidman, 2000). Research in this area has consistently shown that when certain stimulus relations (e.g., Mike is heavier than Bill; Bill is heavier than Sam) are trained with verbally competent human participants, other stimulus relations emerge without specific training (e.g., Sam is lighter than Mike). These emergent (or derived) relations are important because they may be prerequisites to, and form the basis of, generative language acquisition. They are also potentially important because they require a broader definition of what constitutes operant behavior; that is, equivalence classes (or relational frames) represent broader units of operant behavior that include both trained (i.e., reinforced) and untrained stimulus relations.

Private Events

A common misconception of behavior analysis is that it does not acknowledge or attempt to explain internal, private events such as thoughts and dreams. Behavior analysts believe that private events are governed by the same laws that govern overt behavior, and they do not explain these private events using mentalistic processes (Moore, 2003). The major difference between public and private behavior is that whereas the former can be observed and verified by other individuals, private events can only be observed by the individual performing the behavior.

Consider the scenario of a married man driving home with his spouse in one car and a single man driving home alone in another car. The married man looks at his spouse while stopped at a traffic light and says, "Remind me to take the garbage out when we get home." At the same stoplight, the single man thinks silently to himself, "I've got to remember to take the garbage out when I get home."

Behaviorists would view the talking done by the married man and the thinking done by the single man as distinct forms of behavior governed by the same laws, in which talking is a public behavior that can be observed by others and thinking is a private behavior that can only be observed by the single man. Behavior analysts almost exclusively study public behavior because it can be objectively observed, quantified, and subjected to the scientific method. However, behaviorists believe that the general principles of behavior derived from the study of public responses (e.g., talking aloud) also apply to and can be used to explain private responses (e.g., thinking or talking silently to oneself).

Behaviorists are particularly focused on general principles that relate to the function of behavior (its purpose or why it occurs). Behaviorists believe that the function of a

response is largely determined by environmental events that occur in close physical and temporal proximity to the behavior. Important environmental events that influence behavior include (1) the context in which the response occurs (e.g., teenagers behave differently at home with parents than at a party with peers), (2) motivational factors (e.g., searching for a restaurant is more likely if one has not eaten in a while), (3) antecedents that signal which responses will be successful (e.g., proceeding if the traffic light is green because it signals safety, and stopping if it is red because it signals danger), and (4) the consequences or outcomes of responses that influence whether they will reoccur in the future (e.g., studying for a test is more likely to be repeated if it results in a better grade).

Applying these general principles to the previous scenario, a behavior analyst might hypothesize that the married man asked his wife to remind him to take out the trash because (1) stopping at a traffic light provided a signal or cue indicating that it was momentarily safe to shift his attention to matters other than driving the car; (2) the man had previously experienced the negative outcome associated with forgetting to take out the trash (e.g., trash piling up because the cans would not hold it all); and (3) asking his wife to remind him to take out the garbage increased the likelihood that the trash would be removed, avoiding the negative consequence of the trash piling up. The same three reasons would apply to the single man, except that he had no companion in the car to help him remember to take out the trash, so he said the words silently to himself rather than aloud. Thus, although the two responses in this example (talking aloud and thinking about the trash) are quite different topographically (whereas talking can be observed by others, thinking cannot), they are quite similar functionally because both are occasioned by the same antecedent (sitting at the stoplight) and reinforced by the same consequence (avoidance of the trash piling up).

Because covert behaviors cannot be observed by others, the only way to identify whether a private event has occurred is through self-report, and self-observation is often unreliable (Skinner, 1953). In fact, Skinner points out the irony in the fact that an individual is taught to "know oneself" by the verbal community; that is, the two primary ways in which an individual learns to identify appropriately and label his or her private events is to (1) "find commonalities between private and public events," or (2) for others to "identify things that usually occasion it [the private event] or behavior that usually co-occurs" (p. 259). For example, if a child and her mother both cover their ears as a low-flying jet passes them, and then the parent says, "That hurt my ears," the child may subsequently learn to use the label "hurt" to describe (or tact) a similar sensation in the ear caused by an ear infection.

Similarly, if a child vomits, refuses to eat food, and has a temperature, a parent might tell him that his stomach hurts. Skinner explains that if a culture cannot teach an individual to discriminate between private events, then the skill of properly identifying one's own private events may never be developed and, consequently, one may not have an extensive knowledge of "self" (Skinner, 1953).

Studying the Behavior of Individuals

Modern psychology often focuses on the study of groups in order to identify patterns of individual differences. Psychological research focused on topics such as personality, intelligence, self-concept, and self-efficacy generally follows this approach. By contrast, behavior analysis generally focuses on the behavior of individuals in order to identify general principles describing behavior relations that show consistency within and across species (pigeon, dog, human) and environmental contexts (laboratory, home, school) (Keller & Schoenfeld, 1950; Mace, 1996). This fundamental difference between mainstream psychology, which studies groups, and behavior analysis, which studies individuals, is also reflected in their experimental methods. Most psychological researchers employ group-comparison designs and use inferential statistics to identify significant differences between various groups, whereas behavior analysts use single-subject designs to study the generality of general principles of behavior (e.g., behavioral momentum, delay discounting). Behavior analysts find the prediction and control of the behavior of individuals (rather than groups) advantageous because whereas individuals

engage in behavior, groups do not (Johnston & Pennypacker, 1993, p. 23).

When group studies are conducted, the results are often presented in terms of statistical means to describe how the "average" individual in the group behaved, and standard deviations are used to describe how much behavioral variability was present in the group. From a behavioral perspective, these statistics are limited, in that they do not accurately describe the behavior of any single individual in the group (Johnston & Pennypacker, 1993, p. 324). Each individual in the group has a genetic makeup and an extensive learning history that is unique. Consequently, environmental manipulations may evoke different behavior in one individual compared to another individual. To illustrate, one treatment that may be effective for one individual in a group may not be as effective for another individual.

Conversely, in a single-subject design experiment, an individual serves as his or her own experimental control. Thus, the experiment takes into account the individual's unique genetic makeup and operant learning history. Because the individual in a single-subject experiment serves as his or her own control (i.e., his or her behavior in baseline and control conditions is compared to that in treatment conditions), this type of research can more accurately determine whether or not a treatment is effective for a specific individual.

Environmental Explanations of Behavior

As discussed previously, behavior analysts identify causes of behavior in the environment. Skinner (1969b) proposed that variables influencing behavior can fall into two categories: phylogenetic and ontogenetic.

Phylogenetic variables are genetic traits passed from parent to offspring through reproduction. *Natural selection*, as originally described by Charles Darwin, is the process by which the traits most likely to aid in survival are passed on to offspring via reproduction. Individuals with traits that are well adapted to their environment are more likely to survive and procreate; consequently, those adaptive traits are more likely to appear in the next generation than traits that do not facilitate survival and procreation. Natural selection is a gradual process, in that only after many generations does the genetic makeup of an individual evolve to a point where it is drastically different than the genetic makeup of its ancestors (Skinner, 1969b). These genetic variables, in conjunction with an individual's environment, contribute to both respondent and operant behavior. In fact, Skinner (1981) postulated that "operant behavior is an evolved process" (p. 502); that is, operant behavior was selected through the phylogenetic process of natural selection because it provided a means by which individuals could acquire behavior that was adaptive to novel and changing environments during their lifetime.

Ontogenetic variables are similar to phylogenetic variables and natural selection, except that the changes occur within an individual's lifetime (and often from momement to moment) rather than across multiple generations of individuals (Skinner, 1969b). *Ontogeny* refers to the "natural selection" of behaviors as a result of their consequences. If an individual emits a response (e.g., betting on the most muscular looking horse) that produces a favorable (or reinforcing) consequence (e.g., winning the bet), the probability that he or she will repeat that response in similar environmental contexts increases; that is, the behavior is "selected" and "shaped" by the environment because responses that produce favorable outcomes or consequences tend to get repeated in that environment. Similarly, if an individual emits a behavior (e.g., reaching into a hole in the ground) that results in an unfavorable (or punishing) consequence (e., being bitten by an unseen animal), the probability that he or she will emit a similar response in the future decreases. Thus, both natural selection and operant selection involve selection by consequences. With natural selection, the environment selects traits that are correlated with survival of the species, and changes in such traits evolve slowly over many generations. With operant selection, the environment selects responses that are correlated with favorable consequences (e.g., satiation of hunger, quenching of thirst, numbing of pain), and changes in response pattern can occur from one moment to the next or over a person's lifetime.

In both phylogeny and ontogeny, some genetic traits and behaviors are not directly selected; rather, they are *spandrels* (i.e., a by-product or free rider) of selection of other traits or behaviors (Skinner, 1969b). For ex-

ample, suppose a genetic trait for fast twitch muscles aids in survival, allowing organisms to outrun predators. These organisms are more likely to reproduce compared to organisms that run more slowly and are eaten by their prey; consequently, the genetics for fast twitch muscles will be passed on to the next generation of organisms. By contrast, suppose that the organism also has blue eyes. Blue eyes may not aid in the survival of the organism, but because the organism gets the opportunity to reproduce partially because of its fast twitch muscles, the trait of blue eyes will also be passed on to the next generation of organisms. Thus, blue eyes are a spandrel or by-product of natural selection. Similarly, reading a textbook before taking a test may increase the probability that an individual achieves a good grade on a test; consequently, reading behavior may increase in the future. This behavior is being directly reinforced by its consequences. If the individual drinks green tea while reading, then the behavior of drinking green tea may increase as a by-product of the behavior of reading being reinforced. The increase in green tea does not cause the individual to do well on his or her test, but the behavior increases as a by-product of the behavior of reading being reinforced.

Knowledge of spandrels plays a role in the application of behavior analysis. To illustrate, when a behavioral intervention is implemented either to decrease or increase a specific target behavior, it is important to consider what other behaviors in an individual's repertoire will be modified as a by-product of the targeted behavior and to plan accordingly. For example, *extinction* (i.e., no longer providing reinforcement for a behavior that is maintained by that reinforcer) of disruptive behavior may result in an increase in aggression even if this latter response did not produce the reinforcer in the past. Thus, an additional component of treatment should be added to account for this (e.g., providing access to the reinforcer that is contingent on an alternative behavior).

Structural versus Functional Classification of Behavior

Most approaches to classifying and understanding aberrant behavior emphasize its structural properties and how certain responses tend to co-occur. For example, a boy who avoids physical contact and eye contact with others, and displays peculiar vocal and motor responses (e.g., referring to himself as "you" and others as "I," and repetitively spinning objects) may receive the diagnosis of autism. This diagnosis is then often used as an explanation of the aberrant behavior that leads to the diagnosis (e.g., "He repetitively spins objects because he has autism"). As discussed earlier in the example provided by Skinner (1953; i.e., "He eats," "He is hungry"), the statements "He has autism" and "He repetitively spins objects" are two ways of describing the same set of facts; thus, one statement does not explain the other.

Behavior analysts frequently work with children with autism, but they view the diagnosis as descriptive rather than explanative. Because behavior analysts work to identify operant contingencies that are maintaining a behavior, they assess and categorize aberrant behavior according to its function. Other fields of science, such as microbiology, have long understood the importance of analyzing both the structure and function of dynamic entities. Behavior analysts employ a similar practice by categorizing behavior in terms of not only its structural characteristics (e.g., hitting one's self constitutes self-injury) but also its function. For example, one child with autism might slap other people because, when he does, others are less likely to approach him with schoolwork to complete. In this case, the function of aggression would be to avoid schoolwork. By contrast, another child with autism might slap other people because, when she does, her caregivers are more likely to give her physical attention in the form of tactile stimulation (e.g., sensory integration). In this case, the function of aggression would be to gain a specific form of caregiver attention. Thus, although both cases involve slapping others (an aggressive act), the function of the behavior differs. Analyzing the function of an individual's aberrant behavior allows us better to predict which treatments will and will not be effective. For example, a time-out from attention would be an effective treatment for self-injurious behavior maintained by attention, but it would likely worsen self-injurious behavior maintained by avoidance or escape from social interaction.

The Study of Behavior as a Natural Science

The final tenet that distinguishes behavior analysis from traditional psychology is that it examines behavior as a natural science, thus conducting research and developing theories in a similar manner as the natural sciences of chemistry and physics. Behaviors of scientists, like that of any other organism, are a consequence of their interaction with the environment. Consequently, the behavior analyst must apply the same behavior analytic principles to themselves as they do to the individuals with whom they conduct research (Johnston & Pennypacker, 1993). Skinner (1953) stated that "science is first of all a set of attitudes," and it is important that "science reject even its own authorities when they interfere with the observation of nature" (p. 12). Skinner emphasized that "science is a willingness to accept facts even when they are opposed to wishes," and that it is important for scientists to "remain without an answer until a satisfactory one can be found" (pp. 12–13). This approach to science (and the attitudes of the scientist) is equally relevant to clinicians who wish to apply the natural science of behavior analysis to problems of social importance.

Dimensions of the Experimental Analysis of Behavior

In addition to Skinner's (1969a) general views on the attitudes, there are several specific attitudes that form the basis of the experimental analysis of behavior as a natural science. These attitudes include (1) determinism, (2) experimentation, (3) empiricism, (4) reliability, (5) philosophical doubt, and (6) parsimony. If behavior analysts maintain these attitudes, it is more likely that they will conduct objective research that aids in furthering the theories and principles of behavior analysis.

Determinism

The belief or attitude that all events in the universe (including behavioral events) are orderly, lawful, predictable, and determined by physical causes is called *determinism* (Cooper, Heron, & Heward, 2007; Mazur, 2006). In general, this means that behavior does not spontaneously occur (e.g., a child does not hit his brother "out of the blue"); there is always a reason an individual or organism emits a behavior (e.g., hitting in the past resulted in the brother leaving the play area and the child gaining access to the video game). Behavior analysts believe that current behavior is determined by phylogenetic and ontogenetic variables described previously, and we focus on current operant contingencies because they can be altered in ways that promote socially important changes (e.g., reducing sibling aggression).

It is not the case that to be a behavior analyst and to approach the study of behavior as a natural science, one must accept the premise that all behavior is determined. To do so would conflict with the attitudes described below as *philosophical doubt* (which maintains that we should continually question our assumptions, findings, and conclusions) and empiricism (which requires that determinism be empirically demonstrated before it is fully accepted).

Scientists in the field of physics, which is clearly a natural science, have adopted stochastic models and quantum mechanics (which are not deterministic) to explain certain phenomena that are not well accounted for through classical (Newtonian) mechanics (which is deterministic). Nevertheless, a general belief in determinism at this juncture in the development of behavior analysis, if not essential, is at least useful because it helps to focus our attention on the functional characteristics of behavior. Once the functional variables maintaining the behavior are identified, these variables can be manipulated for the purpose of either increasing desirable behavior or decreasing problem behavior. If the behavior of organisms were neither completely nor for the most part lawful, scientists would be unable to identify why an individual emits a behavior and thus be unable to modify the behavior.

Experimentation

If one accepts that behavior is wholly or largely determined by natural physical causes, and that the primary goals of a natural science of behavior are the prediction and control of its subject matter, then one is necessarily led to adopt experimentation as the principal method of studying behavior.

Skinner speculated that "perhaps the greatest contribution which a science of behavior may make to the evaluation of cultural practices is an insistence upon experimentation" (1953, p. 436).

Behavior analysts are interested in experimentation involving the manipulation of environmental antecedents and/or consequences as the independent variables, and behavior as the dependent variable. The purpose of this type of experimentation is to identify the specific environmental variables of which a particular behavior is a function. A *functional relation* is said to exist when a change in an independent behavior reliably produces a defined change in the dependent variable. Describing a functional relation between a response and its reinforcer under a specified environmental context is more precise than saying that the environmental events caused the behavior.

Skinner (1953) acknowledged that other, nonexperimental methods are a part of the scientific analysis of behavior, including casual, clinical, and controlled observations. He also acknowledged the rigor and control achieved in the laboratory with nonhuman species, and that simple responses may be obtained at the price of ecological validity or "unreality in conditions" (p. 37). However, this limitation is countered by the fact that the experimental analysis of behavior focuses on the identification of the basic behavioral processes that underlie both simple animal and complex human behavior.

Skinner (1953) argued that "the commonest objection to a thoroughgoing functional analysis [of complex human behavior] is simply that it cannot be carried out, but the only evidence for this is that it has not yet been carried out" (p. 41). As will be evident in a number of chapters in this book, considerable progress has been made in carrying out functional analyses of complex human response (e.g., self-injurious behavior; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994).

Empiricism

Empiricism is the attitude or viewpoint that the information available to science comes from the senses, and that scientific conclusions should be based primarily on sensory evidence. This basically means that scientists should be careful observers and believe what they observe the world to be rather than what they have been taught that it should be.

When conducting an experiment, it is important that behavior analysts maintain the attitude of empiricism, which is the practice of making scientific decisions regarding interventions, research, and theory development in an objective manner, and based on factual data. As described previously, a scientist's behavior is a function of environmental variables (Johnston & Pennypacker, 1993); thus, at any given time, numerous variables are controlling his or her behavior. These variables may include personal experiences, personal advancement, opinions, or beliefs. As much as possible, a behavior analyst's decisions should be a function of the available empirical data and not of these other variables. Conversely, if variables other than objective data are controlling a scientist's behavior, then the results of the experiment will not be empirical or valid.

Reliability

Conducting a single experiment is not sufficient evidence to conclude how an independent variable affects a dependent variable. Behavior analysts hold the attitude that experimental control must be reliable. Behavior analysts evaluate reliability at multiple levels. One can demonstrate a functional relation between an independent variable (e.g., contingent praise) and a dependent variable (e.g., compliance with instructional requests) in one experiment with only one participant. This typically is done by repeatedly measuring the participant's level of compliance in the absence of praise across multiple sessions, until a stable baseline is obtained. Next, the independent variable is introduced (i.e., compliance would consistently result in praise on a prespecified schedule) and levels of compliance are again repeatedly measured across multiple sessions until stable levels are observed. These two steps (multiple sessions of measuring levels of compliance, with and without praise) are repeated. A functional relation between contingent praise and compliance is demonstrated for this one individual if the phases in which compliance produced praise showed consistently higher levels of compliance than the phases in which compliance did not produce praise. Howev-

er, demonstrating that contingent praise increased compliance with just one individual does not allow us to draw conclusions about the relation between praise and compliance for other individuals; additional replication is required; that is, the generality of the finding would be greatly enhanced by replicating this same functional relation with multiple participants in a given experiment, and replicating it across experiments with different types of participants (e.g., children, adolescents, adults), in different contexts, and over time.

Philosophical Doubt

Even after behavior analysts reliably demonstrate a relation between an independent and dependent variable numerous times, it is important to maintain a reasonable degree of skepticism or *philosophical doubt*, meaning that they "continually question the truthfulness of what is regarded as fact" (Cooper et al., 2007, p. 6). Within the application of philosophical doubt, it is important for behavior analysts to acknowledge that the obtained data are limited and often exploratory because it is almost impossible to collect all of the data and facts. Philosophical doubt is an important attitude for behavior analysts to hold because it ensures that the field of applied behavior analysis continues to expand its theoretical and behavioral principle base and to implement the most efficient and effective behavioral interventions for those who are served.

Parsimony

Another attitude that behavior analysts practice is that of *parsimony*, the viewpoint that when two alternative explanations account for the available observations and facts equally well, the scientist should favor the simpler or more parsimonious explanation. The attitude of parsimony was first discussed by William Occam and is sometimes referred to as "Occam's razor." Similarly, the principle of parsimony is reflected in Einstein's famous quote: "Make things as simple as possible but no simpler." For a behavior analyst, parsimony involves a preference for explanations of behavior that are simple and based on previously established basic principles of behavior analysis, before resorting to explanations that require more assumptions and variables to explain the behavior (Johnston & Pennypacker, 1993). The principle of parsimony is also important for applied behavior analysts because simple interventions (that are effective) are more likely to be implemented and carried out with integrity.

Applied Behavior Analysis

The general principles on which ABA was founded were developed (and continue to be refined) from the results of laboratory experiments in the experimental analysis of behavior. Hence, it is important that the attitudes emphasized in the experimental analysis of behavior also are implemented in applied settings. This text presents detailed accounts of a range of variables within ABA. Thus, the following section briefly describes the basic tenets of the field of ABA.

ABA differs from the experimental analysis of behavior in that it is a clinical discipline in which the general principles of learning and behavior are used to solve or reduce problems of social relevance. Early in ABA's development, applied behavior analysts worked primarily in the fields of psychology and education. As described by Baer, Wolf, and Risley (1968), seven dimensions of applied behavior analysis help to focus our discipline on its central goal of solving problems of social importance. These include (1) applied, (2) behavioral, (3) analytic, (4) technological, (5) conceptually systematic, (6) effective, and (7) generalizable dimensions.

Applied behavior analysts select behaviors that are *applied*, meaning that they are socially acceptable and currently important to the individual whose behavior is being modified and his or her family (Baer et al., 1968). For example, teaching a child with a diagnosis of autism, who does not speak or communicate through gestures or picture symbols, to imitate speech sounds (echoic responses) or to request preferred items (i.e., mands) would represent a socially relevant target of treatment, whereas teaching the child to hammer a nail would not. At any point in time a behavior analyst might target several response classes, and it is important to prioritize which behaviors are most important to modify.

Consistent with the other two branches of behavior analysis, a principal dimension is ABA's focus on direct observation, objective measurement, quantification, prediction, and control of *behavior* (Baer et al., 1968). Behavior analysts typically do not rely on indirect measures of behavior such as self-report, interviews, or checklists (Baer, Wolf, & Risley, 1987). In addition, they do not attribute behavior to characteristics of inner qualities, such as personality traits. Instead, they attempt to identify a function of the behavior by manipulating environmental events as independent variables and observing changes in behavior as the dependent variable.

The third dimension of ABA is that it is *analytic*, which means that when we treat behavior, we use objective and controlled single-case designs that permit a believable demonstration of the effectiveness of our intervention whenever we can. Basically, this means that we strive to demonstrate a functional relation (as previously defined) between our treatment and any observed changes in the target behavior (Baer et al., 1968). In ABA, functional control is demonstrated by various experimental designs, including reversal, multielement, and multiple-baseline designs (see Roane, Rihgdahl, Kelley, & Glover, Chapter 8, this volume, for an explanation of each of these designs). Baer and colleagues (1987) emphasized that when selecting an experimental design to implement, one should select the design that is best suited for the experimental question rather than adjust the experimental question to fit a specific experimental design.

In addition to selecting an appropriate design for evaluating a functional relation, it is important that behavior analysts be *technological*, which means thoroughly and accurately describing their procedures when conducting experiments and implementing behavioral interventions. This information, which includes written procedures, operational definitions of target behaviors, and procedural integrity data, must be documented in a way that allows another reasonably competent applied behavior analyst to replicate the study after reading these documents (Baer et al., 1968, 1987).

The assessments and interventions applied behavior analysts implement are applied in nature. However, these interventions and the approaches used to develop the interventions should be *conceptually systematic* (Baer et al., 1968), which means that they are based on the basic behavior principles that have been empirically validated over many years by scientists who conduct basic research on the behavioral theories of the experimental analysis of behavior. Examples of conceptually systematic intervention components are extinction and schedules of reinforcement.

Many experiments that use group designs incorporate inferential statistics to determine whether there are statistically significant differences between groups. Applied behavior analysts rarely use statistics to determine whether a behavior change is significant. Instead, behavior analysts determine the *effectiveness* of their procedures by evaluating their data, often through visual inspection (Fisher, Kelley, & Lomas, 2003), that is, whether the individual whose behavior was changed and the family, caregivers, and friends of that individual find the behavior change significant. Just because a behavior change is statistically significant does not mean that the change is socially important. For example, a reduction of head banging from a rate of 12 per minute to 6 per minute may be statistically significant. However, the individual is still hitting his or her head over 300 times an hour. Consequently, this is not a socially acceptable level of reduction of head banging. A more significant reduction needs to occur in order to classify the intervention as effective.

The last principle of ABA is that the findings must be *generalizable* to other settings, caregivers, or behaviors (Baer et al., 1968). If a child's aggressive and disruptive behaviors are decreased to near-zero levels at a clinic, but at school and at home the child still engages in the problem behavior, then the behavior reduction has not generalized. Generalization is important because it is not beneficial to decrease negative behavior if the child only spends a few hours a week in the clinic. The behavioral intervention is only beneficial if it decreases the child's behavior across different settings when different caregivers implement it. The most effective way to ensure that the generalization occurs is to program it into the intervention (Stokes & Baer, 1977).

Summary

To summarize, there are three branches of behavior analysis: behaviorism, experimental behavior analysis, and ABA. Each branch is interested in directly studying, predicting, and controlling behavior rather than observing behavior as means of drawing inferences about the *mind*, the *psyche*, the *self*, or other internal mental or metaphysical structures or phenomena. Behaviorists believe that there is continuity between the behavior of human and nonhuman species, and between public and private behavior (e.g., thinking, feeling). Behaviorists believe that all behavior is lawful, that it occurs for a reason, and that it can be studied using the rigorous scientific methods applied in other natural or hard sciences. Finally, behaviorists focus on the function(s) of behavior and believe that it can be explained and controlled by observing and manipulating environmental events that occur in relation to the behavior.

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PART II

BASIC PRINCIPLES AND CONCEPTS

CHAPTER 2

Respondent (Pavlovian) Conditioning

John W. Donahoe and Rocío Vegas

At the dawn of the previous century, two scientists—one in St. Petersburg, Russia, and the other in Cambridge, Massachusetts—independently began their search to discover how the environment produces long-lasting changes in behavior. The first scientist was Ivan Pavlov (1927/1960), a physiologist whose earlier research on digestion would ultimately earn a Nobel Prize. The second was Edward Thorndike (1903), a psychologist whose later published work would ultimately exceed that of any other psychologist—past or present (Jonçich, 1968). The methods used by these pioneers differed, but both described themselves as following in Darwin's footsteps: They were attempting to explain complex phenomena as the cumulative product of simpler, more basic processes. For Darwin, the basic process had been natural selection. For Pavlov and Thorndike, the basic process became known as selection by reinforcement. Darwin studied how changes in *structure* could arise from natural selection. Pavlov and Thorndike studied how changes in *function* could arise from *selection by reinforcement*. All shared the hope that even the most complex phenomena could be explained by relatively simple selection processes acting over time. The selection process discovered by Darwin acted over extremely long periods of time and could be known largely through naturalistic observation. Selection by reinforcement occurred rapidly, however, and could be studied with the powerful procedures available in the laboratory.

Pavlov's and Thorndike's procedures differed in a critically important respect but began from the same starting point—by presenting a stimulus to which the learner would already respond. Both Pavlov and Thorndike presented an *eliciting stimulus*, food, that evoked consummatory behavior. Primarily because of natural selection, the taste, smell, and sight of food elicited a variety of responses—including salivation and approach. Moreover, these stimuli could be readily manipulated, and the responses they elicited could be measured. Where Pavlov and Thorndike differed was in regard to the type of event that reliably preceded the food. In Pavlov's procedure, food was contingent on the prior occurrence of a specified *stimulus*, for example, the "ticking" sound of a metronome. In Thorndike's procedure, food was contingent on the prior occurrence of a specified *behavior*; for example, escape from a cage (or a "puzzle box," as it was called).

The differences and similarities between Pavlov's and Thorndike's procedures are illustrated in Figure 2.1.

As shown in Figure 2.1, the central difference between the procedures is that a specific environment (E_i) reliably precedes the eliciting stimulus in Pavlov's procedure, whereas a specific behavior (B_j) reliably precedes the eliciting stimulus in Thorndike's procedure. Pavlov devised a technical vocabulary for the stimulus and response events in his procedure. The environmental event that preceded the *elicitation process* (a term that designates the eliciting stimulus together with its elicited response) is called the *conditioned stimulus* (CS). The eliciting stimulus is the *unconditioned stimulus* (US), and the elicited response is the *unconditioned response* (UR). In Pavlov's laboratory, the CS might be presentation of the ticking sound of a metronome, the US, presentation of food; and the UR, elicitation of salivation. After several pairings of the CS with the US/UR, the CS evoked a response that, in the typical case, resembled the UR. The response that came to be evoked by the CS was called the *conditioned response* (CR) and is the behavioral change usually monitored in a Pavlovian procedure. In the Pavlovian example illustrated in Figure 2.1, measures of the salivary response serve as the UR and CR. The process whereby the environment acquires its ability to control behavior is called *conditioning* because the ability of the CS to evoke the CR was *conditional* on (i.e., dependent on) pairing the CS with the US/UR. Pavlov's procedure is most often called *classical conditioning* in recognition of his historical priority. Following Pavlov's lead, the outcome of Thorndike's procedure has also come to be called conditioning—but *operant* or *instrumental conditioning* to distinguish it from the procedure used in classical conditioning. However, as already noted, Thorndike's procedure differed from Pavlov's in a critical respect: The event that reliably preceded the elicitation process was a *response*, not a stimulus. Because behav-

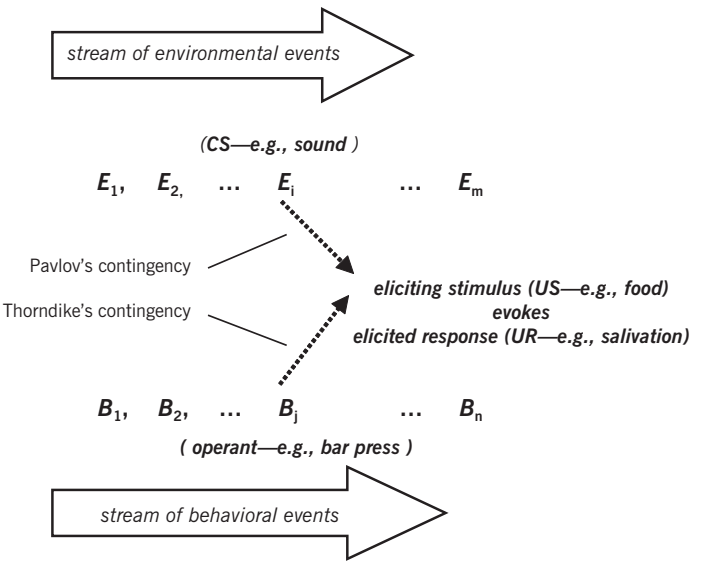


FIGURE 2.1. The critical events in Pavlov's and Thorndike's procedures. In both procedures, the learner is immersed in a stream of environmental (E) events and is continuously behaving (B) in their presence. The experimenter introduces an eliciting stimulus into the environment in both procedures. The critical difference between the two procedures is that in Pavlov's procedure an environmental stimulus (here, E_i) reliably precedes the eliciting stimulus, whereas in Thorndike's procedure a specific behavior (here, B_j) reliably precedes the eliciting stimulus. The technical term for the environmental event that precedes the eliciting stimulus is the conditioned stimulus (CS), for the eliciting stimulus is the unconditioned stimulus (US, which functions as a reinforcer), and for the elicited response is the unconditioned response (UR).

ioral change in both procedures is dependent on the presentation of an eliciting stimulus, the eliciting stimulus is called a *reinforcing stimulus*, or simply a *reinforcer.*

Skinner's View of the Difference between Classical and Operant Conditioning

The implications of the difference between Pavlov's and Thorndike's procedures were not fully appreciated until the work of B. F. Skinner. For example, John B. Watson, who is generally regarded as the "father" of behaviorism, did not sharply distinguish between the two procedures (Watson, 1913). Skinner realized that the classical procedure only permitted an experimental analysis of the relation between the environment and the reinforcer. Thus, the classical procedure was limited to changing the stimuli controlling responses that already could be elicited by other stimuli. Thorndike's procedure, in which a reinforcer could follow *any* response without respect to antecedent stimuli, opened the possibility of changing the full behavioral repertoire of the learner—not just elicited responses.

In *The Behavior of Organisms* (1938), B. F. Skinner's seminal extended treatment of classical and operant conditioning, he identified two procedures that he called Type S (or *respondent*) conditioning and Type R (or *operant*) conditioning. Respondent conditioning corresponded to the Pavlovian procedure. Skinner so named the procedure to emphasize that the behavior of interest (the UR) was a response (i.e., a respondent) elicited by a specified *stimulus* (the US; hence, Type S). Type R conditioning corresponds to the operant procedure, where *operant* is a term that Skinner introduced to emphasize that the response (the R; hence, Type R) operated on the environment to produce the reinforcer (see also Skinner, 1935). Skinner called the procedure Type R conditioning to emphasize that the relation of the organism's *response* to the reinforcer was paramount, and that this response was not occasioned by any specifiable stimulus. In Skinner's words, "there are two types of conditioned reflex, defined according to whether the reinforcing stimulus is correlated with a stimulus or with a response" (1938, p. 62). "The fundamental difference rests upon the term with which the reinforcing stimulus … is correlated. In Type S it is the stimulus …, in Type R the response" (1938, p. 109). Note especially that the two types of conditioning are "defined" (his word) by a procedural distinction, not a process distinction.

Later in the same work, Skinner cited without dissent the views of contemporaries who proposed a theoretical consistency between the conditioning process involved in the classical and operant procedures. "An analysis of differences between the two types has been made by Hilgard (1937), who points out that both types usually occur together and that 'reinforcement' is essentially the same process in both. The present distinctions [Skinner's procedural distinctions] are, however, not questioned" (p. 111). Skinner then cited the following, also without dissent: "Mowrer (1937) holds out the possibility that the two processes may eventually be reduced to a single formula" (p. 111). He noted further that "in Type R … the process is very probably that referred to in Thorndike's Law of Effect" (p. 111). (For a presentation of Thorndike's views as they relate to current work on reinforcement, see Donahoe, 1999.) In summary, Skinner's prescient distinction between classical (respondent, or Type S) and operant (or Type R) conditioning was based on procedural grounds alone. A unified theoretical treatment of the conditioning process involved in the two procedures was a possibility that Skinner both anticipated and welcomed. The view that one fundamental conditioning process occurs in both procedures is sometimes seen as inconsistent with Skinner's treatment of conditioning. It is not (Donahoe, Burgos, & Palmer, 1993).

Factors That Produce Behavioral Change in the Classical Procedure

The classical procedure is best suited for the experimental analysis of the effects of varying the characteristics of the CS and the reinforcer (the US), and of the temporal relation between them. In contrast, the operant procedure is best suited for the experimental analysis of the effects of varying the characteristics of the response and the reinforcer, and of the temporal relation between these two events. Discriminated operant conditioning, which is considered in Catania

(Chapter 3, this volume), permits the experimental analysis of all three events—the environmental stimulus, the behavior that occurs in the presence of the stimulus, and the reinforcer.

Characteristics of the CS

A very wide variety of stimuli have been effectively used as CSs in the classical procedure. They include the usual exteroceptive stimuli—visual, auditory, and tactile stimuli—as well as interoceptive stimuli—those produced by stimulation of internal receptors. Indeed, the regulation of many intraorganismic responses, such as blood pressure, glucose levels, and other behavior mediated by the autonomic nervous system, is influenced by classical conditioning (Dworkin, 1993). Because of its pervasive effect on autonomic responses, emotional behavior is especially affected by the variables manipulated in the respondent procedure (Skinner, 1938). As one example of interoceptive conditioning, stimuli from the insertion of a needle precede the effects of an injected drug, and these stimuli become CSs for drug-related responses. The effect of such CSs can be complex. When internal receptors on neurons sense the increased concentration of the injected compound, the endogenous (internal) production of that compound by neurons is decreased. For example, cocaine raises the level of dopamine, and this increase is detected by receptors on neurons that release dopamine. (*Dopamine* is a neuromodulator that affects the activity of many other neurons because it is widely distributed in the brain. Dopamine plays an important role in drug addiction and in reinforcement.) In reaction to increases in dopamine levels, these neurons lower their rate of production of dopamine. Thus, the UR is not an increase in dopamine from the injection of cocaine, but a decrease in the production of dopamine by neurons whose receptors detect the increased levels of dopamine (which is the functional US). After repeated pairings of the injection CS with the drug, when a placebo is injected (i.e., an injection CS that is not followed by cocaine), neurons show a conditioned *decrease* in the production of dopamine. Decreases in dopamine induce withdrawal symptoms, including drug cravings. The stimulus of the injection produces a conditioned reduction in the endogenous production of dopamine (Eikelboom & Stewart, 1982; see also Sokolowska, Siegel, & Kim, 2002). Classical conditioning clearly plays an important role in dysfunctional behavior, such as drug addiction. Panic disorders are also affected by classical conditioning (e.g., Bouton, Mineka, & Barlow, 2001). The life histories of those afflicted with panic disorder often include pairings of the feared stimulus with an aversive US (Acierno, Hersen, & Van Hasselt, 1993).

Although many stimuli can function as CSs, all stimuli are not equally effective with all USs. As a laboratory example, if food is presented to a pigeon after a localized visual stimulus, the pigeon will come to peck the visual stimulus (Brown & Jenkins, 1968). This procedure, known as *autoshaping*, meets the definition of a classical procedure. Pecking, which was initially elicited by the sight of food, is now directed at a stimulus—the localized light—that reliably precedes the food. However, if food is paired with a stimulus that is not spatially localized, such as a sound, pecking is not observed, although other measures indicate that conditioning has in fact occurred (Leyland & Mackintosh, 1978). The expression of the CR depends in part on the CS with which the US is paired. Some instances of this phenomenon—called *differential associability*—arise from the past history of the individual. As an example with humans, if the textual stimulus "DON'T BLINK" is presented as a CS before a puff of air to the eye, conditioning of the eye blink is impaired relative to a neutral stimulus, such as the presentation of a geometric form. Conversely, if the CS is "BLINK," conditioning is facilitated (Grant, 1972). Interactions between the CS and US have also been shown in the conditioning of phobias. Stimuli that are often the object of phobias, such as spiders, more rapidly become CSs when paired with an aversive US, such as a moderate electric shock (Ohman, Fredrikson, Hugdahl, & Rimmo, 1976). Moreover, when the life histories of persons with phobic behavior are examined, they often contain experiences in which the object of the phobia has been paired with an aversive stimulus (Merckelbach & Muris, 1997).

Instances of differential associability also arise from the past history of the species of

which the individual is a member. For example, taste or smell stimuli more readily become CSs when paired with food and the consequences of ingestion than do visual or auditory stimuli present at the same time (Garcia, Erwin, & Koelling, 1966). If nausea is a consequence of ingestion, as with poisons, then an aversion to the food is conditioned. This phenomenon, called *taste aversion*, undoubtedly owes its occurrence to the special status that olfactory and gustatory stimuli have with respect to the ingestion of food. Over evolutionary time, such stimuli necessarily came immediately before the ingestion of food, thus meeting the relative constancy of environmental conditions required for natural selection to operate. Under constant conditions, privileged neural connections may be selected between these sensory modalities and behavior related to food intake. Taste aversions are generally affected by the same variables as other conditioned responses, although conditioning can take place over longer time intervals between the CS and the US/UR (LoLordo & Droungas, 1989). Conditioned aversions to food eaten before chemotherapy often occur because of the nausea-inducing effects of the treatment. These aversions may be reduced with appropriate conditioning regimens (Bernstein, 1991).

Characteristics of the US/UR

The stimuli that have been used as USs vary almost as widely as those used as CSs. Generally, USs may be subdivided into two classes—those that are *appetitive* (stimuli that elicit approach behavior) and those that are *aversive* (stimuli that elicit escape behavior). Appetitive USs, such as food or water, when presented to an appropriately deprived animal, evoke a range of behavior, including approaching the stimulus and consummatory responses. Similarly, aversive stimuli elicit a range of behavior, including retreating from the stimulus, attacking, and freezing when the stimulus is inescapable. The CRs conditioned to environmental stimuli can either facilitate or interfere with operants when the US occurs in an operant procedure. To interpret possible interactions of respondents with operants, it is well to remember that the total CR is not restricted to the CRs that are measured. USs generally elicit a variety of URs, some of which are less easily detected at the behavioral scale of measurement, such as heart rate changes mediated by the autonomic nervous system. For experimental analysis, the laboratory methods used to study conditioning with the classical procedure usually employ USs that reliably elicit easily detectable URs. Reflexes (US–UR relations that are products of natural selection) are especially reliable and meet these criteria.

Higher-Order Conditioning

In the larger world outside the laboratory, many stimuli that serve as effective reinforcers do not elicit responses that are readily detectable at the behavioral scale of measurement. The sight or even the thought of a stimulus that has been paired with food may function as an effective US with respect to other stimuli. (Imagine the food that you are going to eat at your next meal, particularly if it is close to mealtime. Can you detect an increase in salivation?) The sight of a favored food evokes conditioned salivation through previous pairing with that food. Subsequently, words on a menu that describes the food also evoke salivation through pairing with a picture of the food. It is no accident that the menus of fast-food restaurants contain pictures of the food being described.

Stimuli that function as reinforcers without specific prior experience with those stimuli are *unconditioned* reinforcers. Sweet-tasting substances are examples. Stimuli that function as reinforcers after pairing with another CS become *conditioned* reinforcers. In the classical procedure a stimulus becomes a conditioned reinforcer through being paired with an unconditioned reinforcer, or with an already established conditioned reinforcer. A previous CS can function as a reinforcer for a new CS because the previous CS elicits behavior (the CR) as a result of prior conditioning. This procedure is called *higher-order conditioning,* which was first studied in the laboratory by Pavlov and has since been demonstrated many times. As a laboratory example, CS1 (e.g., a tone) is first paired with food and then, after the CS1 has acquired the ability to evoke a salivary CR, a second stimulus CS2 (e.g., a light) is paired with CS1. As a result, CS2 also acquires the ability to evoke a salivary CR even though

CS2 itself has never been paired with food. If the higher-order procedure is continued and CS1 in the CS2–CS1 sequence is no longer followed by food, CS1 ceases to evoke CRs. Because CS2 is no longer followed by a stimulus that evokes behavior, CS2 also ceases to function as a CS. Responding to CS1 can be maintained by occasionally presenting CS1 alone and pairing it with food, in which case higher-order conditioning of CS2 continues for a longer period of time (Rescorla, 1980). Outside the laboratory, occasional pairings are the rule, as when money is paired with other reinforcers. If money were no longer paired with CSs and USs, it would cease to function as a reinforcer. Stimuli that become CSs by being paired with a US can also reinforce operant behavior. For example, a sound that has been paired with food can increase lever pressing in rats if lever pressing is followed by the sound (Skinner, 1938). This phenomenon is called *conditioned* (or *secondary*) *reinforcement* because the operant has been strengthened by a CS that has been paired with food and not the food itself. For human behavior, most reinforcers are conditioned reinforcers. Recent research at the neural level of experimental analysis has shown that conditioned reinforcers activate the same neural systems as unconditioned reinforcers, although by means of partially different neural pathways (Schultz, 2001; see also Donahoe & Palmer, 1994/2005).

Temporal Relation between the CS and the US/UR

Given an appropriate choice of CS and US, what must occur for conditioning to take place? Research over the past 100 years has identified two critical factors—the temporal relation between the CS and US/UR, and a change in ongoing behavior that is evoked by the US. The first factor, the temporal relation between the CS and the US/UR, was demonstrated by Pavlov. This factor is known as *temporal contiguity*. The second factor was not identified until the late 1960s, with the work of Leon Kamin (1968, 1969). Kamin's findings indicated that temporal contiguity alone was not enough. In addition to being contiguous with the CS, the US also had to evoke a *change* in ongoing behavior; that is, the US had to evoke a response that was not already occurring when the US was presented. Only if such a change occurred would the US function as a reinforcer. This second factor is known as a *behavioral discrepancy*.

Temporal Contiguity

The classical procedure permits an analysis of the effects on conditioning of the temporal relation between the CS and the US/UR (Gormezano & Kehoe, 1981). Experimental analysis is possible because the presentation of both stimuli can be controlled by the experimenter and the relevant behavior can be measured. Figure 2.2 shows a representative finding when the temporal relation between the onset of the CS and US is varied (Smith, Coleman, & Gormezano, 1969). Here the CS was a tone, the US was a mild shock in the vicinity of one eye of a rabbit, and the CR was movement of the nictitating membrane (NM) elicited by the shock. The NM is a semitransparent tissue that can be extended over the eyeball to protect it. This membrane is present in many animals, such as dogs and cats, but is vestigial in humans, in which only the pink tissue in the nasal corner of each eye remains. The NM response is particularly well suited for experimental analysis because movement of the membrane is very rare except when an aversive stimulus

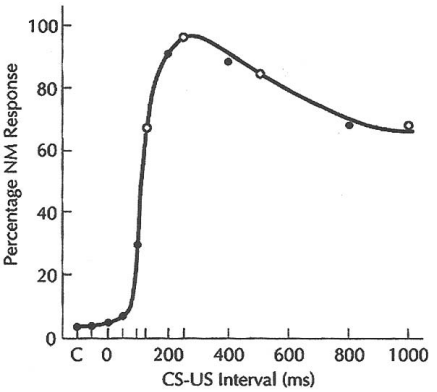


FIGURE 2.2. Effect of the CS–US interval on the strength of conditioning with the classical (Pavlovian) procedure. Different groups of rabbits were trained at each of the CS–US intervals. The CS was a tone, and the US was a mild shock in the region of the eye. The shock elicited a "blink" of the nictitating membrane (NM). From Donahoe and Palmer (1994/2005); based on findings from Smith, Coleman, & Gormezano, 1969. Copyright 2005 by John W. Donahoe. Reprinted by permission.

is applied near the eye. Thus, any movement of the NM during the CS is very likely a CR and not the result of other variables.

After a number of CS–US/UR pairings in which different animals were trained with different intervals between the CS and the US/UR, the major findings were these:

1. When the CS came *after* the US/UR (a *backward conditioning* arrangement), conditioning did not occur.
2. As the forward interval between the CS and the CS–US/UR increased, CR responding became more probable and reached a maximum when the interval attained a relatively short value (here, less than a half-second—500 milliseconds).
3. When the CS–US/UR interval increased beyond this point, CR responding declined.

To summarize, in a well-controlled Pavlovian procedure, selection by reinforcement occurs over only a relatively brief interval. As a result of reinforcement, stimuli (CSs) that reliably precede the elicitation process (US–UR) acquire control over the CR. Depending on the specifics of the training regimen, conditioning may occur in only one or a very few CS–US pairings (e.g., Kehoe & Macrae, 1994; Van Willigen, Emmett, Cote, & Ayres, 1987).

Because the conditioning process typically operates over only a very short time interval, longer-term relations between the environment and behavior must result from filling the gap between the CS and more remote US/URs with moment-to-moment changes in stimuli that serve as higher-order reinforcers. Indeed, even in tightly controlled laboratory situations with the rabbit NM, higher-order conditioning has been shown to occur over intervals as long as 18 seconds (Kehoe, Gibbs, Garcia, & Gormezano, 1979). In the more complex environments outside the laboratory and with learners whose conditioning histories are complex, the opportunities for higher-order and conditioned reinforcement are enormous. For humans especially, many such stimuli are available.

Critical Temporal Relation: CS–US or CS–UR?

In the classical procedure, the experimenter manipulates the relation between stimuli—the CS and US. By contrast, as we have seen, in the operant procedure, the experimenter manipulates the relation between a response (the operant) and a stimulus (the reinforcer, or US). Returning to the classical procedure, the experimenter directly controls the temporal relation between the CS and US, but when that relation is varied, the CS–UR relation necessarily varies as well (see Figure 2.3). Thus, it is generally impossible to determine whether the CS–US or the CS–UR relation is critical. Teasing apart these relations might appear unimportant except that the difference between the events that the experimenter manipulates in classical and operant procedures has led many to interpret the difference as more than a procedural distinction (e.g., Rescorla, 1991). Specifically, in classical procedures, the learner is sometimes said to acquire a stimulus–stimulus relation, whereas a stimulus–response relation is acquired in the operant procedure. The stimulus–response relation of the operant procedure can be appreciated by reference to Figure 2.1. Note that the reinforced operant necessarily occurs in the presence of *some* environmental stimulus. As Skinner (1937) noted, "It is the nature of [operant] behavior that … discriminative stimuli are practically inevitable" (p. 273; see also Catania & Keller, 1981; Dinsmoor, 1995; Donahoe, Palmer, & Burgos, 1997). Thus, some environmental event is very likely to acquire control over behavior in the operant procedure even though the experimenter may not directly manipulate that relation. Because the inference that different *kinds* of relations are acquired in the two procedures rests upon the fact that the experimenter manipulates

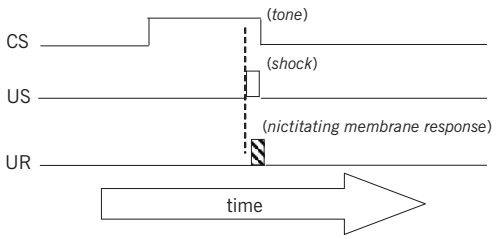


FIGURE 2.3. Schematic diagram of the events in a typical classical (Pavlovian) procedure. A specified environmental stimulus (here, a CS of a tone) precedes an eliciting stimulus (here, a US of a mild shock in the region of the eye of a rabbit) that evokes a response (here, a UR of a brief nictitating membrane response).

different events in the two procedures, it becomes important to determine whether the CS–US relation (a relation between two stimuli) or the CS–UR relation (a relation between a stimulus and a response) is fundamental in the Pavlovian procedure.

Recently, an experimental preparation has been developed in which the UR occurs with sufficient delay after the presentation of the US to separate experimentally the effects of the CS–UR relation from the CS–US relation (Donahoe & Vegas, 2004). Using the injection of water into the mouth of a pigeon as a US and swallowing as a UR, the CS could be introduced *after* the onset of the US but *before* the onset of the UR. Thus, the CS–US relation was backward, a relation that does not generally promote conditioning. Also, the swallowing UR lasts longer than the NM response, which allows the CS to be introduced *after* the onsets of both the US and UR but still overlap the UR. The central finding was that the CS (a light) came to evoke the conditioned response (swallowing) independently of the relation of the CS to the US as long as the CS preceded and/or overlapped the UR. Thus, conditioning in the classical procedure varied more systematically with the temporal relation between the CS and UR than with the relation between the CS and US. The inference that the learner acquired a different *kind* of relation with the classical procedure—a relation between two environmental events (CS–US) instead of an environment–behavior relation (CS–UR)—was based on a misinterpretation of the finding that variations in the CS–US relation affected conditioning. Conditioning in both the classical and the operant procedures changes the environmental control of behavior.

Behavioral Discrepancy Produced by the Reinforcing Stimulus

Until experiments conducted by Leon Kamin in the late 1960s, temporal contiguity between the CS and the US/UR was thought to be enough to produce conditioning in the classical procedure. Kamin's experiments showed that something more was needed, and many subsequent experiments have confirmed and extended his findings by using a variety of methods with both classical and operant procedures (e.g., Rescorla & Wagner, 1972; Vom Saal & Jenkins, 1970). Previous studies had pointed in a similar direction, but their significance was not fully appreciated (e.g., Johnson & Cumming, 1968; Rescorla, 1967). What was that "something more"?

Kamin devised a multiphase classical procedure known as the *blocking design,* which is summarized in Table 2.1. In the experimental group of animals, CRs were conditioned to CS1 during Phase 1. Then, in Phase 2, CS1 continued to be paired with the US, but CS1 was now accompanied by CS2, a stimulus that came on and went off at the same time as CS1. It is important to note that the temporal relation of CS2 to the US/UR should have been enough to condition responding to CS2 if contiguity were all that was required: The temporal relation of CS2 with the US was the same as with CS1, which did acquire CRs. In the Test Phase, CS1 and CS2 were presented separately to determine whether each stimulus had acquired the CR. As shown in Table 2.1, conditioned responding occurred to CS1 but not to CS2. An otherwise effective temporal relation of CS2 to the US did not condition a CR. In technical terms, prior conditioning to CS1 had *blocked* conditioning to CS2.

TABLE 2.1. The Experimental Design Used to Demonstrate the Role of Behavioral Discrepancy in Conditioning

	Experimental group	Control group
Conditioning phase 1	CS1 (tone) → US (food)	CS3 (click) → US (food)
Conditioning phase 2	CS1 (tone) plus CS2 (light) → US (food)	CS1 (tone) plus CS2 (light) → US (food)
Test phase	CS1 (tone) presented alone—CR CS2 (light) presented alone—no CR	CS1 (tone) presented alone—CR CS2 (light) presented alone—CR

Note. In the experimental group, conditioning to CS2 was *blocked* by prior conditioning to CS1.

One possible interpretation of the lack of conditioning to CS2 is that two CSs cannot be simultaneously conditioned to the same US. Various control experiments eliminated this possibility. In one control experiment, animals were first conditioned to an unrelated stimulus, CS3, during Phase 1 (see Table 2.1). Next, during Phase 2, animals in the control group received the same training as the experimental group—CS1 and CS2 were simultaneously presented and paired with the US/UR. Now, when CS1 and CS2 were presented separately during the Test Phase, each stimulus evoked a CR. Thus, two stimuli could be simultaneously conditioned to the same US, and the explanation of blocking must be sought elsewhere.

A compelling explanation of blocking was first offered by Robert Rescorla and Allan Wagner (1972). Stated in behavioral terms instead of the associationist language of the original formulation, a stimulus becomes a CS when—in addition to an appropriate temporal relation to the UR—the UR that is evoked by the US differs from the behavior that was occurring just before the US was presented (Donahoe, Crowley, Millard, & Stickney, 1982; Stickney & Donahoe, 1983). Technically speaking, the US must evoke a *behavioral discrepancy*, which was the "something more." Blocking of conditioning to CS2 occurred during Phase 2 for the experimental group because CS1 was already evoking the CR (e.g., salivation) *before* the US evoked the UR (also salivation). The UR did not constitute a sufficient change in ongoing behavior to support new conditioning. In the control group, however, when the CS was presented during Phase 2, it accompanied a stimulus, CS1, that did *not* evoke a CR and, consequently, both CS1 and CS2 became effective conditioned stimuli.

The significance of the behavioral–discrepancy requirement is that a stimulus must evoke a *change* in behavior if it to function as a reinforcer. In the vernacular, the learner must be "surprised" to receive the stimulus (more precisely, to respond in the way evoked by the stimulus). Natural selection has selected neural mechanisms of conditioning that come into play only when the environment causes the organism to change its ongoing behavior. As a possible practical example, parents who lavish praise independently of the behavior of the child may find that their praise is ineffective as a reinforcer. Frequent and indiscriminate praise is not "surprising." Conversely, parents who dole out praise sparingly may find the same words to be quite effective reinforcers. The more deprived the learner is of contact with a stimulus, the more vigorous the behavior evoked by that stimulus, and the more effectively it can function as a reinforcer (cf. Donahoe, 1997; Premack, 1959; Timberlake & Allison, 1974).

A Unified Principle of Reinforcement

Our present understanding of selection by reinforcement may be summarized as follows: If a stimulus evokes a change in ongoing behavior (a behavioral discrepancy), then that stimulus can function as a reinforcer with respect to the environmental and behavioral events that immediately precede and accompany the discrepancy (temporal contiguity) (Donahoe, Burgos, & Palmer, 1993; Donahoe et al., 1982).

As shown in Figure 2.1, in the classical procedure, the stimulus that reliably precedes the discrepancy is the CS, and the behavior that reliably accompanies the discrepancy is the UR. As also shown in Figure 2.1, in a simple operant procedure, no particular stimulus reliably precedes the discrepancy, and the responses that accompany the discrepancy are the operant and the UR. Thus, both the operant and the CR are acquired in the operant procedure. The basic conditioning process (selection by reinforcement) appears to be the same in both the classical and operant procedures. However, the events that reliably accompany the discrepancy in the two procedures are different and, consequently, the outcomes of the two procedures are different. In the classical procedure a specific stimulus (the CS) gains control over a specific response (the CR), but whatever other responses occur at the time of the discrepancy are unspecified. In the operant procedure, two specific responses (the operant and the CR) are acquired, but whatever antecedent stimuli that permit the operant to be emitted are not specified. (As already noted, a discriminated operant procedure can specify the antecedent stimuli.) Because the reinforcement process appears to be fundamentally the same in the classical and operant procedures, it is known as the

unified reinforcement principle (Donahoe et al., 1982).

In the classical procedure, no behavior other than the UR reliably accompanies a discrepancy, and in the simple operant procedure, no environmental stimulus reliably precedes the discrepancy. However, this does not necessarily mean that no response other than the CR is acquired in the classical procedure, or that no stimulus controls behavior in the operant procedure (Donahoe et al., 1997). To the extent that conditioning is possible with only a single occurrence of a discrepancy, other responses may inadvertently be conditioned in the classical procedure, and stimuli may acquire control of the operant in the operant procedure. Skinner (1948) demonstrated that when reinforcers are presented independently of an animal's behavior, a response may nevertheless be conditioned. The responses that are acquired are those that happen by chance to precede the reinforcer, and these responses are often those evoked by the reinforcer. Thus, a pigeon that is given occasional presentations of food independent of its behavior may begin to pace beside the wall adjacent to the feeder (Staddon & Simmelhag, 1970; Timberlake & Lucas, 1985). Pacing can then be strengthened by subsequent presentations of food. Skinner referred to this phenomenon as *superstitious conditioning.* An analogous phenomenon has been discovered in the classical procedure (Benedict & Ayres, 1972). When a CS and a US are presented independently of one another, chance CS–US pairings sometimes cause the CS to acquire control of the CR, especially when the chance pairings occur early in training.

On a single occasion, the conditioning process cannot distinguish between a chance and a nonchance pairing of an event with a reinforcer. In Pavlov's procedure, perhaps the dog pricked up its ears when hearing the metronome before food was given. The behavior of pricking the ears might be strengthened in the presence of the sound of the metronome, not merely the CR of salivating. Similarly, in Thorndike's procedure, the animal may have looked at the mechanism that released it from the puzzle box to obtain food. Visual stimuli produced by the mechanism may come to control the response of escaping the puzzle box as well as salivation. It is only with repeated experience that chance and nonchance pairings can be distinguished and—more generally—that the classical procedure can be distinguished from the operant procedure. A unified reinforcement principle accommodates the behavioral changes produced by both procedures while also accommodating—even predicting—the occasional emergence of superstitious conditioning in both procedures. Natural selection has produced a conditioning process that is most sensitive to *reliable* relations between the environment and behavior, but the process is not infallible.

Finally, some further comment on the nature of the discrepancy is useful. As noted in the discussion of higher-order and conditioned reinforcement, a stimulus may function as a reinforcer if it engages the neural processes that underlie reinforcement. This is true whether or not those neural processes are accompanied by responses that are detectable at the behavioral scale of measurement. What the experimental analysis of behavior has shown is that the behavior evoked by the reinforcer is more closely linked in time to those neural processes than to the presentation of the reinforcing stimulus; that is, the CS–*UR* temporal relation is more critical than the CS–*US* relation. Considerations of natural selection are consistent with this finding. The *behavior* of the organism is the focus of selection, not the reception of stimuli except as their reception affects behavior. Thomas Huxley, Darwin's stalwart defender, put it this way: "The great end of life is not knowledge, but action." If the behavioral expression of conditioning were not highly correlated with the neural processes that mediate reinforcement, then those processes could not have been naturally selected in the first place. Nevertheless, once those processes have been naturally selected, their behavioral expression is not necessary for the environment to engage them. The neural events that accompany a behavioral discrepancy are the same as those engaged by higher-order and conditioned reinforcing stimuli even though the discrepancy may not be readily detectable at the behavioral level (Schultz, 1997, 2001; see also Donahoe & Palmer, 2005). These neural events must be investigated through the experimental analysis of neuroscience, not behavior. As Skinner recognized: "The … gap between behavior and the variables

of which it is a function can be filled only by neuroscience, and the sooner … the better" (Skinner, 1988, p. 460).

Some Phenomena Associated with the Classical (Respondent) Conditioning Procedure

Thus far, we have been concerned with *acquisition* of environment–behavior relations using the classical procedure and with the process of *reinforcement* that produces acquisition. In this final section, we examine a number of phenomena that accompany the acquisition of CS–CR relations.

Maintenance of Conditioning

The acquisition of conditioning proceeds most rapidly when every presentation of the CS is followed by a reinforcer—whether an unconditioned or conditioned reinforcer. However, once CRs have been acquired, behavior can be maintained at high levels with less frequent reinforcement. The left panel of Figure 2.4 shows the acquisition of CRs in the rabbit NM preparation. During acquisition, every presentation of the CS was followed by the US/UR. The three groups of animals then received different percentages of CS–US/UR pairings. One group continued to receive reinforcers following 100% of CS presentations, and responding was maintained at the same high level as during acquisition. The remaining two groups received a *gradually* reduced percentage of reinforcement. In one group the CS was ultimately followed by the US/UR on 50% of the trials and, in the other group on only 25% of the trials. As shown in the middle panel of Figure 2.4, performance was relatively unchanged even though the percentage of reinforced CSs was reduced to quite low values. When every CS presentation is followed by the US/UR, the procedure is called *continuous* reinforcement; when only some CSs are followed by the reinforcer, it is called *intermittent* reinforcement. In those terms, efficient acquisition of CRs requires continuous reinforcement, but responding can be maintained by the gradual introduction of intermittent reinforcement.

Stimulus Generalization

During acquisition, the stimulus that reliably precedes the reinforcer is the CS. However, the CS is not the only stimulus whose control of the CR is affected by the conditioning process. First, other stimuli that share prop-

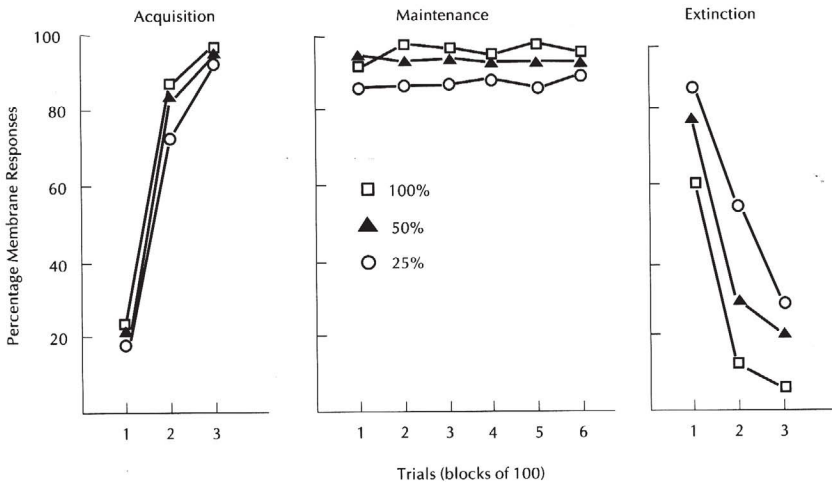


FIGURE 2.4. Acquisition, maintenance, and extinction of a classically conditioned nictitating membrane response in the rabbit. During acquisition, 100% of the CSs were followed by the US. During maintenance, different groups of animals received either 100, 50, or 25% CS–US pairings. During extinction, CS presentations were not followed by the US. From Donahoe and Palmer (1994/2005; based on findings from Gibbs, Latham, & Gormezano, 1978). Copyright 2005 by John W. Donahoe. Reprinted by permission.

erties in common with the CS also come to evoke the CR, although with less strength. For example, if the CS is a tone with a frequency of 1,000 Hertz (Hz), then tones of 800 Hz will likely evoke CRs, although to a lesser degree. Similarly, tones of 600 Hz may also evoke CRs, but to an even lesser degree. Other stimuli acquire the ability to evoke CRs in proportion to their physical similarity to the training CS. This phenomenon, known as *stimulus generalization*, has been documented in many classical procedures with both humans and nonhumans (e.g., Gynther, 1957; Hupka, Liu, & Moore, 1969). The experimental analysis of neuroscience is consistent with the behavioral analysis. Responding to a generalization stimulus occurs to the extent that the generalization stimulus activates the same sensory neurons as the training stimulus (Thompson, 1965). A second source of stimulus generalization arises from whatever other stimuli accompany the CS. These stimuli provide the *stimulus context*. The stimulus context seldom evokes the CR by itself because control by contextual stimuli is blocked by the more reliably present CS. However, the CS together with contextual stimuli furnish the full stimulus compound with which the US/UR is paired, and the context does affect responding (Burns, Burgos, & Donahoe, 2011; Donahoe et al., 1997). Contextual stimuli are sometimes said to function as *occasion-setters* (Grahame, Hallam, & Geier, 1990).

Control by CR-Related Interoceptive Stimuli

As conditioning proceeds, the CR begins to occur during the CS prior to the presentation of the US/UR. Thus, CR-produced stimuli begin to appear before acquisition is complete. As a result, these interoceptive events bear a temporal relation to the behavioral discrepancy that permits them also to control the CR. In an illustrative study, an appetitive US (food) was paired with an aversive stimulus (a moderate electric shock) *after* the CS had been paired with food. (Pairing eliciting stimuli that evoke competing URs is a *counterconditioning* procedure; cf. Richardson & Donahoe, 1967) After food had been paired with shock, when the CS was presented food-related CRs were weakened (Colwill & Rescorla, 1985; Holland & Rescorla, 1975; see also Donahoe & Burgos, 2000). Note that food-related CRs were weakened even though the CS itself had never been paired with shock. This phenomenon is known as *revaluation* in the sense that the "value" of the food US had been lessened by pairing food with shock. The interpretation of this finding is that pairing food with shock changed the interoceptive stimuli that, together with the CS, jointly control the CR, and this change weakened food-related CRs. Clearly, the CR is affected by a complex array of stimuli that includes the effects of stimulus generalization and control by contextual and interoceptive stimuli.

Extinction

After a CS has acquired control of a CR, control may be weakened by presenting the CS but omitting the US. This is an *extinction* procedure. The effect of an extinction procedure on conditioned responding is shown in the right panel of Figure 2.3. The percentage of CS presentations that evoked a CR decreased progressively over the course of extinction. Figure 2.3 also demonstrates another effect: the rate of decrease in responding was slower after intermittent reinforcement than after continuous reinforcement. The responding of animals that received 100% reinforcement throughout training decreased most rapidly, followed successively by animals receiving 50% and 25% reinforcement.

Punishment

Punishment is a term that applies only to the operant procedure. In punishment, the operant response produces a stimulus that *decreases* the strength of the operant. As a laboratory example, lever pressing that is reinforced with food can be punished by the occasional presentation of a moderate electric shock. Food-reinforced lever pressing declines under this procedure, and shock is said to function as a *punisher*. By contrast, conditioning with the classical procedure always produces an increase in responding, that is, an increase in the behavior elicited by the US. Although punishment occurs only in operant procedures, conditioning in the classical procedure is relevant because CRs contribute to punishment. Specifically, CRs and operants are acquired together, and CRs can decrease the operant strength if the operant

and the CR are incompatible (Donahoe & Palmer, 1994/2005). In the preceding example, food conditions lever pressing, whereas shock conditions escape from the lever, as well as autonomic responses (Borgealt, Donahoe, & Weinstein, 1972). Because the organism cannot press the lever while simultaneously escaping from the region with the lever, lever pressing declines. The recovery of lever pressing from punishment depends on the prior extinction of escape responses (Estes & Skinner, 1941).

Certain paradoxical effects of punishment procedures can be understood as the product of interactions between operants and respondents. Monkeys restrained in a chair were first trained to bite a rubber hose for food. This is an operant task, with biting as the operant and food as the reinforcer. The procedure was then changed such that biting the hose, in addition to producing food, occasionally produced an electric shock to the tail. Electric shock applied to the tail of a monkey is a stimulus that elicits biting the hose. Biting is a component of aggressive behavior that is often elicited by aversive stimuli. Instead of reducing the rate of biting the lever, the addition of shock increased the rate of biting, particularly at the times when shock was most likely to be presented. In fact, in many cases, food could be eliminated altogether, and the monkey would continue to bite the hose, the only consequence of which was now the occasional delivery of shock (Branch & Dworkin, 1981; Morse & Kelleher, 1977). This "masochistic" behavior is understandable, at least in part, as a case in which the operant that produced food and the respondent evoked by shock were similar—biting.

Some Implications of Classical Conditioning for Applied Behavior Analysis

Most human behavior of interest comes under environmental control as a result of operant, not respondent, procedures—that is, response–reinforcer, not stimulus–reinforcer, contingencies. Similarly, many techniques used to modify dysfunctional behavior employ operant rather than respondent procedures. Nevertheless, an understanding of the conditioning process as revealed by the classical procedure is important for two principal reasons. First, operant contingencies necessarily include stimulus–reinforcer contingencies: Some environmental stimulus always precedes the reinforcing stimulus (or US; see Figure 2.1). Thus, reinforcer-related responses (CRs) are inevitably acquired in operant procedures. Second, current accounts of operant and classical procedures indicate that both procedures engage the same fundamental conditioning process: whatever stimuli precede the behavioral discrepancy acquire control over whatever responses precede and accompany the discrepancy. In the classical procedure, these stimuli are the CS (and whatever other stimuli accompany the CS) and the behavior is the CR (components of the UR). In the operant procedure, the stimuli are those that precede the discrepancy (discriminative stimuli in discriminated operant procedures), and the behavior is the operant in addition to the UR. The remainder of the chapter indicates some general implications for applied behavior analysis (ABA) that arise from research using the classical procedure.

What Stimuli Control Behavior in the Natural Environment?

The stimuli that control behavior are those that reliably occur in the natural environment prior to the reinforcer. The stimuli controlling behavior in the natural environment are those that reliably occurred before reinforcers in the past. The history of reinforcement cannot be fully known, of course, but the controlling stimuli may be identified by noting the situations in which the behavior now occurs. If the behavioral changes produced by a therapeutic environment are to persist, three guidelines are useful:

1. *To the extent possible, the remedial environment should include stimuli that control the target behavior in the natural environment.* In this way, stimulus generalization from the remedial to the natural environment is maximized (Stokes & Baer, 1977). To determine the controlling stimuli, the conditions in the natural environment that precede the dysfunctional behavior should be identified.

2. If the behavior conditioned in the remedial environment is controlled by stimuli that do not occur in the natural environment, then *stimuli from the remedial environment must be introduced into the natural environ-*

ment. This applies whether the intervention seeks to establish appropriate behavior or behavior that competes with dysfunctional behavior. The result of conditioning is always a change in the environmental guidance of behavior. Reinforcers do not select responses; they select environment–behavior relations (Donahoe et al., 1997).

3. *The contingencies of reinforcement that maintained the dysfunctional behavior in the natural environment should be supplemented or replaced by alternative contingencies that maintain the behavior reinforced in the remedial environment.* To identify the reinforcement contingencies that maintain dysfunctional behavior, the conditions in the natural environment that follow the dysfunctional behavior should be determined. Reinforcers of dysfunctional environment–behavior relations must either be removed or competing behavior must be established that minimizes contact with these reinforcers. No behavioral intervention can "inoculate" the person against the effect of continuing encounters with adverse reinforcement contingencies in the natural environment.

Stimuli from the remedial environment that have acquired control over alternative behavior can be introduced into the natural environment in several general ways. First, these stimuli may be explicitly added to the natural environment. As a simplistic example, to control profligate spending a red card might be paired with an aversive stimulus (US) in the remedial environment. The card could then placed in the person's wallet so that, in the natural environment, the card would be seen before the money is accessible. Second, verbal responses may be conditioned to stimuli present in the natural environment, and these responses may in turn generate verbal stimuli that control alternative behavior. Continuing with the example of profligate spending, every time the person opens his wallet, he might be reinforced in the remedial environment for asking, "Do I really need to buy this?"

Verbal stimuli are potentially among the most effective stimuli to control behavior in the natural environment because the verbal responses that produce them are not dependent on external support in the same way as nonverbal responses. Verbal responses, and the stimuli they produce, are potentially within the behavioral repertoire of the organism in any environment—unlike seeing the red card, which is dependent on its prior placement in the wallet. A second advantage of verbal stimuli is that they can be produced by subvocal verbal behavior, and subvocal behavior cannot be subjected to contingencies of reinforcement by others. Others can ask why the red card is in the wallet because they too can see the red card. But others cannot ask why a particular "thought" occurred (a subvocal verbal response). Subvocal behavior is private behavior—that is, behavior whose stimulus properties are detectable only by the person emitting it (Donahoe & Palmer, 1994/2005; Skinner, 1957). If verbal responses—whether vocal or subvocal—are to be maintained, however, they too must be followed by reinforcers. Private behavior, sometimes called "cognitive behavior," is not immune to the conditioning processes that affect all behavior.

What Responses Are Maintained by the Natural Environment?

As we have seen, behavior is maintained in an environment to the extent that the environment contains stimuli in whose presence the behavior is reinforced. In the absence of reinforcement, an extinction procedure is implemented and responding decreases even when the training and testing environments are identical. Intermittent reinforcement during conditioning increases resistance to the effects of extinction, but responding will not continue indefinitely. Thus, the natural environment must contain reinforcers for the behavior established in the remedial environment. If dysfunctional environment–behavior relations continue to be reinforced in the natural environment, then—even if the long-term effects of the behavior are maladaptive—the dysfunctional behavior will recur and be maintained by these more immediate reinforcers. Behavior that has undergone extinction in the remedial environment will reappear in the natural environment if the remedial environment does not contain all of the stimuli that control dysfunctional behavior in the natural environment. These stimuli foster the resurgence of the maladaptive behavior where it may again be reinforced (Epstein & Skinner, 1980). The recurrence of behavior after extinction is called *spontaneous recovery* (Estes, 1955;

Skinner, 1938). The remedial environment cannot "inoculate" behavior against the effects of reinforcers for dysfunctional behavior.

Addiction provides a particularly striking example of the recurrence of dysfunctional behavior. Research with the classical procedure has shown that CRs evoked early in the conditioning process give rise to stimuli that come to control the CR jointly with the CS. The phenomenon of revaluation documents the existence of control by CR-related stimuli. In the treatment of addiction, "physical dependence" may be eliminated by withholding the substance in the remedial environment. However, to the extent that the remedial environment differs from the natural environment in which the addiction was acquired, drug-related CRs will recur when the person is returned to the natural environment. Moreover, drug-related operant behavior will also recur to the extent that it is controlled by interoceptive stimuli from drug-related CRs. To reduce resurgence of drug-related CRs and the untoward effects of the stimuli they produce, the remedial environment must gradually introduce stimuli that are CSs for these CRs—possibly including even drug paraphernalia—and withholding reinforcement in their presence.

Environment–behavior relations that are selected in the remedial environment will endure if the reinforcers that previously maintained dysfunctional behavior are no longer encountered and newly established immediate reinforcers are available for effective behavior. Eliminating previously encountered reinforcers requires changing the natural environment—often a daunting task—or establishing behavior in the remedial environment that reduces contact with those reinforcers. For someone with an alcohol addiction, a simplistic example of the latter would be taking a route that does not pass by the local pub and being greeted by an adoring partner upon arrival at home. Important sources of immediate reinforcement for behavior that has been established in a remedial environment are the stimuli that are produced by such behavior. For example, behavior such as fluently reading or facilely writing a passage produces stimuli that are discriminated as characteristic of "a job well done." The stimuli produced by such behavior have previously occurred in the remedial environment and have been the occasion for praise (a reinforcer) from a teacher. Because they have been paired with praise, these stimuli have become CSs and can function as conditioned reinforcers (Catania, 1975). However, to maintain their status as conditioned reinforcers, these stimuli must continue to be paired with reinforcers. Being literate may enhance one's ability to get a job, but the environment must provide jobs if the stimuli produced by literate behavior are to endure as conditioned reinforcers. Environment–behavior relations track the momentary contingencies of reinforcement, not remote consequences. In the long run, remedial interventions are no more effective than the contingencies encountered in the natural environment. To be otherwise would contradict all that is known from the experimental analysis of respondent and operant procedures—an effort begun by Pavlov and Thorndike over 100 years ago.

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CHAPTER 3

Basic Operant Contingencies

Main Effects and Side Effects

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Handbooks are often consulted as resources for information about specific topics, so this chapter is organized as a set of somewhat independent sections. It opens with a discussion of operant contingencies, then considers some aspects of the basic contingencies known as reinforcement and punishment and their positive and negative variants, and closes with some implications of these contingencies and brief surveys of a few related issues. For more detailed treatments see Skinner (1938, 1953, 1999), Iversen and Lattal (cf. 1991a, 1991b), Catania (2006), various volumes of the *Journal of the Experimental Analysis of Behavior* and *The Behavior Analyst*, and two special issues of the *European Journal of Behavior Analysis*, one devoted to contingencies (Arntzen, Brekstad, & Holth, 2006) and the other devoted to noncontingent reinforcement (Arntzen, Brekstad, & Holth, 2004).

Response–Consequence Contingencies

Contingencies relating responses to their consequences are properties of environments. They are probability relations among events. When a response changes the probability of some event, we say that the change is contingent on the response; when the change is from a relatively low probability to a probability of 1.0, we usually say that the response has produced the event. An organism is said to *come into contact with a contingency* when its behavior produces some consequences of the contingency. Unless otherwise stated, for convenience the term *contingency* here implies a response–consequence contingency rather than contingencies more broadly conceived (e.g., stimulus–stimulus contingencies).

When responses produce stimuli, the contingent relation is defined by two conditional probabilities: probability of the stimulus (1) given a response and (2) given no response. Without both probabilities specified, the contingent relations cannot be distinguished from incidental temporal *contiguities* of responses and stimuli that are occurring independently over time.

Response–reinforcer relations involve two terms (the *response* and the *reinforcer*), but when correlated with *discriminative* stimuli (stimuli that set the occasion on which responses have consequences), they produce a *three-term contingency*, which involves antecedents, behavior, and consequences. For

example, a child's touch of a card might be reinforced with an edible if the card is green, but not if it is any other color. In this case, green, as the discriminative stimulus, is the first term; the touch, as the response, is the second term; and the edible, as the reinforcer, is the third term. Antecedents may include establishing conditions as well as discriminative stimuli. For example, the edible might not serve as a reinforcer if the child has very recently eaten.

Conditional discriminations add a fourth term, a fifth, and so on, for other contingency relations of various orders of complexity. For example, if a child is presented with green or red balls or blocks, then the appropriate color name might be reinforced given the question "What color?", whereas the appropriate shape name might be reinforced given the question "What shape?" In this example, the questions are the fourth terms that set the occasion for whether the operative three-term contingency is the one involving color, color name, and reinforcer or that involving shape, shape name, and reinforcer.

When a response for which a contingency operates produces a stimulus, the stimulus is sometimes called a *contingent* stimulus. The term *consequence* may refer to such a stimulus, but stimuli are not the only kinds of consequences. The term encompasses stimulus presentations or removals, changes in contingencies, or any other environmental alterations that follow a response. For example, food produced by a response is both a stimulus and a consequence, but food presented independently of behavior is a stimulus only; shock prevented by a response is a stimulus, but the consequence of the response is the absence of shock, which is not a stimulus; replacing a defective light switch does not turn on the light, but it changes the consequences of operating the switch. The term *consequence* is particularly useful when the status of a stimulus as a possible reinforcer or punisher is unknown. Contingencies can also be arranged based on context, as when responses are reinforced based on their variability (e.g., Neuringer, 2004) or as when, in learned helplessness, organisms exposed to environments in which their responses lack consequences become insensitive to new contingencies (e.g., Maier, Albin, & Testa, 1973).

Contingencies, Establishing Events, and Multiple Causation

An *establishing* or *motivational event* is any environmental circumstance that changes the effectiveness of a stimulus as a reinforcer or punisher. Here are some examples: deprivation; satiation; procedures that establish formerly neutral stimuli as conditional reinforcers or as conditional aversive stimuli; and stimulus presentations that change the reinforcing or punishing status of other stimuli, as when an already available screwdriver becomes a reinforcer in the presence of a screw that needs tightening (Michael, 1982).

A *conditional* or *conditioned reinforcer* is a stimulus that functions as a reinforcer because of its contingent relation to another reinforcer. If a conditional reinforcer is based on several different primary reinforcers, then it will be more effective than one based on a relation only to a single primary reinforcer. Such a reinforcer is called a *generalized reinforcer*. For example, the sound of a clicker may serve as a generalized reinforcer of the behavior of a pet if it has been often followed by food, opportunities for play, and other significant consequences.

With regard to establishing events, whether one is in the light or in the dark, a flashlight usually lights when one turns it on, but turning it on usually matters only when it is dark. Thus, a change from indoor lighting to the darkness of a power outage is an establishing event with regard to whether one is likely to turn on the flashlight. It is not a discriminative stimulus because one could have turned the flashlight on even had there been no power outage.

The consequences change, however, if one's flashlight battery has died. The flashlight no longer works. Thus, the dying of the battery is not an establishing event but instead determines whether trying to turn on the flashlight will be reinforced by light. Now finding a fresh battery is important. Once one finds a battery to replace the dead battery, one's flashlight becomes functional again. In other words, the battery going dead had two effects: It had not only a consequential effect because it changed what happened when one tried to turn on the flashlight, but it also had an establishing effect because it made finding a fresh battery important.

Any particular instance of behavior has multiple causes, though some may be more important than others. In behavior analysis we examine the multiple causes of behavior one at a time and assess their relative contributions. Multiple causation operates in the flashlight example because establishing events ordinarily go together with consequential effects, but it is important to be clear about which behavior is related to each. In these examples, turning on the flashlight was behavior with consequences, but the lighting conditions established whether it was important to turn the flashlight on; similarly, when the battery went dead, replacing the battery was behavior with consequences, but the failure of the flashlight to work established whether it was important to change the battery (cf. Michael, 1989).

Distinguishing between Causal Antecedents and Causal Contingencies

Some stimuli have their effects as antecedents of behavior, and other stimuli as its consequences, and sometimes stimuli can serve both roles simultaneously. In chaining, for example, the stimulus produced by a response early in a sequence both reinforces that response and sets the occasion for the next one, as when the opening of a door both reinforces the turn of the doorknob and allows the behavior of stepping through to the next room. Stimuli that reinforce or punish some responses can also elicit or occasion others, so choices among such consequences in reinforcement applications must take into account both the main reinforcing or punishing effects and their eliciting or occasioning side effects.

It may be necessary to determine whether behavior is maintained by its consequences or is produced more directly by stimuli. Imprinting provides a case in point. A newly hatched duckling ordinarily follows the first moving thing it sees; this imprinted stimulus is usually its mother. The duckling's following is sometimes said to be elicited by the imprinted stimulus, but to speak of elicitation is misleading. A natural consequence of walking is changing the duckling's distance from its mother. If closeness is important and requires behavior other than walking, that other behavior should replace the walking.

When a dark compartment containing a moving imprinted stimulus was on one side of a one-way window and a response was available on the other side that lit up the dark side so the duckling could see it, behavior incompatible with following, such as pecking a stationary disk on the wall or standing still on a platform, was readily shaped (Peterson, 1960). In imprinting, therefore, presentations of the to-be-imprinted stimulus are establishing events, not eliciting stimuli. Imprinted stimuli, which acquire their significance by being presented under appropriate circumstances, begin as stimuli toward which the duckling is relatively indifferent but end as ones that function as reinforcers. Imprinted stimuli do not elicit following; rather they become important enough that they can reinforce a variety of responses, including following, pecking, and standing still. The point should have been obvious to early researchers on imprinting. In natural environments, swimming replaces walking when the duckling follows its mother into a body of water. If walking had been mere elicited behavior, it should not have done so.

Analogous relations can have profound implications in clinical settings. For example, interpreting a hospitalized child's problem behavior as elicited behavior when it has its source in reinforcement contingencies might prevent appropriate treatment options from being considered. But misdiagnosis can go either way. For example, if such behavior has its source in eliciting stimuli, perhaps for neurological reasons, interpreting it as shaped by reinforcement contingencies could similarly lead to ineffective treatment. And it can get even more difficult. In multiple causation, eliciting stimuli and reinforcement contingencies may operate at the same time, so identifying the role of one should not rule out assessments of the other.

Reinforcement

A reinforcer is a type of stimulus but reinforcement is neither stimulus nor response. The term *reinforcement* names a relation between behavior and environment. The relation includes at least three components: (1) Responses must have consequences; (2) their probability must increase (i.e., they must become more probable than when not having

those consequences); (3) the increase must occur *because* they have those consequences and not for some other reason. For example, if we knew only that responding increased, we could not say that the response must have been reinforced; maybe it was elicited. It would not even be enough to know that the response was now producing some stimulus it had not been producing before. We would still have to know whether responding increased *because* the stimulus was its consequence.

Assume that an abusive parent gets annoyed whenever an infant cries and tries to suppress the crying by hitting the child. The infant cries and then gets hit, which produces even more crying. Here the consequence of crying is getting hit, and getting hit produces more crying, but we cannot argue that the hitting reinforced the crying. Two criteria for reinforcement are satisfied but not the third. Stimuli may have other effects along with or instead of their effects as consequences of responding. Crying did not increase here because getting hit was a consequence; getting hit brought on crying even if the infant was not crying at the outset. Probably the infant will eventually learn to suppress the crying. At that point we will know that the crying was punished rather than reinforced.

Specificity of Reinforcers

By definition, reinforcement always increases responding relative to what it would have been like without reinforcement. Also by definition, that increase must be specific to the response that produces the consequence. For example, if a rat's lever presses produce shock and only the rat's jumping increases, it would be inappropriate to speak of either pressing or jumping as reinforced.

As an operation, reinforcement is presenting a reinforcer when a response occurs; it is carried out on responses, so we speak of reinforcing responses rather than of reinforcing organisms. We say that a pigeon's key peck was reinforced with food, but not that food reinforced the pigeon or that the pigeon was reinforced for pecking. The main reason for this restriction is that it is too easy to be ambiguous by omitting the response or the reinforcer, or both, when we speak of reinforcing organisms. The restriction forces us to be explicit about what is reinforced by what. For example, if we have been told only that a child has been reinforced, we do not know much about actual contingencies. Although this grammatical restriction forces us to be explicit about which response has been reinforced, it does not prevent us from mentioning the organism whose behavior had consequences.

Function and Topography of Reinforced Responses

Reinforcement creates response classes defined by their functions and not by their forms or topographies. Common contingencies select the members of operant classes, and they do so even if the relations among members are arbitrary. A lever press is a lever press whether the rat presses with right paw, left paw, chin, or rump.

The distinction between function and topography is particularly crucial when it enters into diagnostic categories. The self-injurious behavior of two children may be similar in topography, but if one child's behavior is reinforced socially by attention and the other's is reinforced by avoidance of compliance with simple requests, effective treatment programs designed for the two children will have to be radically different (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990). The first child must be taught more effective ways of engaging the attention of others and must be brought into situations where attention is more readily available. Requests must be selected for the second child that are appropriate to the child's competence, and the child's compliance with those requests must be reinforced (perhaps in the past such behavior has instead been punished). What behavior does is more important than what it looks like.

Assessing Reinforcers

Events that are effective as reinforcers are often described in terms of positive feelings or strong preferences. Such descriptions are subject to the inconsistent practices of verbal communities, so we must be wary of using them to predict whether particular events will serve as reinforcers. It is tempting to equate reinforcers with events colloquially called rewards. But reinforcers do not work because they make the organism "feel good," or because the organism "likes"

them. Our everyday language does not capture what is important about reinforcers. For example, staff predictions of the reinforcers that might be effective in managing the behavior of people with profound handicaps were inconsistent with reinforcers identified by systematically assessing each individual's nonverbal preferences among those events (Fisher et al., 1992; Green et al., 1988).

We sometimes make good guesses about what will be effective reinforcers because reinforcers often involve events of obvious biological significance. But reinforcers are not limited to such events. For example, sensory stimuli, such as flashing lights, can powerfully reinforce the behavior of children along the autism spectrum (Ferrari & Harris, 1981). Restraint also seems an unlikely reinforcer, but in an analysis of self-injurious behavior, restraints that prevented children with severe developmental disabilities from poking or biting themselves were effective in reinforcing arbitrary responses, such as putting marbles in a box (Favell, McGimsey, & Jones, 1978).

In the final analysis, the primary criterion for reinforcement remains whether the consequences of behavior have raised the likelihood of that behavior. Reinforcers are defined by their behavioral effects even though they may sometimes be correlated with other properties, such as reported feelings or preferences.

Delay of Reinforcement

The effects of a reinforcer depend on other responses that preceded it besides the one, usually most recent, that produced it. Thus, when one response is followed by a different reinforced response, the reinforcer may strengthen both. Clinicians and teachers need to take this effect into account because it is important to recognize that reinforcing a single correct response after a long string of errors may strengthen errors along with the correct response.

Assume that a task involves a child's correct responses and errors over trials. Reinforcing every correct response and repeating any trial with an error until the child gets it right guarantees that any sequence of errors will eventually be followed by a reinforced correct response. Correct responses will probably dominate eventually because the reinforcer most closely follows them. But errors may diminish only slowly and perhaps even continue indefinitely at a modest level, though they never actually produce the reinforcer, because they are reliably followed after a delay by a reinforced correct response. Thus, always reinforcing a single correct response after a sequence of errors will probably maintain errors.

Teachers and clinicians must be alert for situations in which they may be strengthening incorrect responses along with correct ones that they reinforce. A reinforcer that follows a sequence of correct responses will probably do a lot more good than a reinforcer that follows a single correct response after several errors. Thus, teachers must judge whether correct responses are so infrequent that they should be reinforced even though they are preceded by errors, or so frequent that the reinforcer can wait until the student has made several correct responses in a row. One other way to reduce the strengthening of errors is to extend the time to the next trial after every error.

Many practical applications of reinforcement include other behavior that precedes the behavior we target for reinforcement. When such behavior shares in the effect of the reinforcer, we may mistakenly conclude that the reinforcer is not doing its job very well. But if the reinforced behavior includes response classes that we did not intend to reinforce, it may simply be doing very well a job other than the one we wanted it to do. When one response is followed by a different reinforced response, the reinforcer may strengthen both, so we should keep behavior that we do not want to reinforce from getting consistently close to reinforcers produced by other responses.

Relativity of Reinforcement

Reinforcement is relative in the sense that it depends on relations between the reinforced response and the reinforcer. A less probable response may be reinforced by an opportunity to engage in a more probable response. The inverse relation does not hold. For example, food is not always a reinforcer. When a parent allows a child to go out and play with friends only after the child has eaten, the opportunity to play may reinforce the eating.

The reversibility of the reinforcement relation has been amply demonstrated (Premack, 1962). For example, levels of food and water deprivation can be selected so that drinking is reinforced by an opportunity to eat at one time, and eating is reinforced by an opportunity to drink at another. In providing an a priori means for predicting whether an opportunity to engage in one response will reinforce some other response, the relativity of reinforcement also avoids the problems of circular definition inherent in some earlier definitions of reinforcement.

The significance of reinforcers is based on the opportunities for behavior that they allow. For example, when time spent in isolation was used in an attempt to punish the tantrums of a 6-year-old girl with autism, her tantrums increased substantially instead of decreasing. This child often engaged in self-stimulation, such as waving her fingers over her eyes to create visual flicker, but that behavior was frequently interrupted by the staff. Time in the isolation room reinforced rather than punished her tantrums because the isolation room allowed her to engage in self-stimulation without interruption (Solnick, Rincover, & Peterson, 1977).

The relativity of reinforcement reminds us that we should not expect the effectiveness of reinforcers to be constant across different reinforced responses, different individuals, or even different time samples of the behavior of a single individual. When a reinforcer is effective on some behavior in some context, we must not assume that it will be effective on other behavior or even on the same behavior in other contexts.

Reinforcement and Extinction

The effects of reinforcers are not permanent. Reinforcers have temporary effects; when reinforcement stops, responding returns to its earlier, lower levels. The decrease in responding during extinction does not require a separate treatment; rather, it is simply one property of reinforcement.

If the effects of reinforcement are temporary, then once we have created new behavior with reinforcers we cannot count on its maintenance after our intervention ends. Consider children learning to read. Only long after they have learned to name letters of the alphabet and to read whole words are they perhaps ready to read stories, so that reading can become "its own reward." Until that happens, teachers have no choice but to arrange artificial contingencies, using extrinsic consequences such as praise to shape the components of reading. Responsible teaching adds extrinsic reinforcers only when there are no effective intrinsic consequences. If we want to maintain behavior after we terminate artificial consequences, we should do so only if natural consequences are in place that will take over that maintenance.

Side Effects of Reinforcement and Extinction

Discontinuing reinforcement in extinction has two components: (1) It terminates a contingency between responses and reinforcers, and (2) reinforcers are no longer delivered. Because of the former, the previously reinforced responding decreases. Because of the latter, unwelcome side effects of extinction may appear. For example, aggressive responding is sometimes a major side effect of extinction (e.g., Lerman, Iwata, & Wallace, 1999). If food is suddenly taken away from a food-deprived rat that has been eating, the rat may become more active and perhaps urinate or defecate. If the food was produced by lever presses, the rat may bite the lever. If other organisms are in the chamber, the rat may attack them (Azrin, Hutchinson, & Hake, 1966). These effects and others, though observed in extinction, are not produced by the termination of the reinforcement contingency because they also occur upon the termination of response-independent food deliveries, where there had been no reinforcement contingency. In either case, a rat that had been eating stops getting food. The termination of a reinforcement contingency in extinction necessarily entails the termination of reinforcer deliveries, and the effects of the latter are necessarily superimposed on the decrease in previously reinforced responding.

Even if reinforcers have produced problem behavior, taking them away may still produce undesired side effects. That is why extinction is not the method of choice for getting rid of behavior that has been created by reinforcement. Suppose a developmentally delayed boy engages in severe self-injurious behavior such as head banging or eye poking, and we discover that his behavior is in

large part maintained by staff attention as a reinforcer. Because of the harm he might do to himself if the self-injurious behavior is ignored, extinction may be ill advised. Giving him attention independently of the self-injurious behavior is one possibility (noncontingent reinforcement, sometimes also called free reinforcement) (Catania, 2005; Lattal, 1974; Sizemore & Lattal, 1977); another is to use attention to reinforce alternative responses, and especially ones incompatible with the self-injury. The self-injury will decrease as alternative responses increase.

These side effects are one reason why extinction has fallen out of favor in applied settings compared to procedures such as noncontingent reinforcement. The *Journal of Applied Behavior Analysis* has relatively few examples of extinction with humans. In general, the solution is not to take the reinforcers away. The better way to reduce misbehavior is to reinforce good behavior, but sometimes we inadvertently encourage the use of extinction, the less effective alternative, especially when we present just a few basic facts about behavior, as in the introductory psychology course. Generations of students seem to have taken from cursory accounts of behavioral methods in introductory textbooks the message that if one sees a child doing something one does not approve of, then one should not reinforce that behavior. Instead, one should just ignore it. Left unanswered are the inevitable subsequent questions, such as how parents should handle things when other problematic behavior maintained by the same reinforcer emerges. Rather than teaching parents to ignore the behavior of their children, we should teach them how to use reinforcers more productively, but that alternative is more difficult. Free noncontingent reinforcement coupled with the shaping of other behavior should be recommended to parents or other caregivers, but doing so poses problems of both communication and implementation (Hagopian, Crockett, van Stone, DeLeon, & Bowman, 2000).

Why has extinction for so long remained the primary way to study the effects of terminating contingencies? One concern is that accidental contiguities of responses and noncontingent reinforcers may have effects similar to those of the contiguities that are scheduled when reinforcers are contingent on responding. If noncontingent and contingent reinforcers have similar effects on behavior early in the transition to noncontingent reinforcement, then responding may decrease more slowly than in extinction. But such effects are usually transient, so this is not a big enough concern to rule noncontingent reinforcement out of consideration in either experimental or applied settings. If higher or lower rates of noncontingent reinforcement are available as options, this concern favors the lower rates. If behavior persists for long periods of time under such arrangements, it is more appropriate to look for other sources of the behavior than to attribute it to adventitious correlations of responses and reinforcers.

Positive Reinforcement and Positive Psychology

Positive reinforcement can be used to change a developmentally delayed child who engages extensively in self-injurious behavior into one who has learned communicative skills and has therefore been empowered to deal in more constructive ways with his or her caregivers. If reinforcers were implicated in the development and maintenance of the self-injurious behavior, then taking them away is not the solution. Reinforcement isn't everything, but extinction isn't anything. If the reinforcers are already there, they should not be wasted; they should instead be used constructively. We all shape each other's behavior, and the more we know about how positive reinforcement works, the more likely that we will use it productively and avoid pitfalls such as the coercive practices that can occur if the control over reinforcers remains one-sided. For these reasons, it might be thought that positive reinforcement would be especially important to the practitioners of an approach called *positive psychology*. Unfortunately, they eschew it, along with the establishing events that make it effective; their rhetoric implies that contingent acts of kindness should always be replaced by random ones (cf. Catania, 2001; Seligman & Csikszentmihalyi, 2000, 2001).

Self-Reinforcement as Misnomer

An organism's delivery of a reinforcer to itself based on its own behavior has been called *self-reinforcement*, but any effect such

an activity might have cannot be attributed to the action of the specific reinforcers delivered by the organism to itself. In so-called self-reinforcement, the contingencies and establishing events modifying the behavior purportedly to be reinforced cannot be separated from those that modify the behavior of self-reinforcing. For example, a student who has made a commitment to watch television only after completing a study assignment might think this arrangement will reinforce studying. But any increase in studying that follows cannot be attributed to the student's contingent watching of television: The student made the commitment to deal with studying this way because studying had already become important for other reasons. Whatever brought the student to commit to "self-reinforce" studying in the first place probably by itself made studying more likely. It is impossible to pull these variables apart.

What was once called *self-reinforcement* is now more properly called *self-regulation* (Bandura, 1976, 1995; Catania, 1975, 1995; Mahoney & Bandura, 1972). To the extent that the activity has effects, it must do so because the individual who appears to "self-reinforce" can discriminate behavior that qualifies for the reinforcer from behavior that does not.

This usage also finesses the problem that the language of self-reinforcement implies reinforcement of the organism rather than reinforcement of behavior. For example, the commitment to reinforce one's own studying involves setting standards for the discrimination between adequate and inadequate studying, so students who try to deal with their study habits in this way are discriminating properties of their own behavior that have become important to them. The contingencies that generate these discriminations are complex and probably involve verbal behavior. The language of self-reinforcement obscures rather than clarifies these phenomena.

Punishment

Paralleling the vocabulary of reinforcement, a punisher is a type of stimulus, but punishment is neither stimulus nor response. The term *punishment* names a relation between behavior and environment. The relation includes at least three components. First, responses must have consequences. Second, their probability must decrease (i.e., they must become less probable than when not having those consequences). Third, the decrease must occur *because* they have those consequences and not for some other reason. For example, if we knew only that responding decreased, we could not say that it must have been punished; maybe it was previously reinforced responding that had since been extinguished. It would not even be enough to know that the response was now producing some stimulus it had not produced before. We would still have to know whether responding decreased *because* that stimulus was its consequence.

As defined, punishment is the inverse of reinforcement; it is defined by decreases in consequential responding, whereas reinforcement is defined by increases. The vocabulary of punishment parallels that of reinforcement in its object: Responses, not organisms, are said to be punished. If a rat's lever pressing produces shock and lever pressing decreases, it is appropriate to say that the rat was shocked and that the lever press was punished; it goes against colloquial usage, but it is not appropriate to say that the rat was punished. As with reinforcement, this grammatical distinction discourages ambiguities in the observation and description of behavior.

Parameters of Punishment

As with reinforcement, the effectiveness of punishment varies with parameters such as magnitude and delay (Azrin & Holz, 1966). For example, the more intense and immediate the punisher, the more effectively it reduces behavior. A punisher introduced at maximum intensity reduces responding more effectively than one introduced at low intensity and gradually increased to maximum intensity. The effectiveness of the punisher may change over time, such as when a punisher of low intensity gradually becomes ineffective after many presentations. As with extinction, it is easier to reduce the likelihood of a response when some other response that produces the same reinforcer is available than when no alternative responses produce that reinforcer. And, in a parametric relation especially relevant to human applications, punishers delivered after short delays

are more effective than those delivered after long ones; with either pets or children, aversive consequences delivered at some point long after unwanted behavior are not likely to be very effective. If verbal specification of the behavior on which the punisher was contingent matters at all, it can do so only given an extensive and sophisticated verbal history on the part of the individual at the receiving end (Skinner, 1957).

A reduction in responding can be studied only if some responding already exists. A response that is never emitted cannot be punished. Experiments on punishment therefore usually superimpose punishment on reinforced responding. But the effects of punishment then also depend on what maintains responding. For example, punishment by shock probably will reduce food-reinforced lever pressing less if a rat is severely food-deprived than if it is only mildly fooddeprived.

Recovery from Punishment

There are ethical constraints on using punishment to change behavior, but punishment cannot be eliminated from natural environments (Perone, 2003). Without punishment, a child who had been burned upon touching a hot stove or bitten upon approaching an unfamiliar barking dog would remain undeterred from doing so again later on. Artificial punishment contingencies, however, are also constrained by practical considerations. Like reinforcement, the effects of punishment are ordinarily temporary; responding usually recovers to earlier levels after punishment is discontinued. That means that just as reinforcement procedures must plan for what will maintain the behavior when reinforcement ends, punishment procedures must plan for environments in which the relevant contingencies may be absent. It may do little long-term good to eliminate a child's self-injurious behavior with punishment in a hospital setting if the punishment contingency does not exist when the child returns home. The reinforcement of alternative behavior might be easier to maintain.

Relativity of Punishment

The effectiveness of punishers, like that of reinforcers, is determined by the relative probabilities of the punished response and the responses occasioned by the punisher; punishment occurs when a more probable response forces the organism to engage in a less probable response. Even stimuli that ordinarily serve as reinforcers can become punishers under appropriate conditions. For example, food that is reinforcing at the beginning of a holiday feast may become aversive by the time the meal has ended. On the other hand, events that superficially seem aversive, such as falling from a height, may be reinforcing under some circumstances (consider skydiving). Like reinforcers, punishers cannot be defined in absolute terms or in terms of common physical properties. Rather, they must be assessed in terms of the relation between punished responses and the responses occasioned by the punisher.

Any given state of affairs may be reinforcing or aversive depending on its context. Suppose a rat receives shocks during a tone, but during a buzzer nothing happens. If chain pulls turn off the tone and turn on the buzzer, the onset of the buzzer will reinforce chain pulls; by pulling the chain, the rat escapes from the tone and its accompanying shock deliveries. Suppose, however, that the rat instead receives food during the tone, but during the buzzer nothing happens. Now if chain pulls turn off the tone and turn on the buzzer, the onset of the buzzer will punish chain pulls; by pulling the chain, the rat produces a time-out from the tone and its accompanying food deliveries. In other words, the buzzer serves as reinforcer or as punisher depending on its context, even though nothing happens during the buzzer in either context. Similarly, as gauged by absenteeism, whether a school environment is punishing or reinforcing may depend on the conditions that prevail at home; for example, as when going to school is punished for one child because it means having to deal with an abusive school bully, but is reinforced for another because it is a convenient way to escape from an even more abusive parent.

Side Effects of Punishment: Eliciting and Discriminative Effects

Aversive stimuli are likely to have other effects besides those that depend on the punishment contingency (e.g., Azrin, Hutchinson, & McLaughlin, 1965). As with reinforce-

ment, punishment necessarily includes both stimulus presentations and a contingency between responses and stimuli, so the effects of the stimulus presentations must be distinguished from those of the contingency. If an organism is shocked or pinched, some of its responses to those stimuli may have little to do with whether they were brought on by the organism's own behavior. To qualify as punishment, the reduction in responding must depend on the contingent relation between responses and punishers, and not simply on the delivery of punishers.

A comparison of the effects of response-produced and response-independent shock on food-reinforced lever pressing in rats (Camp, Raymond, & Church, 1967) showed that both procedures reduced lever pressing relative to noshock conditions, but response-produced shock had substantially larger effects than response-independent shock. Given that both response-produced and response-independent shocks reduced responding, it would not have been possible to assess the effect of the punishment contingency without the comparison. The difference made it appropriate to call the response-produced shock a punisher. For example, had response-produced shock instead produced only the same reduction as response-independent shock, the appropriate conclusion would have been that the reduction depended wholly on the eliciting effects of shock, and that the punishment contingency was irrelevant. Just as we must distinguish between effects of reinforcer deliveries and effects of the contingent relation between responses and reinforcers, so also we must distinguish between effects of punisher deliveries and effects of the contingent relation between responses and punishers.

Punishers can also acquire discriminative properties, as when a response is reinforced only when it is also punished. For example, one experiment alternated a condition in which a pigeon's key pecks had no consequences with another in which every peck produced shock and some produced food reinforcers (Holz & Azrin, 1961). A low rate of pecking was maintained when pecks produced no shock because then they never produced food either; pecking increased once pecks began to produce shock, however, because only then did they occasionally produce food.

We can ask whether these shocks should really be called punishers. In fact here we must conclude that the shock has become a conditional reinforcer. The main difference between the shock and other, more familiar reinforcers is that it acquired its power to reinforce through its relation to food; were that relation discontinued, it would lose that power. As an example of a possible source of masochism, these procedures may be relevant to human behavior. For example, a battered child might provoke a parent to the point of a beating because the beatings are often followed by more attention from the then-remorseful parent than ever follows less traumatic parent–child interactions. A parent's attention can be a potent reinforcer and may sometimes override the effects of consequences that would otherwise serve as punishers.

Passive Avoidance as Misnomer

It has been argued that punishment is reducible to avoidance, in the sense that all behavior other than the punished response avoids the punisher. For example, if a rat is placed on a platform above an electrified grid, then not stepping down onto the grid might be called passive avoidance of shock; by not responding, the rat passively avoids what would otherwise be a punisher. But whereas punishment is a robust phenomenon that can occur within a short time course (the abrupt introduction of a strong punisher reduces responding quickly), the literature on avoidance shows that though avoidance is robust once in place, it is difficult and time-consuming to get it started. Passive avoidance is therefore best regarded as a misnomer for punishment. It is implausible to say that hypothetical behavior presumed to come from relations that are difficult to establish can explain behavior that is easy to establish. Even if punishment did work this way, so that we learn not to stick our hands into fires because by so doing we avoid the aversive proprioceptive stimuli occasioned by approaching the fire, it would make little practical difference. For those who have to make decisions about whether or when to use punishers, punishment works pretty much the same way whichever theoretical position one assumes.

Negative Reinforcement: Escape and Avoidance

Organisms not only produce stimuli, they also get rid of them. Without negative reinforcement, a child would not learn to escape from the cold by coming indoors or to avoid others who might cheat at games or bully or lie. A rat does not ordinarily expose itself to shock, and if shock does occur, the rat escapes from it given the opportunity. If presenting a contingent aversive stimulus punishes a response, removing or preventing that stimulus may reinforce a response. When a response terminates or prevents an aversive stimulus and becomes more probable for that reason, the stimulus is called a *negative reinforcer* and the operation is called *negative reinforcement*.

In traditional usage, *positive* and *negative*, as modifiers of the term *reinforcement*, refer to whether the consequence produced by responding adds something to the environment or takes something away, but we will see later that there are other, better criteria for the distinction. *Negative reinforcer* refers to the stimulus itself and not to its removal; if removal of shock reinforces a rat's lever press, then shock, not the shock-free period that follows the response, is the negative reinforcer. Negative reinforcement involving the removal of a stimulus that is already present is called *escape*. When it involves the postponement or prevention of a stimulus that has not yet been delivered, it is called *avoidance*. This vocabulary is consistent with everyday usage: We escape from aversive circumstances that already exist, but we avoid potential aversive circumstances that have not yet happened. In clinical situations, escape (e.g., from a medical unit) is often called *elopement*.

Stimuli that can reinforce by their presentation can punish by their removal, and *vice versa*. If we know a stimulus is effective as a punisher, then we can reasonably expect it to be effective as a negative reinforcer, and *vice versa*; this consistency is part of our justification for calling the stimulus aversive. Consistencies are to be expected because these categories have their origins in relations among the probabilities of different response classes. But we must not take too much for granted. The fact that we may easily reinforce jumping with shock removal, whereas we may not so effectively punish it with shock presentation, shows that the symmetry of reinforcement and punishment has limits. Reinforcement is most effective if the reinforced response is compatible with the responding occasioned by the reinforcer. Inversely, punishment is most effective if the punished response is incompatible with, or at least independent of, the responding occasioned by the punisher. Thus, it may be easy to reinforce jumping with shock removal (escape) but hard to punish it with shock presentation.

Escape: Competition between Contingencies and Elicited Behavior

In escape, an organism's response terminates an aversive stimulus. In institutional settings, developmentally delayed children sometimes behave aggressively, in that way escaping from simple demands placed upon them, such as tasks designed to teach them how to fasten and unfasten clothing buttons. For two such children, aggression dropped to near-zero levels when they could escape from demand situations by engaging in other behavior incompatible with aggression (Carr, Newsom, & Binkoff, 1980). But such cases of escape might, of course, imply that typical demand situations in such settings do not provide enough reinforcers.

In positive reinforcement, the reinforcer is absent when the reinforced response is emitted. After the response, the reinforcer is presented and occasions other responses. For example, if a rat's lever press is the reinforced response and food is the reinforcer, food is absent while the rat presses; eating does not occur until food is presented after the press. Thus, lever pressing and eating do not directly compete with each other. In escape, however, the negative reinforcer is present before the reinforced response is emitted; it is removed only after the response. For example, if the negative reinforcer is bright light from which the rat can escape by pressing a lever, the rat may reduce the effects of the light by closing its eyes and hiding its head in a corner. Any movement from that position is punished by greater exposure to the light, so the rat is not likely to come out of the corner and press the lever. Getting a rat to escape from light by lever pressing requires procedures that reduce the likelihood of such competing responses (Keller, 1941).

Avoidance: Hard to Initiate but Easy to Maintain

Avoidance involves the prevention of an aversive stimulus by a response; the aversive stimulus is not present when the reinforced response occurs. The two major varieties of avoidance procedure are *deletion* and *postponement*. Deletion procedures are analogous to swatting a mosquito before it gets to where it can bite you: Once swatted, that mosquito is permanently prevented from biting. Postponement procedures are analogous to putting coins in a parking meter: One postpones the violation flag as long as one puts coins in the meter and resets it, but without additional coins the meter eventually runs out.

In *discriminated* or *signaled avoidance*, a stimulus (sometimes called a *warning stimulus*) precedes the aversive stimulus; a response in the presence of this stimulus prevents the aversive stimulus on that trial. In *continuous* or *Sidman avoidance*, no exteroceptive stimulus is arranged. Each response postpones the aversive stimulus (usually, brief shock) for a fixed time period called the *response–shock (R–S) interval*; in the absence of responses, shocks are delivered regularly according to a *shock–shock (S–S) interval* (Sidman, 1953). Shock can be postponed indefinitely provided that no R–S interval ends before a response has been emitted.

Success with avoidance procedures sometimes depends on whether the experimenter chooses a response that the organism is likely to emit in aversive situations. With rats, for example, responses such as jumping a hurdle or running from one side of the chamber to the other are likely to be elicited by aversive stimuli even in the absence of a response-shock contingency. Once responding has been produced by shock, it may continue when shock is absent. Thus, the rat's first few avoidance responses may occur mainly because of their earlier elicitation by shock.

Avoidance behavior may be persistent after a long history of avoidance; it can be slow to extinguish. But the consequence of effective avoidance is that nothing happens: The aversive event is successfully avoided. Given that an avoidance response is not closely followed by shock, avoidance contingencies implicitly involve delays between responses and their consequences. Thus, despite the persistence of avoidance behavior once it is adequately in place, it is often hard to get it started.

This may explain why safety measures and other preventive procedures are not often shaped by natural contingencies. Someone who has never had a bad experience with fire may be less likely to install a smoke detector than someone who has. One significant problem in medicine is the compliance of patients with regimens such as taking prescribed medications. Many patients stop taking their medications once their symptoms have disappeared even though further doses may have continued benefits. And with preventive medication, such as vaccination, taking a dose is followed by nothing happening right from the start. This problem exists over a wide range of preventive measures, from immunizations to safe sex, and from using sterile surgical equipment to purifying drinking water. Given what we know about avoidance contingencies, it is no surprise that such measures are sometimes difficult to shape up and maintain.

Behavioral Criteria for Distinguishing Positive from Negative Reinforcement

Whether stimuli are presented or removed may be a less important criterion for distinguishing positive from negative reinforcement than whether responses generated by the reinforcer occur at times when they can compete with the reinforced response. Consider escape from cold (Weiss & Laties, 1961). In a cold chamber, a rat's lever presses turn on a heat lamp. Because presses add energy in the form of heat, this procedure could be called positive reinforcement. But cold stimulates temperature receptors in the rat's skin, and turning on the heat lamp terminates this effect of cold. Cold is a potent aversive event, so by this interpretation the procedure should be called negative reinforcement.

The justification for choosing the vocabulary of negative reinforcement lies not with questions of physics, such as whether something is presented or removed, but with the behavioral effects of the stimuli presented before and after emission of the reinforced response. Consider the behavior of the rat in the cold. Before the reinforced lever press, it huddles in a corner and shivers. These responses reduce the likelihood that it will press the lever. Once its lever press turns on the heat lamp, these competing re-

sponses become less likely, but a rat that is no longer cold cannot escape from cold. Responses that competed with the reinforced response occurred before rather than after reinforcement, so this example is more like escape from shock or bright light than like production of food or water. In general, the language of negative reinforcement is appropriate when establishing events produce behavior that is likely to compete with the responding to be reinforced.

Another possible criterion is whether one reinforcement situation is preferred over another. In applied areas, such as management, it is useful to distinguish between two management task contingencies: Managers get employees to carry out tasks by either threatening and criticizing until tasks are completed or, more rarely, by providing praise and recognition after tasks are completed. Given a choice, employees are likely to move from settings in which they receive criticism to those in which they receive praise. Assuming that reductions in threats maintain task completion, we may call that contingency negative reinforcement. Assuming that recognition for completing tasks maintains task completion, we may call that contingency positive reinforcement. The preferences of employees for task contingencies justify this reinforcement classification (G. Bruce, e-mail personal communication, 1998).

The Reinforcer in Negative Reinforcement

When a successful avoidance response occurs, its important consequence is that nothing happens. How can the absence of an event affect behavior? According to one view, avoidance responding is maintained because the organism escapes from some properties of the situation that accompanied past aversive stimuli. This view evolved from earlier procedures in which a warning stimulus preceded shock, and the organism prevented shock by responding in the presence of the warning stimulus. Avoidance was most easily acquired when the avoidance response both terminated the warning stimulus and prevented the shock.

In the context of occasional shocks, a shock-free period can serve as a reinforcer. Avoidance contingencies can be arranged in which the organism can either reduce the total number of shocks in a session or postpone individual shocks, even though the same number of shocks is eventually delivered in both cases. Either condition can maintain avoidance. Situations can be created in which a rat postpones shocks within trials even though it does not reduce the overall shock rate, or in which it reduces the overall shock rate even though responding shortens the time to the next shock (Herrnstein & Hineline, 1966; Hineline, 1970).

Establishing Events in Negative Reinforcement

An establishing event that makes positive reinforcers more effective is deprivation. Food is less likely to reinforce the behavior of a rat that has recently eaten than of one that has not eaten for some time. The analogous event for negative reinforcers is *presentation* (it would be called *satiation* were the stimulus food instead of shock); the presentation of aversive stimuli makes their removal reinforcing. Even more so than with positive reinforcement, these establishing effects must be distinguished from discriminative, eliciting, and other effects of stimuli. Issues of multiple causation may be even more prevalent in cases of aversive control than with positive reinforcement (for examples, see Sidman, 1958).

The aversive stimulus is the establishing event because there is no reason to escape or avoid an aversive stimulus unless it is either actually or potentially present. It is tempting to think of the aversive stimulus as signaling a contingency, but contingencies in which responses turn off shock cannot exist in the absence of shock. When responses produce food in positive reinforcement, that contingency can be signaled whether or not the rat has been food-deprived.

An example may be relevant. Shock is delivered to a rat when a light is either on or off; when the light is on, a lever press removes the shock for a while, but when the light is off, a lever press has no effect (Bersh & Lambert, 1975). Under such circumstances the rat comes to press the lever when the light is on but not when it is off. The discriminative stimulus here is the light because the contingency between lever presses and shock removal is signaled by whether the light is on or off. The shock makes shock-free periods reinforcing, and its presentation is therefore

an establishing event; it does not function as a discriminative stimulus because it does not signal the operation of a contingency.

Note that the contingencies that operate in the dark in this example are properly called *extinction* contingencies. Lever presses remove shock when the light is on but not when it is off, but given appropriate contingencies, shock absence would be an effective reinforcer during either. This would not be so were shock never present when the light was off. In all of these cases, contingencies are about the consequences of responding, whereas establishing or motivating events are about whether those consequences are important enough to serve as reinforcers.

Extinction after Negative Reinforcement

As with positive reinforcement and punishment, the effects of negative reinforcement are temporary. And as with those other operations, the effects of terminating contingencies between responses and aversive stimuli must be distinguished from those of simply terminating the aversive stimuli. In shock escape, turning off the shock eliminates responding simply because there is no occasion for escape in the absence of the shock. But in avoidance, turning off the shock source has often been considered an extinction operation. If avoidance responding is maintained at such a rate that shocks are rare, the absence of shocks will make little difference, and responding will continue for a long time. In fact, one widely acknowledged property of avoidance responding is its persistence after aversive stimuli are discontinued. For that reason, avoidance has sometimes been regarded as relevant to cases of the persistence of human behavior, as in compulsions.

Consider the alternatives. With food reinforcement, we can arrange extinction by either turning off the feeder or breaking the connection between responses and the feeder. Both have the same effect: Food is no longer delivered. That is not so with negative reinforcement. In escape or avoidance of shock, shock continues if responses can no longer remove or prevent it. This procedure discontinues the response–shock contingency, but it also increases the number of shocks if responding has kept shock rate low. Thus, by itself this procedure cannot separate the effects of changing the rate of shock from those of changing the contingency.

Discontinuing the aversive stimulus has been the more common extinction procedure in avoidance, but in terms of contingencies presenting the aversive stimulus while discontinuing the consequences of responding more closely parallels extinction after positive reinforcement. The time course of extinction depends on which operation is used and on the way it changes the rate at which aversive stimuli occur (e.g., Hineline, 1981). In any case, extinction after negative reinforcement shows that the effects of negative reinforcement are temporary.

Negative Punishment: Time-Out

The distinction between positive and negative reinforcement is easily extended to positive and negative punishment (though here, too, ambiguous cases are possible). Responses can be punished by some events, such as shock or forced running in a running wheel. Responses also can be punished by the termination of events. For example, removing food contingent on a food-deprived rat's lever presses is likely to reduce the rate of pressing. The problem is that it might be hard to demonstrate negative punishment. If the rat is food-deprived and food is available, it will probably eat rather than press, so we will have few opportunities to punish lever pressing by removing food. For this reason, studies of negative punishment usually have not removed the positive reinforcer itself; paralleling the emphasis on avoidance rather than escape in studies of negative reinforcement, the stimulus in the presence of which responses are reinforced has been removed instead.

For example, suppose two levers are available to a monkey, and presses on one lever produce food whenever a light is on. We can expect presses on the other lever, but we can punish them by making each one produce a time period during which the light turns off and presses on the first lever do nothing. Such periods are called *time-out*, and the procedure is *punishment by time-out from positive reinforcement* (e.g., Ferster, 1958). Time-out originated in experiments like these with pigeons and rats and monkeys but now is probably best known in its

human applications (e.g., Wolf, Risley, & Mees, 1964). For example, time in an isolation room has sometimes been used to punish the problem behavior of institutionalized children. In the casual use of time-out as a punisher by parents and teachers, contingencies are often inconsistently applied, and behavior that occurs during the time-out is too often neglected. The term is occasionally extended to other cases (e.g. *time-out from avoidance*, during which no shocks are delivered).

Higher-Order Classes and Operant Contingencies

Contingencies can operate in combination and present particular challenges when some contingencies are nested in others, in higher-order classes. Sometimes when a response class appears insensitive to its consequences, it is part of a larger class whose other members continue to have the consequences it once shared with them. In such cases, the contingencies operating on the higher-order class may override those arranged for the original class. For example, once generalized imitation has been established, a child may continue to imitate some instance even though that particular imitation is never reinforced. That imitation may seem insensitive to operant contingencies, but it will be maintained by the contingencies that operate on the higher-order class as long as the higher-order class maintains its integrity.

We would ordinarily expect subclasses for which reinforcement has been discontinued to be differentiated from their higher-order classes, but that might not happen if the integrity of the higher-order class depends on its membership in other, interlocking higher-order classes that still include the subclass (e.g., playing the game *Simon Says* on the playground may help to maintain generalized imitation in the classroom even if imitative responses in the classroom are never reinforced). In some cases this might be a problem, but in others it may instead be advantageous, such as when new behavior emerges as a novel instance of the higher-order class (e.g., the generalized imitation of a movement the child has never seen before).

Now consider a boy whose self-injurious behavior is reinforced by attention. Suppose we try to extinguish his self-injurious behavior by ignoring it. We might have trouble from the start because we cannot tolerate the damage he may do to himself. We nevertheless persevere and discover that his self-injurious behavior does not decrease. One possibility is that we have not adequately identified the relevant response class. If the function of this behavior is to produce attention, it may be part of a much larger class of behavior that includes shouting obscenities, acting up, hitting or otherwise abusing the caregivers in the treatment center, and any number of other responses that might get attention (Lalli, Mace, Wohn, & Livezey, 1995). This tells us how important attention is to this child. We must consider a treatment program that uses attention to reinforce more effective and appropriate behavior, but the example also reminds us that we cannot define response classes by what they look like.

The criterion for defining response classes is function, and common consequences are the glue that holds classes of behavior together. The larger class was held together by the common consequences of its members, just as the various topographies of a rat's lever presses (left or right paw, both paws, sitting on it) are held together by the common consequence of producing food. But the human case is distinguished by the embedding of one response class within another. The self-injurious behavior was embedded in the larger class of attention-getting behavior. When a response class seems insensitive to its consequences, such as when the self-injurious behavior seemed not to extinguish, we must entertain the possibility that we have improperly specified the class, and that it is part of a larger class whose other members continue to have the consequences it once shared with them. The hierarchical structure of some classes of behavior may sometimes make it appear that reinforcement is not working, but it may be working on a response class larger than the one in which we have been interested. When reinforcement seems not to be working we should consider whether the response class in which we are interested is part of another larger class (Catania, 1995).

Verbal Behavior and the Hidden Costs of Reward

Reinforcement may be obscured when human verbal and nonverbal behavior interact. For example, instruction-following is more than the following of particular instructions; it is a higher-order class of behavior held together by common contingencies (e.g., Shimoff & Catania, 1998). Following orders in the military is a product of extensive and powerful social contingencies, often based on aversive consequences, but in actual combat, the long-term contingencies that maintain instruction-following in general as a higher-order class may be pitted against the immediate consequences of following a particular order (Skinner, 1969).

Verbal behavior is involved in the distinction between intrinsic and extrinsic reinforcers. An *intrinsic* reward or reinforcer is one that has a natural relation to the responses that produce it, whereas an *extrinsic* one has an arbitrary relation to those responses (e.g., music is an intrinsic consequence of playing an instrument, but the music teacher's praise is an extrinsic one). Events presumed to function as reinforcers because their function has been instructed have been called extrinsic reinforcers (e.g., as when a child is told that it is important to earn good grades), but labeling them so does not guarantee their effectiveness. It has been argued that extrinsic consequences undermine the effectiveness of intrinsic ones, and despite much evidence to the contrary, the argument has persisted and continues to have impact on the use of operant contingencies in schools and other settings (Cameron, Banko, & Pierce, 2001; Cameron & Pierce, 1994; Eisenberger & Cameron, 1996).

In one experiment (Lepper, Greene, & Nisbett, 1973), one group of children received gold stars for artwork such as finger painting; after the gold stars were discontinued, children in this group did less artwork than those in a second group that never received gold stars. The gold stars, extrinsic reinforcers, were said to have undermined the intrinsic reinforcers, the natural consequences of painting. The children had been told to earn the gold stars, however, and the experiment did not test the stars' effectiveness as reinforcers. There were no data to show that children painted more when they got gold stars.

The claimed deleterious effects are only inconsistently demonstrable, and they are small and transient when they do occur (Cameron et al., 2001; Cameron & Pierce, 1994), and problems are more likely to arise with extrinsic reward that is not contingent on performance than with contingent reward (Eisenberger & Cameron, 1996). In any case, if there is an effect, its transience and small size are hardly consistent with the argument that extrinsic reinforcement may ruin the lives of children. Nonverbal effects of reinforcers must be distinguished from the social contingencies that maintain the verbal governance of behavior. When situations involve verbal behavior there is a good chance that verbal governance will override more direct effects of reinforcement.

Reinforcers versus Bribes

In the literature of the "hidden costs of reward," reinforcers have sometimes been equated with bribes (Kohn, 1993), but it is unlikely that the arrangements described as bribes by such critics of the practice of reinforcement involve the direct effects of reinforcers. The language of bribery has an extensive history in law and ethics as an offer of goods or favors in exchange for favorable treatment in business, politics, or other human endeavors. Critics of the practice of reinforcement have extended this language to the common parental practice of specifying a consequence when asking a child to do something (e.g., "If you put away your toys, you can watch television"). There are good reasons to advise parents against the practice of bribery in this sense, but the reasons are different from those offered by the critics. They have correctly recognized the potentially different effects of natural and artificial consequences, but they have also seriously conflated cases of verbal stimulus control with those involving other varieties of contingencies.

Parents sometimes complain that their child only cooperates with requests when there is an immediate and explicit payoff. This problem is one of stimulus control. The parent may sometimes say, "It is time to put your toys away," and at other times may say, "If you put away your toys, you can watch television." But unless the child who

has complied with the request gets an opportunity to watch television whether or not the contingency has been explicitly stated, the child will learn to comply only when the parent states it.

Given that a bribe specifies behavior and its consequences, offers of bribes instead function as stimuli that set the occasion for particular contingencies. The child who is frequently bribed in this sense will learn to discriminate between conditions in which bribes are in effect and those in which they are not, so the parent who often uses bribes will no doubt eventually find that the child complies only when a bribe is offered.

The child will not learn to initiate appropriate behavior if the initiation rests with the one who offers the bribe. Over the long run, therefore, compliance with bribes will probably interfere with the effects of more constructive contingencies. If reinforcement works at all in such cases, it is in strengthening compliance with bribes, which is hardly the best way to make use of reinforcers. When such unintended stimulus control develops, it is important to teach the parent to reinforce compliance without explicitly stating the contingency, or at least to reinforce compliance both when the contingency is explicitly stated and when it is not.

As for the parent who has heard the language of bribes applied to the practice of reinforcement and is therefore reluctant to deliver reinforcers, it is crucial to teach that parent not to accompany the arrangement of contingencies for a child's behavior with statements of those contingencies. And that is probably good advice for teachers and clinicians too.

Reinforcer Classes and Reinforcer-Specific Effects

Operant contingencies involve consequences, and like responses they can profitably be studied in terms of classes (Cuvo, 2000). Successive reinforcers arranged in experimental settings are ordinarily similar but not identical. For example, individual pieces of grain made available when a pigeon's pecks operate its feeder will differ slightly in shape and color; a parent's hugs or smiles or positive comments that reinforce a child's behavior will undoubtedly vary from one instance to the next.

The discussion of higher-order classes examined the different responses that might produce attention and thereby maintain the self-injurious behavior of children with severe developmental disabilities. Because it shares its consequences with other responses, such as shouting obscenities or throwing things, the self-injurious behavior may be part of a larger class we might call attention-getting behavior. Within this class some types of responses may be more probable than others or may be differently available in different settings (Lalli et al., 1995). For example, a child might be more likely to engage in self-injury if nothing to throw is close at hand, or more likely to shout obscenities given one audience than given another. Nevertheless, their membership in a common class makes it likely that these responses will vary together as a function of establishing events or other variables.

But what if attention from staff members on this child's hospital unit does not function like attention from the child's mother when she visits the unit? If we find that one kind of attention cannot substitute for the other, we might best treat attention from these two different sources as two separate reinforcer classes. This is important to know because assessments of problem behavior on the unit may yield different results from those taken at the child's home; therefore, therapeutic interventions shaped up by staff attention on the unit may be incompatible with the kinds of behavior shaped up by the mother's attention at home. An effective treatment program must deal with the mother's behavior as well as the child's or the treatment gains realized on the unit will be lost soon after the child's discharge.

The significance of reinforcer classes has especially been demonstrated in research on the acquisition of arbitrary matching by children and by nonhuman organisms (Dube & McIlvane, 1995; Dube, McIlvane, Mackay, & Stoddard, 1987; Dube, McIlvane, Maguire, Mackay, & Stoddard, 1989; Kastak & Schusterman, 2002; Kastak, Schusterman, & Kastak, 2001; Pilgrim, Jackson, & Galizio, 2000; Schomer, 2002). Experiments on arbitrary matching typically incorporate correction procedures and other features

that reduce the proximity of errors to later reinforcers, and that reduce the likelihood that the organism will attend to dimensions of the environmental that are irrelevant to the task. Nevertheless, some children, as well as some pigeons, learn slowly.

In a typical matching study, all correct responses, whether to one comparison stimulus or the other, produce the same reinforcer. But if the reinforcers as well as the stimuli and responses of the arbitrary matching tasks enter into functional classes, this may be a mistake. While the contingencies may work to separate the different matching classes, such as green peck given square sample and red peck given circle sample, the common reinforcers may work to keep them together. With the matching task modified for children so that correct responses from the different problem classes each produce a different visual reinforcer (e.g., different cartoon pictures displayed on a video monitor), the acquisition of accurate arbitrary matching usually proceeds far more rapidly than when all responses produce the same reinforcer (e.g., Pilgrim, 2004; Urcuioli, 2005). The moral is that, whenever possible, we should arrange different reinforcers rather than a single reinforcer for the maintenance or the shaping of different response classes.

Reinforcement and Cultural Selection

The relations among behavior and its consequences in operant contingencies seem simple, but they have subtle properties, some of which become evident only in special contexts. For example, when side effects are not taken into account, contingencies can appear to be ineffective. Side effects of operant contingencies may have affected their acceptance because they allow the effects of contingencies to be masked in various ways. It is therefore prudent to consider the circumstances in which the properties of operant contingencies may mislead us as we deploy them and evaluate their effects. In the interests of preventing misconceptions and misunderstandings, it is probably even more important to remind ourselves of them whenever we present what we know about operant contingencies to those outside of behavior analysis. To those who argue that these contingencies should not be studied because they can be misused, the appropriate rejoinder is that detailed familiarity with their properties may be the best defense against their misuse. Alone or in combination, the factors considered here may sometimes give the appearance that operant contingencies do not work. On examination, we might instead conclude that they work more ubiquitously and more profoundly than we had originally imagined.

Phylogenic selection is Darwinian selection as it operates in the evolution of species. Ontogenic selection is operant selection as it operates in the shaping of behavior within an individual lifetime. A third level of selection is cultural selection, which involves the selection of behavior as it is passed on from one individual to another (Skinner, 1981). Selection at any one of these levels need not be consistent with selection at the other two. For example, it may not matter how valuable one way of doing things is relative to some other way, if one is easy to pass on from one individual to another, whereas the other can be passed on only with difficulty. The one that is easier to pass on may spread quickly and come to dominate in a culture relative to the other, even if the other would be more beneficial in the long term.

A case in point is the application of techniques of reinforcement relative to those of punishment. Unfortunately, the advantages of reinforcement do not make it more likely than punishment to spread through a culture (Catania, 2000). The problem is that delivering a punisher typically produces more immediate effects on behavior than delivering a reinforcer. Whatever else happens over the long term, a parent who shouts at or strikes a child thought to be misbehaving is likely to see some immediate change in the child's behavior, such as the onset of crying. That change will usually include the termination of the behavior of concern to the parent, even though it may have little to do with whether the behavior will reappear on later occasions, especially in the parent's absence. If stopping the child's behavior is part of what reinforces the parent's application of punishment, the immediacy of that reinforcer will be an important factor in maintenance of the use of punishment by the parent.

With reinforcement, on the other hand, the effects of delivering a reinforcer may not show up until some time has elapsed. In shaping, if a current response is reinforced closer to the target response than any other the shaper has seen before, the likelihood of that response will increase. Even so, many other responses might go by before the shaper sees another one like it. Unlike the punishment case, in which an immediate effect is typically that the target behavior stops, any immediate effect of reinforcement involves behavior unrelated to the target response (e.g., consuming an edible reinforcer). The time periods over which reinforcers change subsequent responding probably play a crucial role in determining how long it takes to teach shaping to students. If that makes it easier to teach aversive techniques than to teach those of reinforcement, perhaps that is also why punitive measures are so commonly used to maintain civil order in so many cultures.

Even as reinforcement begins to be more widely appreciated in our culture, we must not be complacent about teaching what we know about it. Despite the advantages of reinforcement, it is easier to teach the use of punishers than to teach the use of reinforcers, and reinforcement can be misunderstood or be obscured by other processes in various ways. Some people are very good at shaping even without explicit instruction, but mostly the effective use of reinforcers has to be carefully taught.

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CHAPTER 4

Schedules of Reinforcement

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Rules that describe the relationship between responses and reinforcer deliveries are known as *schedules of reinforcement*. These rules can be deliberately arranged in the context of an experiment or behavioral treatment, or they can be surmised from the pattern of responses to reinforcer deliveries that occur naturally. In either case, schedules of reinforcement are important for applied behavior analysts to consider because each schedule can be expected to have predictable effects on one or more dimensions of behavior. With this knowledge, applied behavior analysts are better positioned to describe the conditions of reinforcement that maintain undesirable behavior and to design interventions that have a higher likelihood of increasing desirable behavior.

This chapter discusses the dimensions of behavior that schedules of reinforcement can affect, and presents descriptions and examples of basic schedules and combined schedules of reinforcement.

Schedules of Reinforcement in Context

It is important to understand the effects schedules of reinforcement have on behavior in the broader context in which they operate. The basic unit of analysis in applied behavior analysis (ABA) is the *discriminated operant*, which is a class of responses defined by both the effect the responses have on the environment and the stimuli present when responses occur (Catania, 1998). Occurrences of discriminated operants are affected by events that motivate their occurrence, known as *motivating operations* (Laraway, Snycerski, Michael, & Poling, 2003). Motivating Operations are events preceding occurrences of discriminated operants that can have evocative or abative effects on behavior (i.e., increase or decrease their occurrence). They can also alter the effectiveness of consequences of behavior by establishing or abolishing their reinforcing or punishing effects. Discriminated operants are also affected by antecedent occurrences of stimuli or events that are correlated with the increased or decreased availability of reinforcement (or punishment), known as *discriminative stimuli*. Discriminative stimuli are said to set the occasion for operants to occur because they predict the likely consequences responses will have. However, the effects of discriminative stimuli on behavior are dependent on the presence or absence of related motivating operations (Laraway et al., 2003).

In all natural human environments, individuals are free to engage in any of several concurrently available discriminated operants. Each one is associated with one or more consequences and the individual is said to have a *choice* to engage in any of the alternatives (Fisher & Mazur, 1997; Mace & Roberts, 1993). The variables that influence choice have been studied extensively and are formally developed in the *generalized matching law* (Baum, 1974), which we briefly discuss in a later section of this chapter; however, one of the variables that affects choice is the relative schedule of reinforcement operating for each of the concurrently available alternatives. We also provide a conceptual framework for understanding how concurrent discriminated operants are influenced in a dynamic manner by changes in relative motivation and relative history of reinforcement or punishment (i.e., behavioral mass; Mace, Gritter, Johnson, Malley, & Steege, 2007) (Figure 4.1). A final contextual factor to consider is each discriminated operant's history of reinforcement or punishment. These learning histories affect the relative resistance to change or momentum each discriminated operant has and, in turn, can affect the relative value of concurrently available alternatives and the choices individuals make. Nevin and Grace (2000) refer to these histories as *behavioral mass* in the context of their formulation of *behavioral momentum theory* (see later sections on resistance to change and behavioral momentum).

The purpose of this preface to our discussion of schedules of reinforcement is to emphasize that the effects of reinforcement schedules on behavior are *relative, not absolute* (Herrnstein, 1961, 1970); that is, the influence of any given schedule of reinforcement on a discriminated operant will depend on the relative factors that affect choice including reinforcer rate, quality, and delay, response effort, motivation, and behavioral mass. The practical significance of this conceptual model is that applied behavior analysts may need to consider a broad range of factors that influence both desirable and undesirable behavior to maximize the effectiveness of their interventions.

Behavior Dimensions Affected by Schedules of Reinforcement

In ABA practice, reinforcers are delivered contingently. There are three general types of contingencies. First, the contingency can be between the number of responses that occur and the delivery of a reinforcer, known as a *ratio contingency*. Second, the contingency can be between the occurrence of responses and the passage of intervals of time, known as an *interval contingency*. Finally, the contingency can be between the passage of an interval of time with no relation to the occurrence of responses, known as a *time contingency*. The particular arrangement of ratio, interval, and time contingencies can affect the rate of a response, the periodicity

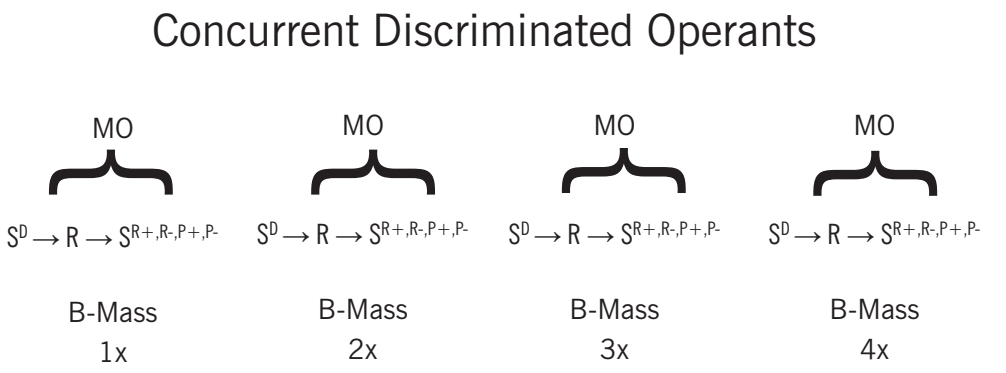


FIGURE 4.1. Framework for conceptualizing discriminated operants in context: The dynamic interplay between motivating operations, behavioral mass, and the classic three-term contingency.

of a response, and the resistance to change of a response.

Response Rate

Response rate is defined as the ratio of the number of responses to an interval of time, or response count divided by time. Its synonym is *frequency*. An alternative expression of response rate is the average time between responses, or *interresponse time* (IRT), which is defined as the average time that elapses between the offset of one response and the onset of the next response in the response class. Response rate and IRT have a perfect inverse correlation such that a unit increase in response rate will have a corresponding unit decrease in IRT. In ABA practice, response rate is often an important dimension of behavior that the behavior analyst aims to alter, generally attempting to increase the frequency of desirable behaviors and/or decrease the frequency of undesirable ones. Thus, knowing the effects of different schedules of reinforcement on response rate is important in the design of interventions.

Response Periodicity

Response periodicity refers to the pattern of responses in relation to the passage of time. Whereas IRT expresses the *average* time between responses, response periodicity reflects the pattern of times between individual responses, or individual IRTs, during a specified time period. In general, schedules of reinforcement promote four patterns of response periodicity. The first possible pattern is a fairly *constant* time between responses showing little variability in individual IRTs. This pattern is characteristic of variable-ratio (VR) and variable-interval (VI) schedules (which we discuss subsequently). A second pattern is a *pause* in responding that follows a comparatively higher response rate. Both fixed-ratio (FR) and fixed-interval (FI) schedules can promote temporary pauses in responding after reinforcer deliveries before responding resumes. A third pattern is the *suspension* of responding following a given response pattern. Time, extinction, and differential reinforcement of other behavior (DRO) schedules can result in a reduction in response rates to zero or near zero. Finally, response periodicity can show a pattern of *celeration* (Johnston & Pennypacker, 1980, 1993), which refers to a progressive change in individual IRTs. Progressively shorter IRTs reflect *acceleration* in response rate, whereas progressively longer IRTs reflect *deceleration*. A variety of schedules of reinforcement can promote these response patterns, as we discuss in the following sections of the chapter.

Resistance to Change

An important dimension of behavior that applied behavior analysts increasingly take into consideration is its resistance to change, which refers to the rate of deceleration in responding that follows the introduction of some *response disruptor* (i.e., events that disrupt the response–reinforcer relation; Nevin, 1974; Nevin, Mandell, & Atak, 1983). Common response disruptors include extinction, satiation, alternative reinforcement, punishment, dark-key (or between-session) reinforcement, and distraction. Each of these operations can decelerate responding. This dimension of behavior is particularly relevant to ABA work aimed at strengthening the resistance to change of desirable behavior and weakening the resistance to change of undesirable behaviors.

Basic Schedules of Reinforcement

Ferster and Skinner (1957) provided the foundational work for schedules of reinforcement in their compilation of over 100 experimental demonstrations of the patterns of responding promoted by various schedules. Numerous applications of various schedules of reinforcement in ABA work have demonstrated the relevance of these schedules to the assessment and treatment of human behavior.

Basic schedules are single schedules of reinforcement applied to one class of responses, which form the building blocks for the more complex, combined schedules of reinforcement (described later). Table 4.1 summarizes the basic schedules discussed in this chapter, along with schedule definitions, the response patterns each schedule promotes, and applications of the schedule in ABA work.

TABLE 4.1. Basic Schedules of Reinforcement, ABA Example, and the Response Patterns Promoted

Schedule	Definition	ABA example	Response pattern promoted
FR—fixed ratio	Reinforcers are contingent on every *i*th response (e.g., FR4—every fourth response)	Cohen et al. (2001) demonstrated FR patterns by measuring muscle contractions emitted by undergraduate students.	High response rate with comparatively short and uniform IRTs. Pause in responding follows reinforcer deliveries.
VR—variable ratio	Reinforcers are contingent on a variable number of responses; the average number of responses defines the schedule.	DeLuca and Holburn (1992) showed VR patterns by measuring obese children's rate of stationary bike revolutions.	High response rate with comparatively short and uniform IRTs.
FI—fixed interval	Reinforcers are contingent on the first response following a fixed time interval.	Critchfield et al. (2003) analyzed the bill-passing behavior of the U.S. Congress.	Possible cumulative record scalloping when measurement of the passage of time is unavailable.
VI—variable interval	Reinforcers are contingent on the first response following a variable interval of time; the average of these intervals defines the schedule.	Martens, Lockner, and Kelly (1992) demonstrated VI response patterns in the academic engagement of typically developing 8-year-olds.	Moderate response rates with uniform but longer IRTs than ratio schedules.
EXT—extinction	Discontinuation of a reinforcement contingency either by withholding contingent reinforcement or delivering reinforcers independently of behavior according to FT or VT schedules.	Magee and Ellis (2001) demonstrated the extinction process for several challenging behaviors (e.g., out-of-seat behavior, hand mouthing, yelling, and property destruction) exhibited by children with developmental disabilities.	When contingent reinforcement is withheld—a sudden increase in response rate (burst) followed by a reduction to zero. When the reinforcement contingency is discontinued but reinforcers are delivered on FT or VT schedules—a sharp drop in response rate to near-zero or zero levels.
FT–VT—fixed or variable time schedules	Reinforcers are delivered independently of any behavior at FT or VT intervals.	Vollmer et al. (1998) used FT schedules to reduce problem behaviors (i.e., aggression, self-injurious behavior, disruption, and tantrums) displayed by both children and adults with mental retardation. Mace and Lalli (1991) used VT schedules to reduce bizarre vocalizations emitted by an adult with moderate mental retardation.	When combined with EXT, sharp drop in response rate to near-zero or zero levels. When combined with ratio or interval schedules, a reduction in the reinforced class of behaviors.

(cont.)

TABLE 4.1. *(cont.)*

Schedule	Definition	ABA example	Response pattern promoted
DRA—differential reinforcement of alternative behavior	Reinforcers are contingent on specific topographies of behavior and *not* others. Combines ratio or intervals schedules with extinction.	Harding et al. (2004) used DRA schedules to increase adults' correct execution of various martial arts techniques.	Comparatively higher response rates for behaviors that produce reinforcers than for those that do not.
DRH–DRL—differential reinforcement of high or low rate behavior	Reinforcers are delivered after a specified time interval if response rates are at or above (DRH) or at or below (DRL) a specified rate.	Lane et al. (2007) used DRH schedules to increase a child's class participation (i.e., rates of hand raising and question answering). Wright and Vollmer (2002) used a DRL schedule to reduce rapid eating in an adolescent with mental retardation.	DRH schedules promote response rates higher than the specified criterion. DRL schedules promote response rates below the criterion.
DRO—differential reinforcement of other behavior	Reinforcers are contingent on the absence of specified behavior(s) during a specified time interval. Also called omission training.	Heard and Watson (1999) used an interval DRO schedule to reduce wandering behavior exhibited by geriatric patients. Kahng, Abt, and Schonbachler (2001) used a momentary DRO schedule to reduce the rate of aggression displayed by a woman with developmental disabilities.	Low or zero rates of the target behavior omitted from reinforcement. Behaviors other than the target behavior increase in rate.

Ratio Schedules

Ratio schedules of reinforcement specify the number of responses that are required to effect delivery of a reinforcer, independent of the amount of time taken to complete the schedule requirement. However, because slow response rates delay the time to reinforcement, ratio schedules generally promote relatively high response rates with relatively constant individual IRTs, with some exceptions noted below. The response patterns promoted by ratio schedules are influenced by two schedule features: (1) the ratio of responses to reinforcers (RRR) and (2) the predictability of this ratio.

FR Schedules

In an FR schedule, the number of responses required to produce a reinforcer is constant (e.g., inputting three-digit area code and seven-digit phone number to make a call is an example of an FR 10 schedule).

When the RRR is very low, as in the case of the FR 1 schedule (also known as a *continuous reinforcement schedule* [CRF]), responses rates are also typically low. However, as reinforcer deliveries become less frequent (e.g., FR 5), the response rates promoted by the schedule increase rapidly and eventually support comparatively high rates of responding. As the RRR increases, pauses in responding after the reinforcer delivery also increase, known as the *postreinforcement pause* (Felton & Lyon, 1966). Finally, as the RRR becomes comparatively high, pauses in responding can appear before the reinforcer is delivered. This is known as *ratio strain*, and it can result in either the temporary interruption of responding or its cessation. The predictability of the RRR in FR schedules generally promotes the highest

response rates with uniform individual IRTs. However, humans may show FR response patterns even when the RRR is not held constant. For example, a parent may tell a child that he or she may engage in a leisure activity as soon as a math homework assignment is completed. Because the child knows how many math problems must be completed, the RRR is predictable and the characteristic FR response pattern may be promoted.

Cohen, Richardson, Klebez, Febbo, and Tucker (2001) provided undergraduate psychology majors with auditory and visual biofeedback for electromyography (EMG) readings from their forearms. Participants were instructed alternately to tense and relax their forearms. Different groups of students received feedback on whether their EMG values moved from below a predetermined threshold to above the threshold (responses). Feedback was provided for these responses according to five different schedules of reinforcement. Two of the schedules were FR schedules: FR 1 (CRF) and FR 4 schedules. The FR 4 schedule generated the highest rates of responding, whereas the FR 1 schedule produced response rates that were approximately half of the higher RRR.

VR Schedules

Like FR schedules, VR schedules (also known as *random-ratio* [RR] schedules) deliver reinforcers contingent on the number of responses that are emitted. However, in VR schedules, the interreinforcement response criteria vary for each reinforcer delivery. The *schedule value* is defined as the average RRR over the course of the VR condition (e.g., reinforcers delivered after the second response, then after the sixth response, and then after four more responses would be a VR 4). Many human behaviors maintained by VR schedules include sampling restaurants in search of ones that suit one's taste, purchasing lottery tickets, looking for misplaced items, and answering questions on weekly homework assignments.

VR schedules generally promote high rates of responding, with short and fairly uniform individual IRTs. However, when the RRR exceeds a threshold (in pigeons, this value can exceed 200 key pecks per minute [Brandauer, 1958]), response rates decline as the RRR increases. In addition, ratio strain can occur at lower RRR values when single interreinforcer intervals become quite large. Finally, the unpredictability of the individual RRRs tends to promote short postreinforcement pauses.

DeLuca and Holburn (1992) reinforced revolutions on an exercise bicycle with preferred objects on a VR schedule for three obese children. Following calculation of baseline revolutions per minute, an initial VR schedule value was set at 15% above baseline. Two additional increases in VR values were implemented after participants demonstrated stability in each VR condition. The progressive arrangement of the VR schedule value, also known as a *progressive VR schedule,* resulted in an approximate doubling of pedal revolution rates.

Interval Schedules

Interval schedules of reinforcement define the point in time that responses become eligible for reinforcement. The *interval value* indicates the minimum time that must elapse before a response produces a reinforcer. Unlike ratio schedules, the rate of responding does not affect the rate of reinforcement—response rate and reinforcement rate are independent to the extent that higher response rates do not produce higher rates of reinforcement in interval schedules. The contingency is between the response periodicity and the delivery of reinforcers. Thus, interval schedules generally support lower response rates than ratio schedules do (Cohen et al., 2001).

An *adjunctive* procedure known as a *limited hold* is sometimes needed for interval schedules to support a consistent response pattern. A limited hold specifies the amount of time that reinforcers are available once they have been "set up" by the schedule. Thus, a 5-second limited hold means that if a response does not occur within 5 seconds of becoming eligible for reinforcement, the opportunity for reinforcement is forfeited.

FI Schedules

In an FI schedule of reinforcement, the first response that occurs following the expiration of a constant time interval results in the delivery of a reinforcer. Thus, a FI 5-minute schedule arranges the availability of rein-

forcement to occur every 5 minutes. The predictability of reinforcer availability can promote a pattern of behavior that is sensitive to this periodicity. In the laboratory, especially with nonhuman participants, FI schedules tend to promote an escalation in response rates toward the end of the interval. When expressed in a cumulative record of responses, the pattern takes the appearance of a "scallop." Following delivery of each reinforcer, there is a postreinforcement pause that can last more than half of the interreinforcement interval.

There has been some speculation whether FI scalloping occurs in humans in natural environments. For example, Critchfield, Haley, Sabo, Colbert, and Macropoulis (2003) analyzed the bill-passing behavior of the United States Congress over a 52-year period. Each 2-year Congress comprises two sessions of approximately equal duration. Critchfield and colleagues found that, graphed in cumulative records, bill passing escalated toward the end of each session in accord with the FI scalloping seen in nonhuman species experiments in the laboratory. However, FI scalloping is a productive response pattern only when there is no external means to discriminate time. When the end of an FI schedule is clearly signaled, the most parsimonious response pattern would be to emit a single response at the completion of the interval. In the case of Congressional behavior, the contingency would appear to be between the number of bills passed and the production of the reinforcing consequence of reelection or campaign donations rather than the particular timing of the completion of any one legislative act. The escalation in bill passing toward the end of Congressional sessions bears resemblance to procrastination in completing work that can be referred to during a campaign as the basis for financial or electoral support. The consensus of other authors examining FI scalloping in humans is that it is a rare occurrence (Hyten & Madden, 1993; Ninness, Ozenne, & McCuller, 2000).

VI Schedules

VI schedules (also known as *random interval* [RI]) make responses eligible for reinforcement on the basis of an average interval of time that elapses (e.g., reinforcers delivered after the 10th second, then after 20 more seconds, and then after 15 more seconds would be a VI 15-second schedule). Hantula and Crowell (1994) provided a BASIC program for deriving interval values based on the formula by Fleshler and Hoffman (1962) such that the time between reinforcer deliveries is truly random. Because the interreinforcement interval is unpredictable, VI schedules promote consistent response rates with fairly uniform individual IRTs.

Teacher attention is often delivered on a VI schedule because its availability is dependent not on the number of responses a student makes but on the availability of the teacher to observe and reinforce student behavior. Martens, Lochner, and Kelly (1992) provided praise contingent on academic engagement for two 8-year-old students with low baseline rates of academic engagement. Praise was delivered alternately on VI 5-minute and VI 2-minute schedules of reinforcement. Both schedules improved academic engagement; however, the VI 2-minute schedules consistently resulted in higher levels of engagement for both students, a finding consistent with basic research with nonhuman specifies (Catania & Reynolds, 1968).

Extinction Schedules

Extinction (EXT) schedules withhold reinforcement for specified response topographies during certain time periods. EXT schedules come in two general forms. First, they can constitute a change from a condition in which responses were reinforced to one in which reinforcement is discontinued. When extinction follows positive reinforcement, it is denoted as EXT+, and when it follows negative reinforcement, the denotation is EXT–. Second, an EXT schedule can be arranged for responses that have not been explicitly reinforced in the past but should not be reinforced during the process of teaching a new skill. For example, when teaching a child with autism to say the word *apple*, vocalized sounds unrelated to *a, p*, and *l* would be designated as ineligible for reinforcement.

Magee and Ellis (2001) used EXT alone to reduce multiple undesirable behaviors for two children. A functional analysis showed that one child's out-of-seat behavior oc-

curred at high levels when a therapist discontinued instructions contingent on the behavior. Escape extinction (EXT–) consisted of the continuous presentation of instructions every 10 seconds regardless of occurrences of undesirable behavior. The second child's functional analysis showed that his object mouthing was maintained by adult attention. Positive reinforcement extinction (EXT+) for this child involved withholding attention following any undesirable responses. Both EXT schedules were effective in reducing out-of-seat behavior and hand mouthing. However, Magee and Ellis found that when these two behaviors were placed on extinction, other topographies of undesirable behaviors emerged—first yelling in one child and property destruction in the other. When these behaviors were placed on extinction, additional topographies of undesirable behaviors began occurring. The sequential emergence of multiple undesirable behaviors demonstrated that the behaviors were members of a response class hierarchy (Lalli, Mace, Wohn, & Livezey, 1995).

Magee and Ellis (2001) illustrated that EXT schedules can have collateral effects in addition to the reduction of responses subject to extinction. These include the extinction burst (initial increases in responding), extinction-induced aggression (violent acts related and unrelated to the source of reinforcement), agitated or emotional behavior, resumption of previously reinforced behaviors, behavioral contrast (increased occurrences of undesirable behavior in settings not employing extinction), and spontaneous recovery (recurrence of the extinguished target behavior). Lerman, Iwata, and Wallace (1999) examined the prevalence of extinction bursts and extinction-induced aggression for 41 cases of individuals with self-injurious behavior who received treatment using EXT alone or EXT plus additional treatment components. They found response bursting was evident in 39% of all cases; 22% showed increased aggression and 58% showed neither side effect. However, of the cases treated with EXT alone, 69% showed response bursting and 29% showed increased aggression compared to only 15% for either side effect when treated with EXT plus another treatment component. These findings suggest the importance of combining EXT with other schedules to avoid unwanted side effects.

Time Schedules

Time schedules arrange occurrence of reinforcer deliveries contingent on the passage of an interval of time and independent of an individual's behavior. Reinforcers are said to be *response-independent* and delivered *noncontingently*.[1] In ABA work, time schedules are employed to (1) *enrich* an environment and alter the motivation of individuals to engage in undesirable behavior to obtain reinforcement (Horner, 1980); (2) serve as an experimental control procedure to demonstrate the effects of a contingency between a response and a reinforcer (Thompson & Iwata, 2005); and (3) reduce undesirable behavior. Our discussion here focuses on this last application of time schedules.

Fixed or Variable Time Schedules

Reinforcers can be delivered in time schedules at regular or fixed intervals (FT schedules) or at random or variable intervals (VT schedules). Mace and Lalli (1991) combined descriptive and experimental analysis to show that a man's bizarre vocalizations were maintained by staff attention. The functional relationship between bizarre speech and staff attention was then disrupted by delivering neutral comments to the participant on a VT 90-second schedule and discontinuing attention for bizarre comments. Numerous studies have demonstrated that time schedules are an effective and efficient method for reducing a wide range of undesirable behavior maintained by both positive and negative reinforcement (Vollmer, Marcus, & Rihgdahl, 1995; for reviews, see Tucker, Sigafoos, & Bushell, 1998; Vollmer & Hackenberg, 2001).

Time schedules are an attractive treatment alternative for a number of reasons. First, they often result in rapid suppression

[1]The term *noncontingent reinforcement* (NCR) was introduced to describe fixed-time (FT) and variable-time (VT) schedules (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). However, Poling and Normand (1999) questioned the technical accuracy of the term to describe the noncontingent delivery of reinforcers. Because noncontingent delivery of reinforcers does not constitute a reinforcement operation or process (i.e., nothing is reinforced), the term NCR does appear to be a misnomer and is not used in our discussion of the topic.

of undesirable behavior when the reinforcer maintaining undesirable behavior is time contingent (Lalli, Casey, & Kates, 1997; Mace & Lalli, 1991). Second, as indicated earlier, adding time-contingent reinforcers to a context can reduce the motivation to engage in extreme acts (undesirable behavior) to obtain reinforcement. This may also increase the attractiveness of prosocial alternative behaviors that require less effort to effect reinforcement (Ecott & Critchfield, 2004). Third, relative to EXT schedules, time schedules often obviate an extinction burst. For example, Vollmer and colleagues (1998) compared FT deliveries of maintaining reinforcers with the withholding of those reinforcers (i.e., EXT). For all three of the participants in their study, an extinction burst was evident during EXT. However, the FT schedule resulted in rapid or immediate suppression of undesirable behavior without response bursting. We note that response bursting has been reported when the rate of time schedule reinforcer deliveries is faded and apparently becomes too lean. Vollmer, Rihgdahl, Roane, and Marcus (1997) found that undesirable behavior escalated to approximately five times the baseline rate during FT schedule thinning; Mace and colleagues (2008) reported similar findings.

There are several procedural variations of time schedules to consider when designing interventions. First, a time schedule value must be selected that is sufficiently dense to suppress undesirable behavior. For example, Rihgdahl, Vollmer, Borrero, and Connell (2001) evaluated whether initial time schedule values are best set at those similar or dissimilar to the rates of baseline reinforcement. They found that FT schedule values that were similar to baseline rates of reinforcement for undesirable behavior were less effective than those that were dissimilar. This finding held even when the FT schedule values were four to nine times leaner than the baseline reinforcement rates. This counterintuitive finding may be attributed to dissimilar rates being easier to discriminate from baseline. A second procedural question is whether time schedules must be used in conjunction with EXT to be effective (see discussion on conjunctive schedules below). Lalli and colleagues (1997) compared FT schedules with and without EXT and found that they were comparably effective at reducing undesirable behavior; however, this finding was based on only one participant receiving FT intervention without EXT. Third, the majority of clinical studies employing time schedules have evaluated FT rather than VT schedules, but studies comparing the efficacy of FT versus VT schedules have found them to be similarly effective (Carr, Kellum, & Chong, 2001; Van Camp, Lerman, Kelley, Contrucci, & Vorndran, 2000). We suggest the initial use of FT schedules and a shift to VT schedules after initial treatment effects are established. The predictability of reinforcer deliveries in FI and VI schedules, and the characteristic response patterns they promote, may logically extend to time schedules.

There is some theoretical interest in which behavioral process(es) are invoked in time schedules to make them effective. The shift from contingent baseline reinforcement to time-contingent reinforcer deliveries involves two simultaneous operations. First, the response–reinforcer contingency in baseline is discontinued, constituting a procedural variation of extinction. Second, the motivating operations (MOs) change by supplying reinforcers on a time schedule. This presumably abolishes the consequence as an effective reinforcer for undesirable behavior and abates those same responses. Kahng, Iwata, Thompson, and Hanley (2000) examined response patterns in the time period immediately following FT intervention. They reasoned that if FT effects were due to extinction, responding would not resume following FT treatment because the response–reinforcer contingency was not reinstated. Alternatively, if FT effects were the result of altered MOs, response rates could be expected to resume when reinforcers shift from being available to unavailable. The findings of Kahng and colleagues were mixed in their analysis, with one participant each supporting the EXT and MO accounts, and a third showing a change in response patterns over time from supporting the MO account to the EXT account. Finally, Ecott and Critchfield (2004) suggested that time schedules may be effective because reinforcer deliveries may temporally coincide with other behaviors and result in adventitious reinforcement of those responses. In a laboratory demonstration with undergraduate students, two behaviors were concurrently reinforced with

points. The "target behavior" was reinforced on a VI 10-second schedule, and the "alternative behavior" was placed on a VI 30-second schedule (see discussion of concurrent schedules of reinforcement below). Following stability in this baseline phase, the proportion of reinforcer deliveries for the target behavior that was response contingent was systematically varied from 100, 66, and 33 to 0%. Results showed that as the proportion of time-contingent reinforcer deliveries increased, the response rates for the alternative behavior increased. Ecott and Critchfield suggested that adventitious reinforcement of alternative behavior is one possible account of the behavioral process involved in time schedule treatment effects.

Differential Reinforcement Schedules

Differential schedules of reinforcement specify the dimensions of behavior that are and are not eligible for reinforcement. They may also define the stimuli that must be present for responses to be reinforced (i.e., an S^D), as well as the stimuli in the presence of which responses will not be reinforced (i.e., an S^Δ), thus defining the discriminated operant. As such, differential reinforcement schedules implicitly involve two types of operations: (1) positive or negative reinforcement and (2) extinction. The behavior dimensions subject to reinforcement and extinction include specific forms or topographies of responses, response rates and the periodicity of responding, and the amount of time spent engaging in specific behaviors.

In ABA practice, the criteria for reinforcement are often changed systematically to promote gradual and progressive changes in responding toward a target criterion. When this involves the discriminative stimuli correlated with reinforcement, the operation is known as *fading*. For example, Flood and Wilder (2004) used differential reinforcement and fading to increase the amount of time an 11-year-old boy with separation anxiety disorder could spend away from his mother without crying, whining, or exhibiting other emotional behavior. Access to preferred items was made contingent on the boy meeting his goals for time spent away from his mother without distress. The time goals were faded from 3 minutes to 90 minutes over 27 treatment sessions. A similar fading and differential reinforcement procedure was used to increase the distance the boy's mother was from the therapy room. By contrast, when changes in specific response topographies or in response rates are subject to changing criteria for reinforcement, the operation is known as *shaping*. Ricciardi, Luiselli, and Camare (2006) used shaping and differential reinforcement to increase approach responses to feared animated toys in an 8-year-old boy with autism. Distance from the feared objects was gradually decreased from 6 meters to being able to touch the feared toys. Access to preferred items was contingent on the boy remaining in a target proximity of the feared objects that gradually increased in five steps. Differential reinforcement procedures and their application are discussed more fully by Hanley and Tiger (Chapter 14, this volume).

Combined Schedules of Reinforcement

Combined schedules of reinforcement comprise two or more basic schedules. Each basic schedule is referred to as a *schedule component*. These components are arranged to alternate, be available at the same time, occur in a sequence, or in some combination of these arrangements. Combined schedules are particularly relevant to ABA because they better represent the circumstances humans encounter in everyday life. Our coverage of combined schedules includes definitions, examples, and a discussion of the relationship between certain combined schedules and contemporary developments in ABA, such as behavioral contrast, matching theory, and behavioral momentum. Table 4.2 summarizes the combined schedules discussed here, along with schedule definitions, response patterns promoted by each schedule, and applications in ABA work.

Multiple and Mixed Schedules

In a multiple and mixed schedule, two or more schedule components alternate in a random, counterbalanced, or natural temporal sequence. The difference between multiple and mixed schedules is that schedule components are correlated with distinct stimuli in multiple schedules and are not in mixed schedules. As an individual experiences the

TABLE 4.2. Combined Schedules of Reinforcement, ABA Example, and the Response Patterns Promoted

Schedule	Definition	ABA example	Response pattern promoted
Multiple/ mixed schedules	Alternation of two or more schedules of reinforcement. In a multiple schedule, each schedule is correlated with a distinct stimulus (e.g., a VR schedule in context *A* alternates with a DRL schedule in context *B*). In a mixed schedule, no distinct stimuli are correlated with each schedule (e.g., a VR schedule and DRL schedule alternate in the same context).	Tiger and Hanley (2005) used MULT and MIX FR 1 EXT_1 EXT_2 schedules to produce differential rates of social approach responses emitted by preschoolers.	Schedule-specific patterns of behavior are observed in each component. Schedule-specific response patterns are more pronounced in multiple than in mixed schedules.
Concurrent/ conjoint schedules	Two or more schedules of reinforcement are available at the same time. In a concurrent schedule, each schedule is correlated with a distinct stimulus (e.g., a choice between VR reinforcement from source *A* and VI reinforcement from source *B* in the same context). In a conjoint schedule, no distinct stimuli are correlated with each schedule (e.g., behavior *A* produces VR reinforcement and behavior *B* produces DRH reinforcement in the same context).	Conger and Killeen (1974) employed CONC VI VI schedules to demonstrate college students' allocation of attending responses.	Concurrent interval schedules promote allocation of responding to each schedule in proportion to relative rates of reinforcement obtained on each schedule. Concurrent ratio schedules promote exclusive responding on the relatively denser schedule of reinforcement.
Chained/ tandem schedules	Two or more schedules of reinforcement are available. Completion of schedule *A* produces schedule *B*, and completion of schedule *B* produces reinforcement. In a chained schedule, each schedule component is correlated with a distinct stimulus. In a tandem schedule, no distinct stimuli are correlated with each schedule component.	Hoerger and Mace (2006) used concurrent-chain schedules to measure impulsive versus self-controlled choices made by male children with and without symptoms of ADHD.	Schedule-specific patterns of behavior are observed in each component. Schedule-specific response patterns are more pronounced in chained than in tandem schedules.
Conjunctive schedule	Two or more schedules of reinforcement are arranged. All schedule requirements must be completed to receive reinforcement.	Vollmer et al. (1997) used a conjunctive FT DRO schedule to reduce aggression in an adolescent with mental retardation.	Schedule-specific patterns of behavior are observed in each component.
Alternative schedule	Two or more schedules of reinforcement are available concurrently. The first schedule completed produces reinforcement.	Bowman et al. (1997) utilized an ALT FR 1 FR 1 EXT schedule to evaluate the reinforcer preferences of children with mental retardation.	Responding reflects a preference for one schedule component.

multiple schedules, the correlated stimuli acquire stimulus control over responding and become discriminative stimuli. To the extent that the schedule components differ, differential responding in the schedule components usually occurs more rapidly and is more pronounced in multiple schedules compared to mixed schedules.

Humans encounter multiple schedules with regularity. Students in school who attend a sequence of classes throughout the day experience a multiple schedule. Each class is a schedule component and is correlated with distinct stimuli, such as different teachers, textbooks, classrooms, and seating arrangements. The teachers in each class undoubtedly reinforce students' participation in classroom activities on different schedules, with some on ratio schedules, others on interval schedules, and still others on DRH schedules. Mixed (MIX) schedules are also frequently encountered. The first time we read a novel, watch a film, or drive through unfamiliar countryside, our points of interest (i.e., the availability of reinforcement) for attention to the activity vary from one point in time to another. However, there is no indication that the reinforcing properties of the novel, film, or drive are about to shift. Because these activities are usually not repeated, any stimuli correlated with changes in reinforcement do not develop stimulus control (i.e., the MIX schedule does not become a multiple [MULT] schedule).

Tiger and Hanley (2005) used MULT and MIX schedules to study variables that promote discriminative control of social approach responses in preschool children. Two children sat facing the experimenter at tables containing a variety of academic materials. The experimenter looked down except when delivering 5 seconds of attention contingent on social approach responses. The children were alternately presented with three schedule components in a randomized order. In the FR 1 component, each social approach response was reinforced with attention. In the EXT_1 component, one child's social initiatives were reinforced while the other child's were not, and in the EXT_2 component, neither child's approaches were reinforced. In the MULT schedule, denoted MULT FR 1 EXT_1 EXT_2, the experimenter wore a different colored floral lei during each component. The leis were not worn during the MIX schedule: MIX FR1 EXT_1 EXT_2. The students first experienced the MIX schedule and their social approach responses were undifferentiated across the three components, indicating that the children were unaware of when approach responses would and would not be reinforced. In the subsequent MULT schedule, approach responses became somewhat differentiated for one child, showing more approaches during the FR 1 component than the EXT components. However, approaches remained undifferentiated for the second child. To enhance stimulus control, the experimenter then described the rules of reinforcement and extinction for each schedule component and how each was correlated with a different colored lei, resulting in a MULT schedule with rules. This condition resulted in the greatest differential responding, which continued following a return to the MIX schedule.

Behavioral Contrast

Behavioral contrast is a phenomenon that results from an interaction among schedule components in a MULT schedule; that is, events in one schedule component affect responding in the other components. Reynolds (1961) first described this interaction in an experiment with pigeons exposed to two different MULT schedules. In the first schedule, key pecking was reinforced on a VI 3-minute schedule when the response keys were alternately illuminated red and green, resulting in a MULT VI 3-minute VI 3-minute schedule. Following stable responding in this schedule, the second multiple schedule was introduced. In this schedule, the green component was changed from VI 3-minute to extinction resulting in a MULT VI 3-minute EXT schedule. Figure 4.2 shows the results of Reynolds's experiment. Behavioral contrast is evident in the second MULT schedule. Whereas responding declined as expected during the EXT component, responding in the unchanged VI 3-minute component increased substantially. It is noteworthy that the increased response rate evident in the unchanged component did not result in an increased rate of reinforcement because response rate and reinforcement rate are largely independent in interval schedules. Behavioral contrast in interval schedules represents an "irratio-

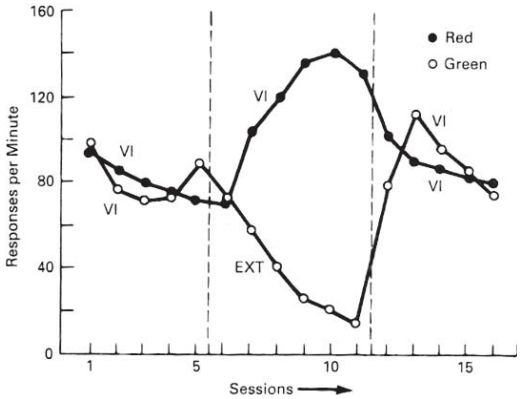


FIGURE 4.2. Reynolds's (1961) illustration of behavioral contrast in the multiple schedule arrangement: MULT VI 3-minute VI 3-minute schedules followed by MULT VI 3-minute EXT schedules resulted in relative increases in response rates in the unchanged VI 3-minute component.

nal" expenditure of responses (and caloric expenditure). This would not be the case in multiple ratio schedules in which increased responding in the unchanged component would compensate for the loss of reinforcement in the EXT component. There are numerous accounts for behavioral contrast (see Catania, 1998, p. 183, for this discussion).

There is growing evidence that humans show behavioral contrast. For example, Hantula and Crowell (1994) exposed undergraduate psychology students to equal MULT VI VI schedules in the context of a computerized stock investment task. Participants could make "investments" in stocks in two different markets that were alternately available and signaled by a written notice. Investments were reinforced with a 30% gain according to VI schedules. Following the MULT VI VI baseline, one market was placed on EXT and the other remained on the unchanged VI schedule. Five of the six study participants showed substantially increased investments in the unchanged VI component under the MULT VI EXT schedule.

Behavioral contrast can be particularly relevant in clinical ABA work. Interventions typically involve the discontinuation of reinforcement for undesirable behavior. When the undesirable behavior has been reinforced at a high rate and is then placed on EXT in one context, such as school, contrast effects may emerge in other contexts in which the intervention has not been implemented (e.g., home). This may be more likely if the reinforcement of prosocial alternative behavior does not fully compensate for the reduction in reinforcement from the EXT schedule. This possibility should guide the selection of reinforcement schedules for the prosocial behavior and the advisement of parents, for example, of the possible side effects of intervention.

Concurrent and Conjoint Schedules

Concurrent and conjoint schedules arrange for two or more schedule components to be available at the same time, such that the individual is free to alternate among the components at any point. This arrangement permits the assessment of the relative preference for the schedule components and the study of choice. As with MULT and MIX schedules, the difference between concurrent and conjoint schedules is that schedule components in concurrent schedules are correlated with distinct stimuli and are not in conjoint schedules. Concurrent schedules are characteristic of all human environments where numerous alternatives are available at any point in time and are generally correlated with distinct stimuli. For example, a woman commuting to work with a friend on a subway will have many different, concurrently available alternatives. She can converse with her friend on a variety of topics, read a newspaper, do a crossword puzzle, listen to music, people watch, plan her work day, and so on. Each of these activities is correlated with distinct stimuli, and each provides reinforcers according to some schedule. Because human environments are characterized by concurrent schedules of reinforcement, this is our emphasis in this chapter.

Concurrent (CONC) schedules can be arranged for any combination of interval, ratio, or differential schedules of reinforcement (Davison & McCarthy, 1988). However, the majority of studies employing concurrent schedules have used CONC VI VI schedules. This is because CONC ratio schedules ordinarily result in exclusive responding on the richer of the two schedules (Herrnstein & Loveland, 1975). The arrangement of asymmetrical schedules such as CONC VI

FR can produce a preference for the qualitative features of one of the schedules that is independent of the amount of reinforcement derived from the schedule (Baum, 1974). Experiments arranging CONC VI VI schedules generally include an adjunctive procedure known as a *changeover delay* (COD), which imposes a brief time interval during which responses cannot be reinforced immediately after switching from one schedule to another. The COD reduces the likelihood that schedule switching will be accidentally reinforced should the first response after the schedule switch be eligible for reinforcement.

Matching Theory

CONC schedules promote a pattern of response allocation that is very orderly. Herrnstein (1961, 1970) formulated the *matching law* that quantitatively described the functional relationship between relative response rates on CONC alternatives and relative obtained rates of reinforcement. The matching law states that relative response rate will match or be equal to relative reinforcement rate. In its simplest form, the matching law is expressed as $B1/B1 + B2 = r1/r1 + r2$, where $B1$ and $B2$ are response rates for two behaviors, and $r1$ and $r2$ are the obtained reinforcement rates for the two behaviors. This equation can be reduced to $B1/B2 = r1/r2$, and a line can be fitted to logarithmic transformations of the obtained data in the form of $\log (B1/B2) = a \log (r1/r2) + \log k$, where a is the slope of the line and $\log k$ is its intercept at the y-axis (see Baum, 1974, and McDowell, 1989, for full descriptions of mathematical transformations of the simplified form of the matching law). When there is perfect matching, $a = 1.0$ and $\log k = 0$. Values of $a > 1.0$ are known as *overmatching,* and values < 1.0 are referred to as *undermatching*, reflecting the individual's sensitivity to relative reinforcement rate. Values of $\log k > 0$ reflect a bias for $B1$, and values < 0 show a bias for $B2$ due to variables other than relative reinforcement rate (see below).

Conger and Killeen (1974) provided one of the first demonstrations of the matching law involving human social behavior. Their study participants engaged in conversation with two experimenters who provided comments of approval contingent on statements of the participant. The experimenters' comments were provided on different sets of CONC VI VI schedules. The dependent measure in the study, relative time participants directed verbal statements to the two experimenters, was found to match closely the relative rates of experimenter attention. Numerous studies have established the generality of the matching law relative to human behavior in the laboratory (Pierce & Epling, 1984) and to a wide range of socially relevant human behavior, from academic engagement (Martens et al., 1992) to the performance of basketball players (Vollmer & Bourret, 2000). Although generally robust, there have also been several reports of human performance departing from matching (Pierce & Epling, 1984). For example, Mace, Neef, Shade, and Mauro (1994) needed to employ a variety of adjunctive procedures in addition to a 15-seconds LH and COD (4 seconds, 8 seconds, or 10 seconds), such as a timer counting down to the end of each reinforcement interval and demonstrating how to allocate responding to maximize obtained reinforcement in order for adolescents to allocate their time to arithmetic problems in accordance with matching.

When choices differ only by the variable of relative rate of reinforcement, the choices are said to be *symmetrical*. However, human choices in natural environments are most often *asymmetrical*. Response alternatives can differ along several different parameters of reinforcement, including reinforcer quality, reinforcer delay, reinforcer amount, reinforcement schedule features, and control of reinforcers. Alternatives can also differ with respect to the response requirements or effort involved in obtaining reinforcement. Baum (1974) provided a matching equation that accommodated independent variables other than relative reinforcement rate. The *generalized matching law* expresses that $B1/B2 = V1/V2$, where V refers to the *value* of the given alternative as defined by the sum of the relative reinforcement parameters and response effort.

Mace and Roberts (1993) illustrated the applied relevance of the generalized matching law. They provided a conceptual framework to guide the functional assessment of undesirable behaviors and the selection of behavioral treatments. In a descriptive analysis of undesirable behavior under natural conditions, the behavior analyst can identify

the quality of the reinforcing consequence, the magnitude of delay to reinforcement, the amount of reinforcement provided, and the response requirement to produce reinforcement, and estimate the operative schedule of reinforcement. With this information, the behavior analyst can design an intervention that should effectively compete with the parameters of reinforcement and response effort that maintain undesirable behavior. This tool affords a more refined approach to the development of interventions based on the variables that affect choice.

Chained and Tandem Schedules

Chained and tandem schedules organize sequences of behavior that lead to reinforcement. Both schedules comprise two or more components arranged in a sequence. In a two-component example, completion of the schedule requirements for the *initial link* produces the onset of the second component, or *terminal link*. Completion of the terminal link schedule requirements results in delivery of a reinforcer. Schedule components in chained schedules are correlated with distinct stimuli, whereas components in tandem schedules are not. Human behavior is regularly exposed to chained and tandem schedules. For example, numerous sequences of behavior required to experience a vacation constitute a chained schedule, such as planning the vacation (initial link), booking transportation (*interim link*), and transportation to the desired location (terminal link). Completion of all of these schedule components produces access to the reinforcing events available at the vacation site.

As is true of the basic schedules of reinforcement discussed earlier, chained and tandem schedules rarely operate in isolation. The more common characteristic of natural human environments is for initial links to consist of a concurrent schedule; that is, humans are typically presented with a choice of sequential activities and terminal reinforcers. This arrangement is known as a *concurrent chain schedule*. In laboratory experiments, the initial link schedule requirements are usually identical (e.g., CONC VI 20 seconds VI 20 seconds). However, terminal link reinforcers, and sometimes schedule requirements, differ. Completion of the initial link alternative produces the S^D for the terminal link associated with that alternative. For example, completion of initial link *A* results in presentation of the S^D for terminal link *A*, and completion of this schedule requirement results in delivery of reinforcer *A*. A parallel sequence is followed for meeting the schedule requirements for initial link *B* (see Figure 4.3 for a diagram of the concurrent chain schedule employed by Rachlin & Green, 1972).

Self-Control

One contemporary development in ABA that employs concurrent-chain schedules is the behavioral model of self-control. Rachlin and Green (1972) formally developed the model in an experiment with pigeons. Figure 4.3 diagrams the concurrent-chain procedure they employed. The initial link was a CONC FR 25 FR 25 schedule with both response keys illuminated white. Completion of the right FR 25 schedule (top sequence) resulted in darkening of the response keys and houselight for *T*-seconds. After the blackout, the response keys were reilluminated green (right key) and red (left key).

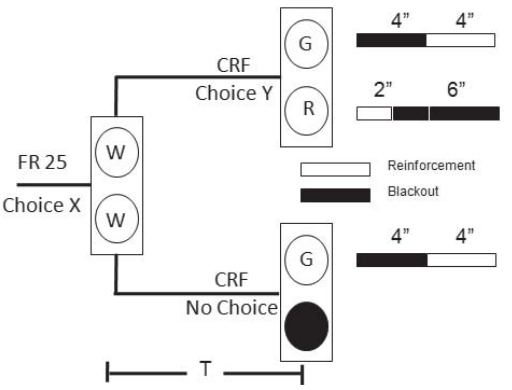


FIGURE 4.3. Rachlin and Green's (1972) concurrent-chain schedule illustrates a behavioral model of self-control. The initial link (CONC FR 25 FR 25) presented a choice between access to the terminal link schedules. Completion of the top (right) link produced a *T*-second delay followed by CONC CRF CRF schedules that presented a choice between small immediate reinforcement and large delayed reinforcement. Completion of the bottom (left) link produced a *T*-second delay followed by CONC CRF EXT schedules and the option only for large delayed reinforcement.

The terminal link was a CONC CRF CRF schedule in which a single key peck on green resulted in a 4-second blackout followed by a 4-second access to food, and a single key peck on red resulted in immediate access to 2 seconds of food followed by a 6-second blackout. Thus, completion of the right FR 25 initial link resulted in later exposure to a choice between small immediate reinforcement (SIR) and large delayed reinforcement (LDR). By contrast, completion of the left initial link FR 25 schedule resulted in a similar blackout for *T*-seconds followed by the illumination of the green key alternative only with the LDR contingency. When the time interval between completion of the initial link and onset of the terminal link was short (e.g., 0.5 seconds), the pigeons reliably chose the red key alternative. Rachlin and Green describe this choice as an *impulsive* one because it forfeits an additional 2-second access to food available for the green key. Thus, the delay to reinforcement discounts the value of the LDR. When the experimenters varied the value of *T*, pigeons showed a shift in their preference on the initial link. In general, as the value of *T* increased, so did the probability of choosing the left initial link FR 25 schedule that later resulted in no choice and the LDR contingency only. Rachlin and Green referred to choosing the left initial link key as making a *commitment response*, one that avoids the "temptation" of SIR and exposes the individual to the LDR contingency only. *Self-control* is said to occur when the individual (1) chooses the LDR over the SIR contingency when exposed to both or (2) makes the commitment response in the initial link.

Numerous applied studies have utilized concurrent-chain schedules to study impulsivity and self-control. The behavior of children with attention-deficit/hyperactivity disorder (ADHD) is particularly relevant to this procedure because a defining characteristic of this disorder is impulsivity and a primary clinical goal is the development of self-control. For example, numerous studies have found that children with ADHD are more likely than their typically developing peers to choose SIR over LDR impulsively (e.g., Hoerger & Mace, 2006; Neef, Marckel, et al., 2005; Schweitzer & Sulzer-Azaroff, 1988). Other studies have shown that impulsive behavior is sensitive to variables other than delayed reinforcement, such as response effort (Hoerger & Mace, 2006). Finally, this paradigm has been used guide the development of specific interventions to promote self-control, such as delay fading and commitment training (Binder, Dixon, & Ghezzi, 2000; DuPaul & Ervin, 1996), and to evaluate response to stimulant medication (Neef, Bicard, Endo, Coury, & Aman, 2005). Thus, the concurrent-chain schedule has provided a conceptual model for understanding impulsivity and self-control, a procedure for objectively assessing an individual's sensitivity to delayed reinforcement and other variables, and a model for identifying specific interventions to promote self-control and evaluating pharmacological interventions.

Behavioral Momentum Theory

Behavioral momentum is a metaphor proposed by Nevin and colleagues (1983) to describe the tendency for baseline response rates to persist following some response disruptor (see earlier discussion of resistance to change). As in Newton's second law of motion, behavioral momentum is the product of behavioral mass and behavioral velocity, where *behavioral velocity* is baseline response rate and *behavioral mass* is the resistance of baseline response rate to change following application of varying amounts of some response disruptor. When response rates are graphed across varying amounts of the response disruptor (e.g., sessions of extinction, amounts of presession food), the height of the curve or function on the *y*-axis reflects behavioral velocity, and the slope of the function across the *x*-axis reflects resistance to change; the total area under the curve represents a response's behavioral momentum.

Behavioral momentum has been studied using a variety of schedules of reinforcement, including multiple schedules (Nevin et al., 1983), multiple concurrent schedules (Nevin, Tota, Torquato, & Shull, 1990), and concurrent-chain schedules (Grace & Nevin, 1997). Numerous studies have shown that resistance to change is a function of the reinforcement conditions related to these schedules. For example, Nevin (1974) and Nevin and colleagues (1983) used a two-component multiple schedule to demon-

strate that resistance to change is a positive function of baseline rate of reinforcement. Different pairs of MULT VI VI schedules arranged a higher rate of reinforcement in one component relative to the other. During conditions of EXT, satiation, and dark-key food, key pecking in pigeons was more persistent in the component with the higher baseline reinforcement rate. In a subsequent series of experiments, Nevin and colleagues (1990) tested the competing hypotheses that resistance to change is a function of baseline response–reinforcer relations versus baseline stimulus–reinforcer relations. In their Experiment 2, baseline consisted of a three-component multiple concurrent schedule. In each component of the MULT, two CONC schedules operated, where the left key is the first CONC schedule and the right key the second: CONC VI 45/hour VI 15/hour (green), CONC EXT VI 15/hour (red), and CONC EXT VI 60/hour (white). In this arrangement, the response–reinforcer contingencies were equal in the green- and red-key components (15/hour each) and less than the white-key component (60/hour). By contrast the stimulus–reinforcer contingences (i.e., the total reinforcers delivered in the presence of each color) were equal in green and white (60/hour each) and less than red (15/hour). Tests of the resistance of right-key pecking to extinction and satiation showed that resistance to change was a positive function of the total number of reinforcers delivered in each component (color-reinforcer contingency) rather the number of reinforcers delivered on the right key (peck-reinforcer contingency). Nevin and colleagues' general findings have been replicated in several human studies (e.g., Cohen et al., 2001; Dube & McIlvane, 2001; Mace et al., 1990).

Ahern, Clark, Gardenier, Chung, and Dube (2003) illustrated the relevance of the Nevin and colleagues (1990) findings to clinically important human behavior. A functional analysis of the stereotypical behavior of three children with autism supported the conclusion that stereotypy was maintained by automatic reinforcement. Next, preferred objects were identified via a preference assessment. Levels of stereotypical behavior were then compared in a test sequence of conditions and a control sequence. The test sequence consisted of baseline (no play materials available) → VT delivery of a preferred item → test (continuous access to a second preferred item) → baseline. The control sequence consisted of baseline → baseline → test → baseline. Ahern and colleagues found that while both the VT and test conditions reduced stereotypical behavior relative to baseline (due to the effects of alternative reinforcement), stereotypy was higher in the test condition that followed VT reinforcer deliveries than in the test condition that followed baseline with no toys available. Mace (2000) and Ahern and colleagues pointed out that while interventions based on differential reinforcement of alternative behaviors (DRA) and FT or VT schedules reliably reduce occurrences of undesirable behavior, these same interventions can have persistence-strengthening effects on undesirable behavior.

Grace and Nevin (2000) proposed a unifying theory of choice and behavioral momentum in which the variables functionally related to preference or choice are the same as those related to resistance to change. One study forming the basis of this theory was conducted by Grace and Nevin (1997), who randomly alternated a concurrent-chain procedure and a multiple schedule procedure within a single experimental session. Three response keys were mounted on a wall above a food magazine. In the concurrent-chain procedure, the side keys were illuminated white in the initial link consisting of equal CONC VI 20-second VI 20-second schedules. Initial link reinforcement consisted of terminal link entry and darkening of the side keys, and illumination of the center key either green or red depending on whether terminal link entry was contingent on a left or a right initial link key peck. The terminal key colors were correlated with a higher- or lower-rate VI schedule. Thirty-six cycles of the concurrent-chain arrangement were presented each session. Thus, the concurrent-chain procedure permitted the assessment of preference for the terminal link as a function of choice in the initial link. The multiple schedule procedure in the experimental session involved the usual alternation of green and red keys correlated with the same VI schedules used in the concurrent-chain procedure. Following this baseline arrangement, resistance to change was tested by dark-key food deliveries between components in the multiple schedule. Grace and Nevin found

that preference in the concurrent chains and resistance to change in the multiple schedule were comparably predicted by relative rate of reinforcement. Mace, Mauro, Boyajian, and Eckert (1997) demonstrated the applied significance of Grace and Nevin's work. They modified the high-*p* procedure that was inspired by the behavioral momentum metaphor to increase its effectiveness. Knowing that reinforcer quality affects choice, Mace et al. reasoned that supplying a higher-quality reinforcer (food) contingent on compliance to high-*p* instructions would increase the resistance of compliance to change when a low-*p* instruction was presented. The high-*p* procedure with food proved effective at increasing compliance to low-*p* instructions that were unresponsive to the high-*p* procedure without food.

Conjunctive and Alternative Schedules

Both conjunctive and alternative schedules comprise two or more schedule components. In conjunctive schedules, the schedule requirements for *all* components must be satisfied to produce a reinforcer delivery. Unlike chained schedules, the order of schedule completion is irrelevant in conjunctive schedules. By contrast, alternative schedules arrange schedule components to be available concurrently. The reinforcer is contingent on completion of *either* component, whichever occurs first.

Vollmer and colleagues (1997) evaluated the effectiveness of FT schedules to reduce the severe aggressive behavior of a 13-year-old girl with severe mental retardation, whose aggression was maintained by tangible reinforcement. Following a functional analysis baseline, access to a preferred magazine was initially delivered continuously, resulting in zero occurrences of aggression. During attempts to thin the schedule to an FT schedule, aggression reemerged sharply at an FT 30-second schedule. A within-session analysis of the temporal relationship between FT reinforcer deliveries and occurrences of aggression showed that scheduled reinforcer deliveries often coincided within 10 seconds of aggressive acts. This suggested that the FT schedule could have adventitiously reinforced aggressive behavior. To avoid this possibility, Vollmer and colleagues introduced a conjunctive FT DRO 10-second schedule. Access to the preferred magazine was set up by the FT schedule; however, the magazine was delivered only if there had been no aggression during the last 10 seconds of the FT interval; that is, both the FT and DRO schedule requirements had to be satisfied to give the girl access to the magazine. After an initial response burst, the conjunctive schedule reduced aggression to low levels, and the FT schedule was then successfully thinned to a conjunctive FT 5-minute DRO 10-second schedule.

Bowman, Piazza, Fisher, Hagopian, and Kogan (1997) used an alternative (ALT) schedule of reinforcement to evaluate preference for varied presentation of less preferred reinforcers versus constant delivery of highly preferred reinforcers. Participants were taught a simple response such as sitting in a chair, standing in a square, operating a microswitch, or stuffing an envelope to obtain a reinforcer. The study compared three conditions of reinforcement that were made available concurrently: varied reinforcers, constant reinforcers, and EXT. For example, three chairs were positioned in a room, and the reinforcers available for each response were placed on the chair. Each time the criteria for reinforcement were met (e.g., sitting in a chair or operating a microswitch), the reinforcer (varied, constant, or no reinforcer) was delivered. Thus, the schedule denotation was ALT FR 1 FR 1 EXT. Unlike concurrent schedules of reinforcement in which the individual can switch among schedules to obtain reinforcement from all schedule components, the alternative schedule reflects a preference for one reinforcer over another. Bowman and colleagues found that four out of six participants showed a preference for the varied lower-preference reinforcer, suggesting that lower-preference reinforcers can be made more effective when varied.

Summary and Conclusion

We have reviewed basic and combined schedules of reinforcement, and have provided definitions for each schedule and illustrations of the applications of the schedules in the ABA research literature. Schedules of reinforcement promote specific patterns of responding but do so only in a broader context of available concurrent discriminated

operants. That broader context includes the temporary motivational conditions for each discriminated operant and its particular history of reinforcement or behavioral mass. We have provided an overview of some contemporary developments in ABA, such as behavioral contrast, the matching theory, self-control, and behavioral momentum theory, and have illustrated that these topics are directly related to specific schedules of reinforcement. Deliberate use of schedules of reinforcement offers applied behavior analysts a powerful tool to understand the conditions that maintain behavior and to design highly effective interventions.

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CHAPTER 5

Stimulus Control and Generalization

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The term *stimulus control* has been used in a variety of ways and has broad connotations. Stimulus control may be defined in terms of the changes in the probability of a form or rate of a behavior that occur as a result of presentation of a stimulus. Defined in this way, stimulus control would include discriminative, eliciting, and reinforcing functions (Skinner, 1938). The discussion for this chapter is restricted primarily to discriminative control, the stimulus control that is developed as a function of the presentation of positive reinforcers or the withdrawal of negative reinforcers (aversive stimuli) contingent on a response in the presence of a stimulus.

The term *generalization* also has been used in a variety of ways. In basic laboratory work with nonhuman subjects, it typically has referred to primary stimulus generalization. For example, once a response is conditioned to occur whenever a 1,000-cycles-per-second (cps) tone is presented, a response also will occur when a 1,500- or a 670-cps tone is presented (Jenkins & Harrison, 1960). Applied behavior analysts have used the term in a much broader sense. Stokes and Baer (1977) used the term to refer to "any occurrence of relevant behavior under nontraining conditions (i.e., across subjects, settings, people, behaviors, and/or time) without the scheduling of the same events in those as had been scheduled in the training conditions" (p. 350). We use the term *generalization* in a slightly different way. Generalization for us includes more rapid learning of new discriminations based on the learning of similar discriminations in the past (i.e., learning to learn; Harlow, 1949).

Individuals are subjected continuously to contextual or background stimuli (visual, auditory, tactile, gustatory, olfactory). These stimuli can be external or produced by the individual's own body. Whether a specific stimulus gains control over a specific response depends on a variety of factors. First, it depends on the saliency of the stimulus (i.e., how different the stimulus is from the background stimuli; Dinsmoor, 1995b). For example, a shout presented in a quiet library would be salient. By contrast, a whisper presented at a basketball game would not be salient. In typical laboratory studies of stimulus control, experimenters design the laboratory environment to control the background stimuli by reducing any extraneous auditory or visual stimuli. For example, a nonhuman subject may be placed in a closed chamber with white noise presented at a constant level, and with any distracting visual

stimuli eliminated. The control may not be as complete in many experimental settings if the study involves human subjects, yet attempts should be made to eliminate changes in the background stimuli that may be distracting to humans.

Second, a stimulus must be associated with differential consequences if that stimulus is to gain control over a specific response. A salient stimulus evokes responses when first presented prior to any conditioning. The stimulus becomes a part of the background stimuli if differential contingencies do not occur for specific responses in the repeated presence of the stimulus. For example, the neighbor's barking dog may evoke a startle response (e.g., turning toward the source of the barking, increasing heart rate) initially. However, the barking becomes part of the background stimuli that no longer evoke the initial responses if barking continues without differential contingencies following the barking.

Third, the response must be a part of the individual's behavioral repertoire for the stimulus to gain control over a response. For example, individuals without speech often are taught other forms of verbal behavior (e.g., sign language, picture exchange system). The alternative form of verbal behavior is selected typically based on responses that the individual already emits (e.g., pointing, touching); that is, a response that is already in the individual's repertoire (e.g., fine motor) is selected instead of a response that the individual has not emitted (e.g., speech).

This chapter begins with the establishment of simple discriminations and proceeds to more complex stimulus control. The first section on simple stimulus control may initially seem quite removed from the type of complex discriminations required in one's daily life. However, the importance of simple discriminations may become more apparent in later sections on more complex discriminations.

Establishing Control by a Single Stimulus

One must have a salient stimulus, a somewhat controlled environment, and a response that is part of the individual's repertoire to bring a response under the control of a stimulus. The selected response can be brought under the control of a salient stimulus if (1) a reinforcing consequence immediately follows each response made in the presence of the stimulus, (2) reinforcement of responding does not occur in the absence of the stimulus, and (3) there are no other conditions correlated with reinforcement and nonreinforcement. The presentation of the stimulus should occur over varying periods of time, so that responding is not based on temporal patterns, to ensure that the relevant stimulus is controlling the response. For example, if a stimulus is presented once every minute for 30 seconds, forming a temporal discrimination could be based on time rather than the presentation of the stimulus. Therefore, it is important to present the stimulus on a variable-time schedule.

Some responding may occur just before the stimulus is presented if the stimulus is presented regardless of the individual's response during the absence of that stimulus. In that case, the responses that occur immediately prior to the presentation of the stimulus are reinforced by the occurrence of the stimulus because reinforcement is delivered when responding occurs in its presence. Such reinforcement may impede discriminative responding. Therefore, it is best to delay the presentation of the stimulus if a response occurs just before its scheduled presentation to allow for extinction of the response during the absence of the relevant stimulus (Ferster & Perrott, 1968).

Once responding occurs primarily when the stimulus is present and not when it is absent, it should be determined whether responding is under the control of the discriminative properties of the relevant stimulus or of reinforcement. During the procedures described earlier, the reinforcing stimulus may develop discriminative properties because reinforcement of responding is likely to be followed by more reinforcement, and nonreinforcement is likely to be followed by more nonreinforcement. Hence, it is possible that a student would respond more after reinforcement was delivered (the stimulus-present condition) than following a response that was not reinforced (the stimulus-absent period), regardless of the stimulus (Blough, 1966). However, one can be sure that it is the relevant stimulus controlling the response if responding begins immediately after the

stimulus is presented and stops immediately after the stimulus is terminated.

It is best to start with a very salient stimulus when establishing control over a specific response. However, other similar stimuli also may control the response once control is established. Stimulus generalization allows for the reinforcement of responses in the presence of stimuli that initially may have been very difficult to condition. For example, Fulton and Spradlin (1971) initially established control over a button-pressing response to a 70-decibel 500-Hertz tone (a salient stimulus for people with normal hearing) to assess the hearing of children with severe retardation. Control was not limited solely to a 70-decibel 500-Hertz tone for most participants; less intense tones also controlled responding. The fact that the children responded to not only the 70-decibel tone but also slightly less intense tones allowed for the reinforcement of responses to tones of lower intensity. After responses to lower-intensity tones had been reinforced, generalization occurred to tones of still lower intensity. Stimulus control was maintained by the tone until the tone reached threshold levels (i.e., the magnitude level of the stimulus at which responding is no longer discriminative) as a result of stimulus generalization and reinforcement of responses to tones with lower intensity than the previously reinforced tones.

The type of stimulus control just described is probably the simplest form of operant stimulus control. Even though most studies of the establishment of this type of simple stimulus control have been limited to auditory and visual stimuli, these procedures can be used to establish control by stimuli presented in other modalities (e.g., tactile, gustatory, olfactory). Control by members of a single stimulus may have few parallels in the daily lives of individuals, but as noted earlier, it has been useful in evaluating the hearing of people with severe cognitive disabilities (Fulton & Spradlin, 1971). Another practical use of this type of training involves conditioning dogs to sniff for narcotics and explosives. Although the odors of narcotics and explosives are not salient stimuli for humans, they are for dogs. The dogs typically are trained to respond to the odors related to a specific substance (e.g., narcotics, explosives) by reinforcing a specific response (i.e., sit and stay) when the odor of the substance is present and not when it is absent.

Differential Stimulus Control by Successively Presented Stimuli

The mere detection of the presence of a stimulus is important under some conditions, but more often, stimulus control involves a discrimination between two stimuli: a positive stimulus (i.e., stimulus correlated with reinforcement) and a negative stimulus (i.e., stimulus correlated with nonreinforcement). The positive stimulus (e.g., a red light) may be alternated with a negative stimulus (e.g., a green light) of the same intensity and presentation duration to establish a successive discrimination (i.e., the stimuli occur at different times). However, discriminative responding under this condition can be slow and may not occur for all experimental participants.

A fading procedure would likely be more efficient to establish a more rapid discrimination among the stimuli (Terrace, 1966). Initially, a fading procedure would require that the positive stimulus is salient (e.g., a bright red light), whereas the negative stimulus is not (e.g., a faint green light). Moreover, the presentations of the faint green light would be brief in comparison to the duration of the positive stimulus presentation. A brief negative stimulus presentation increases the likelihood that responding occurs only in the presence of the positive stimulus and not in the presence of the negative stimulus. Once responding occurs only in the presence of the positive stimulus (e.g., red light), the intensity of the negative stimulus (e.g., green light) should be increased gradually if responding does not occur in the presence of the negative stimulus. Once the intensity of the negative stimulus equals that of the positive stimulus and responses do not occur in the presence of the negative stimulus, the duration of its presentation should be increased gradually to equal the duration of the positive stimulus presentations.

Macht (1971) used similar procedures to teach a discrimination between forward and reversed E's to children with retardation. Students were taught to press a lever when the letter E (positive stimulus) was presented and not to press the lever when a solid black

square (negative stimulus) was presented. Initially, presentations of the E's were long in duration. When responding paused, the black square was presented for a brief period. Durations were increased over subsequent presentations of the black square. Responses in the presence of the black square were punished. Once responding between the E and the square was discriminative, small components of the reversed E were introduced. The discrimination between the forward E and the reversed E was established using variations of this procedure. Each child's vision then was evaluated by systematically moving the child farther and farther from the apparatus that presented the forward and reversed E's.

When the first discrimination (e.g., forward and reversed E's) has been established using a fading technique as described earlier, the next discrimination to be established (e.g., A vs. F) may not require extensive programming or may be established in fewer stimulus presentations. In addition, future discriminations (e.g., N vs. M) may be established more quickly even when presented without a fading program. This type of improvement in discriminative learning has been attributed to the control of attending responses (Dinsmoor, 1995a). It also may be considered as a special case of learning to learn or a learning set (Harlow, 1949).

Even though establishing discrimination between a forward and reversed E may be sufficient for the evaluation of subjective vision, it is insufficient for most educational purposes. For example, teaching the discrimination between a forward and reversed E will most likely not establish a discrimination between the letters E and F. Therefore, one should use a variety of different negative stimuli (e.g., F, P, B, I) and variations of the positive stimulus when teaching such a discrimination (e.g., *E,* **E**; see Engelmann & Carnine, 1982, for a more complete discussion).

Differential Stimulus Control by Two or More Simultaneously Presented Stimuli

A simple simultaneous discrimination involves the discrimination between two or more stimuli presented at the same time. Sidman and Stoddard (1967) established fine circle–ellipse discriminations using a fading procedure that involved an apparatus with eight translucent keys on which light and figures were projected. Initially, there was great disparity between the positive (circle on a fully illuminated white key) and negative (no figures, nonilluminated keys) stimuli. Training began with the presentation of one positive and seven negative stimuli. Touching the positive stimulus produced reinforcement, whereas touching any of the negative stimuli did not. The previous fading step was reinstated when errors were made. Gradually, the seven negative stimuli were illuminated until they were the same intensity as the positive stimulus. Next, a horizontal line was introduced on each of the negative stimulus keys. On successive trials, responding to the positive stimulus was followed by the gradual morphing of the negative stimulus figure (i.e., the horizontal line morphed into a very narrow ellipse). Once the negative stimulus keys were illuminated with an ellipse, the ellipse morphed into an ellipse-like circle that was similar to that on the positive stimulus key. Eventually, the threshold for the circle–ellipse discrimination was established.

Sometimes it is desirable to extend stimulus control from stimuli that already control differential responding to stimuli that currently do not. One method that has been used to transfer control from already existing stimulus dimensions to novel ones is a delayed prompting procedure (Touchette, 1971). Touchette demonstrated the delayed prompting procedure with three adult students with moderate mental retardation. A discrimination between two salient stimuli, a red (positive stimulus) and a white (negative stimulus) light, was established by reinforcing responses to the red key and not reinforcing responses to the white key. After the initial discrimination, a new discrimination was established between two stimuli with minimal disparity: a horizontal E with the legs pointing up versus a horizontal E with the legs pointing down. Initially, the positive and negative stimuli were superimposed on the red and white stimuli, which already controlled behavior. Following the first correct response, the onset of the red background light behind the positive stimulus was delayed for 0.5 seconds. On each additional trial, the onset of the red background stimulus was delayed an additional 0.5 sec-

onds and decreased by 0.5 seconds for each incorrect response. Correct responding occurred before the delivery of the prompt (i.e., the red light) within 10 trials with all three students. However, such rapid acquisition of correct responding does not always occur. Subsequent research suggests the students may have been atypical (e.g., Oppenheimer, Saunders, & Spradlin, 1993).

Oppenheimer and colleagues (1993) found three different outcomes resulting from a similar procedure with 30 adults with mental retardation. First, like Touchette's participants, some individuals responded before the red light occurred and were correct. Second, some individuals responded before the red light occurred but were correct on only 50% of the trials. Third, some individuals never responded before the red light occurred. The experimenters conducted further testing with this group of individuals to determine (1) whether responding did not occur because the discrimination between the horizontal E's had not been established, or (2) whether the discrimination between the two horizontal E's had been established but the individual was waiting until the red light came on before responding. Tests were conducted by presenting the red light simultaneously on the keys behind both the correct and the incorrect E. Some individuals did not preempt the red light because the discrimination was not established; that is, their performance was at chance level when the red light was projected on both keys. However, other individuals responded correctly when the red light was projected on both E's. Therefore, the red light functioned as a "go" stimulus for discriminative responding between the E's for some individuals.

The procedures just described are useful in the laboratory study of discrimination and sensory processes. However, many discrimination situations involve making different responses to different stimuli. Variants of the delayed prompt technique (e.g., progressive and constant time or prompt delay) for teaching a two-choice visual discrimination have been implemented widely (e.g., Handen & Zane, 1987). Delayed prompt procedures have been used to teach such skills as selection of letters and numbers (e.g., Bradley-Johnson, Sunderman, & Johnson, 1983; Touchette & Howard, 1984), sight word reading (e.g., Gast, Ault, Wolery, Doyle, & Belanger, 1988; Knight, Ross, Taylor, & Ramasamy, 2003), and naming and requesting (Charlop, Schreibman, & Thibodeau, 1985; Charlop & Walsh, 1986; Halle, Baer, & Spradlin, 1981; Halle, Marshall, & Spradlin, 1979; Knight et al., 2003).

If one is to teach a child with imitative speech to name printed numerals, one could present the numeral 1 while simultaneously presenting the auditory stimulus "one." Reinforcement for the vocalization should be presented when the student imitates "one." On subsequent trials, the auditory stimulus "one" should be presented after a delay (a few seconds) following the printed numeral 1. Reinforcement should be delivered if the student names the numeral before the auditory stimulus is presented; ideally, the probability of reinforcement would be greater for such preemptive responses (Touchette & Howard, 1984). After the student consistently names the numeral 1, training on the numeral 2 could begin. Initially, the auditory stimulus "two" should be presented simultaneously with the printed numeral 2. When the student imitates "two," the response should be reinforced. Presentations of the printed numeral 2 should continue with a brief delay before the auditory stimulus. This procedure should continue until the student consistently responds prior to the auditory stimulus. Then, the printed numerals 1 and 2 should be introduced in a random order. Initially, the auditory stimuli should be presented simultaneously with the printed numerals to prevent initial errors. Then, the printed numerals (1 or 2) should be presented 4 to 5 seconds prior to the auditory stimulus. This procedure should produce the discrimination quite rapidly for most students. Other printed numerals could be introduced using this same procedure. In fact, it probably would be sufficient to begin by intermixing the printed numerals if the delayed-prompt technique were used with most typically developing students.

Conditional Stimulus Control

In spite of the seeming complexity of the use of delayed prompts to teach naming, all of the discriminations previously discussed have been either simple-successive or simple-

simultaneous discriminations. Even though such simple-successive and -simultaneous discriminations are essential, many of the discriminations that individuals make during their daily activities are *conditional discriminations*, in which reinforcement of a response in the presence of a stimulus is dependent on the presence or absence of other stimuli. For example, a conditional discrimination is demonstrated if salt is passed following the command "Pass the salt," and bread is passed following the command "Pass the bread"; that is, the discriminated behavior is conditional because the positive stimulus (e.g., salt, bread) changes depending on which command is provided (Serna, Dube, & McIlvane, 1997).

Simultaneous identity matching is a very simple conditional-discrimination procedure. This procedure has been studied widely in laboratories with both human and nonhumans. In the laboratory, the typical procedure involves presenting a visual sample stimulus (e.g., the numeral 2) to which the experimental participant must respond. Then two or more comparison stimuli (e.g., 2 and 3 or 2, 3, 4, and 5) are presented following the participant's response to the sample. One of the comparison stimuli (e.g., 2) is identical to the sample stimulus; the remaining stimulus (e.g., 3) or stimuli (e.g., 3, 4, and 5) differ in some way from the sample stimulus. The disparity between the correct comparison stimulus and the other stimuli may be large or small. Different stimuli are presented as samples from trial to trial; thus, the "correct" comparison stimulus is conditional on which sample is present. Identity-matching experiments have involved simple trial-and-error procedures (K. Saunders, Johnson, Tompkins, Dutcher, & Williams, 1997; R. Saunders & Sherman, 1986), and also fading procedures (Dube, Iennaco, & McIlvane, 1993). When fading procedures are used, the first few trials of an identity-matching-to-sample task might present only the single comparison stimulus that matches the sample stimulus, or all of the other comparisons may be blank. After a few trials, the experimenter may begin to fade-in the nonmatching stimulus or stimuli. The nonmatching stimuli would become more visible until the intensity of the nonmatching stimuli matched that of the sample stimulus with each successive trial of correct responding. Typically, after a few comparison stimuli have been matched to samples, new stimuli are typically matched on their first presentation; that is, generalized identity matching is exhibited. Generalized matching is not exhibited readily with nonhuman participants and some individuals with severe mental retardation. The authors consider generalized identity matching as another example of generalization.

The identity-matching task is used extensively in preacademic workbooks to teach letter and number discrimination to students. Usually, the sample letter or number is presented at the left margin, and the choice letters or numbers are presented in a row to the right of the sample. The student's response is to mark the correct choice. This workbook task is an example of identity matching; however, it is not an ideal teaching technique because reinforcement for correct responses typically is delayed.

Simultaneous identity matching requires discrimination of the sample stimuli from the remaining comparison stimuli; however, it neither requires nor ensures successive discrimination among sample stimuli because the sample stimulus remains available throughout the trial. However, if the sample is removed following the onset of the comparisons, the procedure is a delayed matching-to-sample procedure and probably requires successive discrimination of the sample stimuli (e.g., Constantine & Sidman, 1975).

Closely related to the identity-matching task is the oddity procedure. In this discrimination the student is presented an array of three or more stimuli, all of which are similar except one. Sidman and Stoddard (1967) presented such a display to their students; however, they used only one stimulus, a circle, as the correct odd stimulus. Other experimenters have presented series of trials on which the odd stimulus (positive stimulus) was different on various trials (e.g., Dickerson & Girardeau, 1971; Ellis & Sloan, 1959; Smeets & Striefel, 1974; Soraci et al., 1987; Stromer & Stromer, 1989). For example, on one trial, the numeral 1 might be presented as the single positive stimulus with two or more numeral 2's as the negative stimuli. On other trials, a single 2 might be presented with two or more 1s. In that case, the oddity task is a conditional discrimination task

because the stimulus designated as correct depends on the other stimuli. The oddity procedure, like the identity-matching procedure, has been used extensively in preacademic workbooks.

A more complex type of conditional discrimination is one in which the comparison stimuli are not similar physically to the sample stimulus. Auditory–visual matching (e.g., receptive labeling) consists of the presentation of an auditory sample (e.g., dictated object names) with visual comparisons (e.g., an array of objects). For example, if a teacher is training a student to touch specific printed numerals (e.g., 1 and 2) in response to corresponding auditory samples (e.g., "one" or "two"), the correct response is conditional on the sample presented; that is, if the auditory sample is "one," the correct response is the numeral 1, whereas if the auditory sample is "two," the correct response is the numeral 2. Such a conditional discrimination depends on (1) a successive discrimination of the auditory stimuli "one" and "two," (2) a simultaneous discrimination between the printed numerals (i.e., 1 and 2), and (3) the correspondence of the auditory stimulus with the numeral (i.e., "one" and 1). Not all typically developing children learn such conditional discriminations without being taught the discrimination in components. In those cases, conditional responding also can be established by teaching the discrimination in components (see K. Saunders & Spradlin, 1993).

The first component of a component-teaching procedure is the establishment of successive discriminations among the auditory number samples. If the student emits vocal behavior, the discrimination may be taught by having the student echo the auditory stimuli. The second component includes the establishment of discriminated responding to the comparison stimuli (e.g., printed numerals). A match-to-sample probe can be conducted with the numerals. If matching occurs (e.g., 1 to 1, and 2 to 2), then the third component can be implemented. If not, the discrimination between the printed numerals should be established. The third component is to establish the relation between the auditory stimulus (e.g., "one") and the corresponding numeral comparison (e.g., 1). This final step in developing a conditional discrimination may be trained by using a delayed-prompt procedure (Touchette & Howard, 1984) or a blocking procedure (K. Saunders & Spradlin, 1993; K. Saunders, Williams, & Spradlin, 1995; Smeets & Striefel, 1994).

Once a conditional discrimination has been taught (e.g., between "one" and 1, and "two" and 2), the second conditional discrimination is typically taught with less careful programming and fewer trials. After teaching the first number discrimination (e.g., 1 and 2), the teacher could introduce the next printed numeral to be discriminated (e.g., 3) and the corresponding auditory sample (e.g., "three") intermixed with trials involving the previously discriminated numerals. When the novel sample and comparison stimuli (e.g., auditory sample "three" and the numeral 3) are presented with previously trained comparisons (e.g., numeral 1 or 2), the selection of the novel comparison may emerge without direct training. This type of performance has been termed *exclusion* (Dixon, 1977; McIlvane, Kledaras, Lowry, & Stoddard, 1992). The emergence of exclusionary relations has been demonstrated between three-dimensional visual and auditory stimuli (e.g., McIlvane & Stoddard, 1981, 1985), between two-dimensional visual and auditory stimuli (e.g., Wilkinson & Green, 1998; Wilkinson & McIlvane, 1994), and between text and auditory stimuli (e.g., de Rose, de Souza, & Hanna, 1996). However, it is necessary to test for control by the emerged relation under different conditions (e.g., multiple trials with more than two previously unknown comparisons) to ensure control by the sample (Carr, 2003). The new relation may be trained using a variation of the procedure used to teach the initial conditional discrimination, if the discrimination is not established by exclusion.

Equivalence Classes

Previously, we noted that many people might be interested not in establishing control by a single stimulus but by members of a stimulus class (i.e., two or more stimuli that are observed to control the same response class). Many stimulus classes are determined by configurations of shared physical properties (e.g., balls, cars, humans, men, women, cats, red objects). The actual configurations

of shared physical characteristics determining class membership have been the focus of research by psycholinguists, cognitive psychologists (Medin & Smith, 1984; Rosch, 1973), and behavior analysts (e.g., Fields et al., 2002; Fields & Reeve, 2001; Galizio, Stewart, & Pilgrim, 2004). However, many important stimulus classes are not defined by shared physical properties (e.g., toys, tools, letters, numbers, medical doctors, lawyers). The members of these classes are defined more by the substitutability of each member under some conditions. For example, "toys" may be defined as a stimulus class because they are items that children manipulate, and they all may be stored in a toy box. "Medical doctors" may be considered a stimulus class because it is appropriate to call them "doctor," and any member with the appropriate credentials may practice medicine.

Sidman (1971) established an equivalence class using a symbolic-matching procedure with a 17-year-old boy with microcephaly and severe mental retardation. Prior to the experiment, the student selected 20 pictures when presented with their corresponding dictated words (AB) and could name 20 pictures when presented with the pictures (BD). However, he did not name the 20 printed words related to the pictures (CD), select printed words in response to their dictated names (AC), select printed words to the pictures (BC), or select the pictures when presented with the printed words (CB). The selection of printed words was trained when he was presented corresponding dictated words (AC). After training, probes were conducted to see if he would select printed words when given the respective pictures (BC) and if he would select the pictures when presented the respective printed word (CB). Not only did he select the printed words when the dictated words were presented, but the (BC and CB) relations between pictures and printed words emerged, regardless of whether the printed words were presented as sample stimuli or comparison stimuli. In addition, after the initial AC training, many of the printed words were named by the student (CD). This training established 20 stimulus classes; each class consisted of the spoken word, the printed word, and the pictures.

Although the results of Sidman's (1971) study were remarkable, the design was less than ideal for demonstrating the development of new stimulus classes because the stimuli were common (e.g., cat, car, dog) and only one student participated. Sidman's experiment led to a flurry of research directed toward the development of stimulus classes comprising stimuli that shared no defining physical properties (R. Saunders, Saunders, Kirby, & Spradlin, 1988; R. Saunders, Wachter, & Spradlin, 1988; Sidman, Cresson, & Willson-Morris, 1974; Sidman, Kirk, & Willson-Morris, 1985; Sidman & Tailby, 1982; Spradlin, Cotter, & Baxley, 1973; Spradlin & Saunders, 1986; Wetherby, Karlan, & Spradlin, 1983). These studies and others led to numerous theoretical discussions concerning the necessary and sufficient conditions for the development of such classes (Baer, 1982; Fields & Verhave, 1987; Hayes, Barnes-Holmes, & Roche, 2001; Horne & Lowe, 1996; R. Saunders & Green, 1992; Sidman, 1994, 2000; Sidman & Tailby, 1982).

Most matching-to-sample studies after Sidman's (1971) article focusing on the conditions under which relations emerge used procedures with better experimental control (Sidman et al., 1974; Sidman & Tailby, 1982; Spradlin et al., 1973). Experimental stimuli are typically abstract forms (e.g., #, @, ?) or nonsense stimuli (e.g., "vek," "zog"; Fields & Verhave, 1990; Sidman et al., 1974; Sidman & Tailby, 1982; Spradlin et al., 1973). A general procedure is begun by teaching an AB conditional discrimination (i.e., if sample stimulus A1 is presented, selection of comparison stimulus B1 is reinforced, if sample A2 is presented, selection of B2 is reinforced). After the AB discrimination has been established, a new discrimination is taught (BC). In this case, the stimuli (B1 and B2) are presented as samples, and two new comparison stimuli (C1 and C2) are introduced. Once the BC discrimination has been demonstrated, the AB and BC conditional discrimination trials are intermixed. Probe trials are introduced when discrimination is nearly perfect on the AB and BC discriminations. Probe trials usually are introduced without reinforcement or differential feedback and within a series of the AB and BC trials. The first probes are often probes for symmetry (i.e., A1 is the correct comparison when B1 is presented as the sample stimulus, and A2 is the correct comparison when B2 is presented as a sample). In addition, the

CB probe is conducted to determine if the appropriate comparison (B1 and B2) will be selected when presented with the samples C1 and C2. Typically, symmetry is demonstrated (Fields & Verhave, 1990; Pilgrim & Galizio, 1990).

Another probe is conducted to test for transitivity (e.g., determining if the comparison C1 will be selected when A1 is presented as the sample, and if C2 will be selected when A2 is presented as the sample). In addition, probes are conducted to determine if A1 (comparison) will be selected if C1 is presented as the sample, and if A2 (comparison) will be selected when C2 is presented as the sample. This final probe is a combined test for symmetry and transitivity because it cannot be positive unless both symmetry and transitivity are present. When all of these tests are positive, they are said to demonstrate *equivalence* (Sidman & Tailby, 1982). Even though some percentage of students who learn the AB and BC conditional discriminations fail the equivalence tests, a majority of students given this training pass these tests.

AB and BC training can establish an equivalence class; however, these are not the only combinations that result in an equivalence class. Training AB and AC conditional discriminations or BA and CA conditional discriminations also produce equivalence classes. In fact, some research suggests that teaching students to select a single comparison in response to multiple samples is a more effective procedure for demonstrating stimulus equivalence than the other two procedures (Spradlin & Saunders, 1986). All of the tests for equivalence can be made when all of the stimuli are visual. However, if A1 and A2 are auditory stimuli, typically A1 and A2 are not presented as comparisons because of problems involved in presenting and discriminating two simultaneous auditory stimuli.

When studying the development of equivalence classes in a laboratory, the procedures and outcomes may appear initially quite remote from the problems encountered in our daily lives. However, they may not appear quite as remote with an example of equivalence encountered in our daily lives, number equivalence. Although many students learn to select the numerals 1 through 4 easily in response to dictated number names, and also to name the numerals 1 through 4, some do not. These students can be taught three conditional discriminations (AB, AC, and AD) and perhaps nine additional conditional discriminations will emerge through symmetry and transitivity (BA, BC, CA, CB, CD, DA, DC, BD, and DB). Additionally, naming numerals, sets (i.e., quantity), and words (BE, CE, DE) may emerge. Naming responses are likely if the student names either the numerals or the sets prior to training (Gast, VanBiervliet, & Spradlin, 1979). As previously noted, there are many ways that number equivalence classes can be established. For example, one might teach the student to select (1) the numerals in response to their dictated names (AB), (2) sets in response to their printed numerals (BC), and (3) printed words in response to their respective sets (CD). An effective procedure for establishing all of the performances if the student is verbal would be to teach the (1) selection of printed numerals in response to presentation of dictated words (AB), (2) names of the printed numerals (BE), (3) selection of sets in response to presentation of printed numerals (BC), (4) selection of the printed words in response to presentation of sets (CD), and (5) appropriate responding to an intermix of trials from all the trained discriminations (1, 2, and 3). This procedure may be redundant if students name printed numerals after being taught to select printed numerals in response to dictated number names (AB). However, this procedure ensures the familiarity of all the generalization testing formats and that the naming response is in the student's repertoire. In addition, intermixing trials also maintains prerequisite conditional discriminations (Saunders, Wachter, et al., 1988; Spradlin et al., 1973). There are numerous ways of establishing equivalence classes via conditional discriminations. In addition, four new conditional discriminations (BC, CB, BA, and CA) may emerge when there are three visual stimuli within each class, and AB and BC conditional discriminations are trained. Teaching three conditional discriminations (AB, AC, AD) may produce nine new emergent discriminations (BC, CB, BD, DB, CD, DC, BA, CA, DA) when the number of visual stimuli in each class increases to four stimuli; that is, the number of potential untaught discriminations increases dramatically as the number of stimuli in

each class increases. Moreover, equivalence classes with as many as nine members in each class have been established (Saunders, Wachter, et al., 1988).

Equivalence classes have been established using stimuli that have potential social use, including equivalence between printed names, dictated names, and faces of therapists (Cowley, Green, & Braunling-McMorrow, 1992); between dictated words, objects, and manual signs (VanBiervliet, 1977); reading-relevant stimuli (de Rose et al., 1996; de Rose, de Souza, Rossito, & de Rose, 1992; Wultz & Hollis, 1980), prearithmetic skills (Gast et al., 1979), money relations (Stoddard, Brown, Hurlbert, Manoli, & McIlvane, 1989), and spelling and reading (Mackay, 1985; Mueller, Olmi, & Saunders, 2000; Stromer & Mackay, 1992).

Research has demonstrated a number of interesting findings concerning subsequent performances following the establishment of equivalence classes. First, new members can be added readily to the class (e.g., Gast et al., 1979; Saunders, Wachter, et al., 1988). For example, Saunders, Wachter, and colleagues (1988) established two eight-member classes of visual stimuli, using procedures analogous to those described earlier. Experimenters taught the students to select two visual stimuli (one member from each equivalence class) in response to two different auditory stimuli (i.e., nonsense syllables) after they had established the two classes of eight stimuli each. Three of the four students selected the seven remaining stimuli within each class in response to their respective spoken nonsense syllables when probe trials were presented. The fourth student was taught to select a second stimulus in response to each auditory stimulus. After this training, students selected the remaining six stimuli of each class in response to their respective auditory stimuli.

Second, equivalence classes are durable. After training and probing, Saunders, Wachtel, and colleagues (1988) dismissed their students for 2–5 months and then retested to see if the auditory stimuli still controlled the selection of the same comparison stimuli. During the retest, no differential reinforcement was provided for baseline training or probe trials. Correct selections occurred immediately for three of the four students. Responding for the fourth student gradually recovered to prebreak levels even though differential reinforcement was not delivered for baseline training or probe trials.

Third, performances that indicate equivalence are resistant to change as a function of changes in baseline reinforcement conditions (Pilgrim & Galizio, 1990; Saunders, Saunders, et al., 1988). Pilgrim and Galizio (1990) taught five college students AB and AC conditional discriminations. All students demonstrated equivalence after training. The contingencies then were reversed for the AC discrimination (i.e., selecting C2 was reinforced when presented sample A1 and selecting C1 was reinforced when presented with sample A2). Symmetry responding to CA relations reversed for some of the students, but none of the BC or CB responding reversed. Saunders, Saunders, and colleagues (1988) found that equivalence classes were difficult to disrupt once they were established. Additionally, when the contingencies were reversed and responses shifted to meet the contingencies for a single baseline conditional discrimination during training in isolation, the performance reverted back to those in line with the initial contingencies once it was intermixed with the initial baseline conditional discriminations.

Fourth, conditioning an operant response in the presence of a member of the class results in generalization to other members of the class once an equivalence class has been established. Barnes and Keenan (1993) demonstrated the transfer of operant responding from one member of an equivalence class to other members. The authors established two equivalence classes (A1, B1, and C1; A2, B2, and C2) by training AB and AC relations with college students. After the equivalence classes were demonstrated, the students were trained to respond slowly when one stimulus (B1) was presented and rapidly when the second stimulus (B2) was presented. Then, four remaining stimuli (A1, C1, A2, and C2) were presented. Slow responses were emitted in the presence of A1 and C1, whereas rapid responses occurred in the presence of A2 and C2. A similar transfer of control from some members of an equivalence class to a remaining member of that class also was demonstrated by Gast and colleagues (1979).

Fifth, if one or more members of an equivalence class are conditioned to elicit an

emotional response, other members of that class will elicit that response (Dougher, Auguston, Markham, Wulfert, & Greenway, 1994). Dougher and colleagues (1994) established two four-member equivalence classes (A1, B1, C1, and D1) and (A2, B2, C2, and D2) by training AB, AC, and AD conditional discriminations with eight students. The experimenters used two of the stimuli (B1 and B2) in a separate classical conditioning setting after they had established the two four-member equivalence classes. During this phase, B1 and B2 were presented successively. B1 always was followed by shock, and B2 was never followed by shock. B1 came to elicit a galvanic skin response; B2 did not. Six of the eight students exhibited galvanic skin responses to the stimulus class of which B1 was a member, and did not exhibit galvanic skin responses to the stimulus class including B2 when the six remaining stimuli from the two classes were presented. This study demonstrated that emotional responses could develop without direct conditioning if stimuli that evoke those responses are members of an equivalence class.

The preceding text provides a small sample of equivalence studies and some of their implications for understanding the development of stimulus control. Procedures other than conditional discriminations also have resulted in the development of equivalence classes. For example, if a student is taught to say a specific word in response to a set of previously unrelated stimuli, those stimuli are likely to function as a class (Reese, 1972). Researchers have demonstrated that stimuli presented in the same sequence position function as equivalence classes (Mackay, Stoddard, & Spencer, 1989; Sigurdardottir, Green, & Saunders, 1990). For example, if a student is taught to place three stimuli (N, B, and X) in a 1-2-3 sequence while being taught to place stimuli E, L, and Z in a 1-2-3 sequence, stimuli N and E will very likely become members of one equivalence class, Stimuli B and L will likely become members of another, and stimuli X and Z will become members of a third class. In addition, stimuli that occur contiguously also may come to function as members of an equivalence class (Stromer & Stromer, 1990a, 1990b).

Finally, stimuli may be added to an already established equivalence class merely on the basis of shared consequences (Dube & McIlvane, 1995). In summary, there are many ways that equivalence classes can be established. We would venture that, in a given context, two or more stimuli will become members of the same equivalence class, without a change in contingencies, if those stimuli are substitutable.

It must be noted that the formation of a stimulus class is determined contextually. For example, if a teacher asks a student to put all of the toys in one box and all of the tools in another box, the student will respond differently than if the teacher asks that all the soft items be placed in one box and all the hard items in another. Bush, Sidman, and de Rose (1989) demonstrated such contextual control over equivalence class membership with traditional matching-to-sample procedures.

As noted earlier, this is far from a complete discussion of stimulus equivalence and related phenomenon. The reader is referred to writings by Sidman (1994; 2000), Hayes (1991), Hayes and colleagues (2001), and Horne and Lowe (1996) for extensive discussions and theoretical interpretations of the necessary and sufficient conditions for the development of such stimulus control.

Stimulus Control Based on Recombination of Stimulus–Response Components

One of the remarkable characteristics of human behavior is the degree to which responding to complex stimuli occurs without previous direct experience. For example, young children develop generalized imitation such that their behavior can approximate the behavior of a model closely, even though they have never had direct training on imitating the specific model being presented (e.g., Baer, Peterson, & Sherman, 1967; Peterson, 1968). In addition, individuals also may respond appropriately to specific verbal instructions they have never encountered previously (e.g., Striefel, Wetherby, & Karlan, 1976). *Recombinative generalization* occurs when responses targeted during training are recombined in novel ways. For example, if a student is taught to "push glass" and "drop car," the student then may "push car" and "drop glass" also. Striefel and his colleagues (1976, 1978) extended previous work by demonstrating recombinative gen-

eralization of stimulus response units with nonvocal children with severe and profound mental retardation. They conducted a series of studies to establish instruction following with verb–noun combinations (e.g., "Push glass," "Drop car"). Imitative responding was first taught using instructions, models, reinforcement, and time-out. *Simultaneous* vocal instructions (e.g., "Push glass") were presented with the model when imitation independently occurred. A *delayed-prompt procedure* was used to train independent instruction following consistent performance. New nouns were taught using the same procedure (e.g., "Push glass then push car") once independent responding occurred following the instruction. Following accurate responding, the two instructions were intermixed. A new verb instruction was introduced with the first noun trained and was later intermixed with the previously taught verb instruction (e.g., "Drop glass" vs. "Push glass"). Training continued with other nouns until responding was accurate with both verb instructions involving all 12 nouns. Novel verbs were trained using the same procedures.

Other researchers have extended recombinatory generalization to more complex forms of instruction following and accompanying grammatical verbal phrases describing actions (e.g., Goldstein & Mousetis, 1989) and reading skills and spelling (Mueller et al., 2000; K. Saunders, O'Donnell, Vaidya, & Williams, 2003). See Goldstein (1984), Wetherby and Striefel (1978), and Saunders (Chapter 6, this volume) for a more complete discussion of research conducted on recombinatory generalization and its potential value in understanding the development of complex behavior and guiding teaching programs.

Studies on the recombination of stimulus response units (instruction following) with nonvocal children with severe and profound retardation may suggest a model for understanding the development of generalized imitation. Baer and colleagues (1967) taught imitation of a number of different behaviors to three children with severe and profound mental retardation. The children imitated novel behaviors after training, and they demonstrated generalized imitation. The authors discussed these phenomena in terms of behavior similarity and response classes. However, the similarity interpretation acknowledges that the similarity only occurs for an observer. For the child who is being taught to imitate, there is no similarity between the stimuli being modeled and the response being made. In a sense, imitation training is another instruction-following task. However, the instructional stimuli are visual rather than auditory. Siegel and Spradlin (1978) speculated that generalized imitation might involve a very similar process to that demonstrated by Striefel and colleagues (1976); that is, when trained to imitate specific motor responses, children learn individual components and then recombine them when they imitate a novel motor response. Siegel and Spradlin noted that 21 of the 131 motor imitations taught to a student (who required the most exemplars prior to showing generalized imitations) involved the action tapping. They suggested that after being taught to tap a few objects or body parts, it would not be surprising if the students tapped new objects or body parts without additional training. In addition, the authors suggest that generalized imitation is limited generally to models within the general training domain (e.g., vocal, motor). Therefore, fine motor movements may not be imitated if training involves following gross motor movements, and imitation may not occur following vocal models if imitation training involves nonvocal motor movements.

Some Concluding Remarks

As one looks at the demands of daily activities, nearly every act throughout the day requires some sort of stimulus discrimination. If each discrimination had to be taught directly, it would be an impossible task due to the time required to teach each discrimination by direct reinforcement. Yet a vast amount of discriminations are made, allowing individuals to respond appropriately in a complex world. The pages of this chapter perhaps provide a less puzzling account of the acquisition of such a vast repertoire of discriminations. When we discussed simple successive discriminations, we noted that even though a single stimulus might be conditioned to control a response, other physically similar stimuli also could control that response. Fulton and Spradlin's (1971) re-

search on auditory stimulus control demonstrated that if a student is taught to press a button in response to a 500-Hertz 70-decibel tone, pressing the button also may occur in response to tones with other frequencies and volumes. Hence, it is easy to extend the stimulus control across a total range of frequencies and volumes accessible to human hearing. Therefore, more learning occurs than what is directly taught even in simple successive discriminations. However, the equivalence paradigm provides even more examples of how an extensive repertoire of discriminations can emerge from very little teaching. In the hypothetical number example, only three conditional discriminations were taught before the nine additional conditional discriminations emerged, and potentially, three stimuli names. Saunders, Wachter, and colleagues (1988) taught seven conditional discriminations and developed a total repertoire of 56 conditional discriminations with students with mild retardation. In other words, seven conditional discriminations were taught and 49 emerged.

Recombinative generalization provides an additional example of how a small amount of training results in an extensive repertoire. Striefel and colleagues (1976) taught 31 noun–verb instructions to a student with severe retardation, and 113 emerged without training. The recombination of letter–sound units makes it possible for students to respond appropriately to almost any new printed English word after being taught only a limited number of letter–sound units.

In short, research on primary stimulus generalization, stimulus equivalence, and recombinatory generalization provides examples of how behavioral repertoires are acquired rapidly, and suggests methods for the effective teaching of such vast repertoires.

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CHAPTER 6

Designing Instructional Programming for Early Reading Skills

Kathryn J. Saunders

Reading is the most important skill that children acquire in their early years of schooling. It is a major means of conveying information and ideas in our culture, and, as such, serves as the foundation for much of subsequent training and education. Reading skills expand opportunities for living an independent life and open doors to greater employment opportunities, enrichment, and entertainment. In short, reading is a skill of profound social significance. Despite the importance of a functional reading repertoire, many adults in the United States do not achieve rudimentary reading skills. The most recent National Assessment of Adult Literacy found that 14% of adults in the United States performed *below* the basic level of literacy (e.g., locating easily identifiable information in short, commonplace prose texts; Kutner et al., 2007).

Reading is a complex system of skills with many interacting components, one of which is naming individual printed words. Although individual-word recognition is only one of many component skills that make up reading, proficiency in this skill could not be more critical. As a national leader in reading research and policy put it, "Unless the processes involved in individual word recognition operate properly, nothing else in the system can either" (Adams, 1990, p. 3).

Beyond reading words that have been trained directly, there is consensus that fluent word recognition must have a generative component; that is, proficient readers can read untaught words that are composed of new combinations of previously learned letters and sounds. Experts in reading instruction refer to these skills as *decoding* or *word attack*. The most common means of teaching decoding skills is *phonics instruction*, which involves teaching the learner to produce the sounds of individual letters, and to blend the sounds into a word. Engelmann's Direct Instruction is an example of a phonics-based reading program (Engelmann, 1983).

Decoding skills are not an end unto themselves. Their value lies in providing a major means for the addition to a reader's repertoire of words that can be recognized quickly, as a whole. Share (1995) has referred to decoding skills as a "self-teaching mechanism" to emphasize their importance in expanding the reading vocabulary. Stanovich (2000) pointed out that delays in acquiring decoding skills have a cascading, long-term, negative effect on reading achievement.

Just as decoding is a critical component skill within the broader scope of reading, there are prerequisite and component skills of decoding. In fact, within the reading literature, the major scientific development of the last few decades has been the illumination of component skills that make decoding instruction successful. The goal of this chapter is to describe these skills in terms of the stimulus control involved and discuss instructional programming to establish them. More specifically, the chapter addresses subskills that culminate in the development of the *alphabetic principle*—the concept that when the same sound occurs in different words, it is represented by the same letter (Byrne, 1998). Figure 6.1 provides an overview of the content of the chapter. In brief, the top arm of the schematic involves control by visual stimuli—printed letters and words—and the bottom arm involves control by auditory stimuli—spoken words and the abstraction of sounds that make up syllables.

The content of the chapter represents the kind of analysis that develops instructional programming according to behavioral principles, as explicated in Holland (1960) and in *The Technology of Teaching* (Skinner, 1968). That approach is to build a complex skill gradually by teaching skill components to a high level of accuracy. In the ideal instructional sequence, the student is so well prepared for each new step of instruction that errors are kept to a minimum throughout the instructional sequence. Likewise, for students who are struggling to acquire a complex skill, this analysis points to specific skills that might underlie that difficulty. It should be noted that the chapter does not lay out a complete instructional program that has been tested empirically because this has not been done. Instead, the chapter integrates basic and applied behavior analytic research on stimulus control with findings from the reading literature to identify key skills for success in early reading instruction.

Visual Stimulus Control

Letter Discrimination and Letter Naming

Several major reviews of the reading literature have concluded that knowledge of letter names is one of the strongest predictors of success in early reading instruction. The report of the National Research Council (Snow, Burns, & Griffin, 1998), noted that the number of printed letters a child is able to name in kindergarten "appears to be nearly as successful at predicting future reading as an entire readiness test" (p. 133). The report of the National Reading Panel (2000) also notes the importance of early letter naming, citing research showing that letter naming and phonemic awareness are the two best predictors of success in the first 2 years of reading instruction. Adams (1990) stressed the importance of a child becoming "confident and quick at recognizing individual letters" *before* learning to read whole words.

> While every aspect of reading growth depends on the speed and accuracy of letter perception, learning to recognize and discriminate individual letters is just too big, too hard, and too fussy a task to be mastered incidentally, in tandem with some other hard and fussy task, or without an adult's focused attention to its progress and difficulties. Succinctly, what a waste to correct the pronunciation of a letter sound or word if the child's confusion was really in the visual identity of the letter. (p. 363)

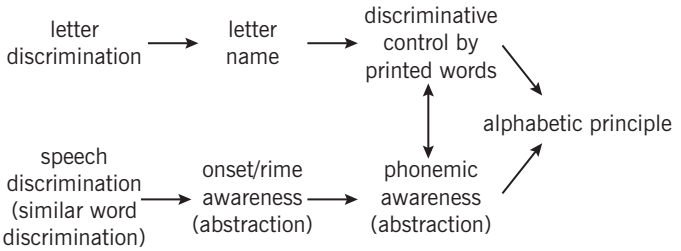


FIGURE 6.1. The course of development for the major skill components covered in this chapter. Skills involving visual and auditory stimulus control are shown in the top and bottom streams, respectively.

Although the literature I have briefly summarized addressed the number of letters named, as Adams (1990) points out, speed also is important. Practitioners of precision teaching have long emphasized the importance of building the rate, in addition to the accuracy, of academic skills (e.g., White & Haring, 1980). Given that letter recognition is a component of whole-word recognition, it stands to reason that slow letter naming would affect the fluency of whole-word naming; that is, the rate of individual component skills seems bound to affect the rate of complex skills of which the individual skills are components. At least one widely used assessment tool, the Dynamic Indicators of Basic Early Literacy Skills (DIBELS, 6th ed.; Good & Kaminski, 2002) includes a letter-naming fluency test.

Studies in the reading literature have shown that the *speed* with which visual stimuli (objects, letters, numerals, and colors) are named both predicts future reading skills and correlates positively with current skills (e.g., Bowers & Swanson, 1991; Denckla & Rudel, 1976; Wolf, Bally, & Morris, 1986). In the typical test for "rapid automated naming" of letters, five different letters are presented in random order and repeatedly. A pretest ensures that participants name the stimuli accurately, thus placing the focus on speed rather than accuracy. The emerging consensus is that deficits in naming *speed* are one of two major factors associated with problems learning to read (Sunseth & Bowers, 2002; Wolf et al., 1986). Children who lag behind their peers in either phonological awareness or naming speed are likely to lag behind their peers in reading achievement. Children who have deficits in both of these skills (termed a *double deficit*), lag further behind in reading achievement than children who have a single deficit.

Considerations in Instructional Programming for Letter Naming

Picture a child being shown printed letters, one at a time, and naming them. Naming the letters involves discriminating the letters from one another. The discrimination is called a *successive* discrimination because the child responds to one letter at a time, in succession.[1] Some prereading children have had little previous experience to prepare them for the task of discriminating these abstract, two-dimensional forms, especially when presented successively. Physically similar letters such as *b* and *d* may be especially difficult. What kind of instruction, if presented prior to instruction in letter naming, might promote the acquisition of letter naming with minimal errors?

Simultaneous Discrimination of Letters. Teaching simultaneous discriminations prior to successive discriminations may facilitate the acquisition of the successive discrimination. In a *simultaneous* discrimination, two or more letters are presented simultaneously on each trial. One letter is designated as the correct stimulus, and the student's task is to point to that letter on each trial. Unlike the successive discrimination, the simultaneous discrimination allows direct comparison of the letters. Simultaneous discriminations are learned more readily than successive discriminations involving the same stimuli (Carter & Eckerman, 1975). Furthermore, teaching discriminations between visually dissimilar letters (e.g., *a* and *t*) before teaching similar letters (e.g., *b* and *d*, or *m* and *n*) has been shown to result in more rapid learning of the difficult discriminations (Carnine, 1980). It bears emphasis that although discriminative control of a spoken letter name (e.g., "b") may appear to be established before its similar counterpart (e.g., "d") has been taught, it is important to ensure that the response "b" is under the control of the letter *b* only.

For teaching discriminations between stimuli that are similar, such as the letters *b* and *d*, laboratory-developed stimulus control–shaping procedures can be used. In general, effective procedures begin with a discrimination that is already in the student's repertoire, or that can be taught relatively easily. Over a number of intermediate steps, stimulus control is transferred from the original stimuli to the target stimuli. Two examples follow; they are directly applicable to letter discrimination because they

[1]Some reading programs advocate teaching the letter sounds rather than the names. Either would establish the successive discrimination of the letters.

involve the discrimination of abstract, two-dimensional forms. In one type of fading procedure, the difference between the stimuli initially is exaggerated, and the stimuli gradually "morph" to their terminal form. Schilmoeller, Schilmoeller, Etzel, and LeBlanc (1979) used such a fading sequence with young children. In the Schilmoeller study, a witch in a peaked hat changed gradually into a triangle on a lined background, and a sun surrounded by clouds changed into a circle on a lined background.

Another fading strategy, intensity fading, was shown in a classic study by Sidman and Stoddard (1967). Participants with intellectual disabilities learned to select a circle that was presented on one key of an eight-key response panel, along with seven ellipses. The fading procedure had two phases. At the beginning of the first phase, only the circle was lighted (the keys with the ellipses were dark), producing highly accurate circle pressing. Over trials, the brightness of the blank keys increased in seven steps, contingent on high accuracy. At the beginning of the second phase, very faint ellipses appeared on the previously blank keys, and the ellipses became darker in 10 steps. All participants who mastered the light–dark discrimination subsequently mastered the circle–ellipse discrimination.

Another procedure that has been used to test, and to teach if necessary, the simultaneous discrimination is the identity matching-to-sample task (Samuels, 1973). Figure 6.2 illustrates two trials in a typical form of the identity-matching task. The trial begins with the presentation of one of the two or more sample stimuli that are presented across trials. An observing response to the sample (e.g., touching it) results in the presentation of two or more comparison stimuli (sometimes called *choice stimuli*). In some usages of the procedure, the sample and comparison stimuli are presented all at once. Selection of the comparison stimulus that is identical to the sample is defined as correct. Matching to sample is called a *conditional* discrimination because the comparison stimulus that is correct is conditional upon the sample that is presented.

Receptive Letter Naming. There is evidence that teaching receptive letter naming can facilitate the acquisition of expressive naming (Sidman, Cresson, & Willson-Morris, 1974). As with identity matching, the student's task is to select a printed letter from

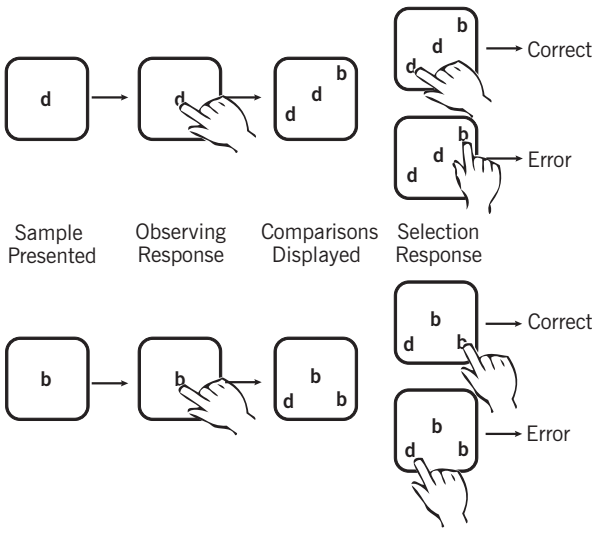


FIGURE 6.2. Trial events for correct and incorrect responses under each of two trial types in a simultaneous identity matching-to-sample procedure. The trial begins with the presentation of the sample stimulus. An observing response produces two comparison stimuli, one of which is identical to the sample. The correct response is selecting the stimulus that is identical to the sample.

among two or more choices (a simultaneous discrimination), and the choice that is correct depends on which sample is presented (i.e., a conditional discrimination). Unlike the identity-matching task, the student's response to the letters is controlled by the spoken letter name. The procedure is called *arbitrary matching* because, in contrast to identity matching, the sample and choice stimulus cannot be matched based on physical similarity. The literature on stimulus equivalence contains many examples of increased accuracy in naming printed words that participants have learned to select upon hearing the spoken name (see O'Donnell & Saunders, 2003). Moreover, data from our laboratory suggest that young children can learn to name letters via the receptive naming task provided they already name a few letters (Schmidt, Baynham, Skinner, Stein, & Saunders, 2009).

Note, however, that the arbitrary matching-to-sample task ensures only the simultaneous discrimination of the letters (i.e., the letters are presented simultaneously as comparison stimuli). Thus, if arbitrary matching procedures are used in the absence of procedures that teach the successive letter discrimination, letter naming may not emerge because students have not mastered the successive discrimination of the letters (see Sidman et al., 1982).

Delayed Identity Matching of Letters. With the exception of naming itself, none of the procedures discussed to this point involve a successive discrimination of printed letters. One possible programming step (delayed matching-to-sample) involves a successive discrimination (a similar observation is made in Williams, 1969). Delayed matching is just like the simultaneous-matching procedure shown in Figure 6.2 except that, as shown in Figure 6.3, the sample disappears at the moment the comparisons are presented. Thus, the learner cannot directly compare the sample and comparison stimuli.

There may appear to be a chicken-and-egg problem in proposing delayed identity matching as a procedure to facilitate naming acquisition. Students who first master delayed matching learn to name letters with fewer errors than students who do not receive such pretraining (Samuels, 1973). On the other hand, naming the sample stimulus has been shown to increase delayed-matching accuracy (Constantine & Sidman, 1975). Clearly, the procedures are related, in that both involve a successive discrimination, and if nothing else, teaching both at the same time

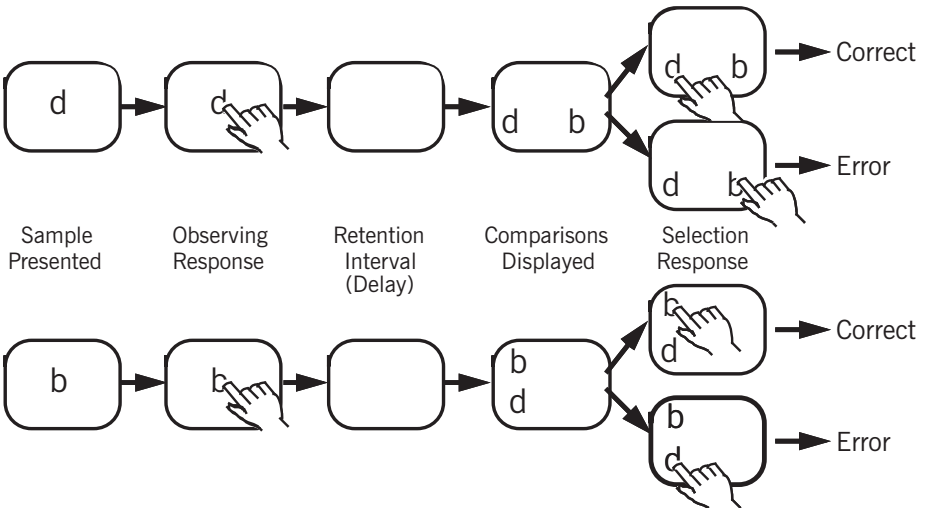


FIGURE 6.3. Trial events for correct and incorrect responses under each of two trial types in a delayed identity matching-to-sample procedure. The trial begins with the presentation of the sample stimulus. An observing response removes the sample and produces two comparison stimuli, one of which is identical to the sample. The correct response is selecting the stimulus that is identical to the sample.

might facilitate letter naming. Furthermore, the delayed-matching task provides an opportunity to practice the successive discrimination without an explicit naming requirement. This characteristic might be valuable in computerizing instruction, and also as a means of practicing the successive discrimination for individuals with extreme articulation difficulties.

The Special Case of Reversible Letters

A discussion of letter naming would not be complete without mentioning reversal errors, such as failures to discriminate the letters *b* and *d*. Such errors might be alarming because they were once thought to be symptoms of a neurological disorder that caused children to "see" print in reverse (i.e., dyslexia). Although explaining reversal errors in terms of a neurological disorder has long been discredited scientifically, one sometimes sees references to it in the popular press. As Stanovich (2001) points out, however, no carefully controlled study supports the theory that reversal errors stem from a neurological disorder. To the contrary, although children without reading disabilities make fewer errors overall than do children with reading disabilities, reversal errors account for the same proportion of the errors in both groups of children. Put simply, physically similar letters are more difficult to discriminate for all children. Moreover, reversals can be corrected through explicit teaching procedures (e.g., Griffiths & Griffiths, 1975; Stromer, 1975). Current thinking on the causes of reading disability instead centers on the skills addressed in this chapter: deficits in component skills that underlie the development of the alphabetic principle and decoding skills.

Summary

Accurate and fluent letter naming should be established prior to learning to read words. This section offers a number of teaching tasks that would be expected to facilitate the acquisition of letter naming by establishing component skills. Many children already have the necessary discrimination skills by the time formal instruction in letter naming begins. It would be wise, however, for teachers to ensure that the prerequisite discriminations are in place prior to letter-naming instruction. An assessment of identity matching, for example, can be conducted with paper and pencil. For physically similar letters, more detailed instructional programming, such as the procedures reported by Schilmoeller and colleagues (1979) and Sidman and Stoddard (1967), might be necessary.

Discriminative Control by Printed Words

In addition to fluent knowledge of individual letters, reading instruction must, of course, establish discriminative control by combinations of letters (words). The ultimate goal of word-recognition instruction is the rapid reading of whole words. As we see later in this chapter, stimulus control by every letter in a word is part and parcel of the development of the alphabetic principle.

It is sometimes assumed that the ability to discriminate individual letters is sufficient to promote the discrimination of individual printed words. Converging evidence from basic and applied research, however, suggests caution in this assumption. Laboratory studies using a delayed matching-to-sample procedure have shown that attention may be restricted to only one element of a two-element complex sample stimulus (Stromer, McIlvane, Dube, & Mackay, 1993). Although the Stromer and colleagues (1993) study used letter-like nonsense stimuli, the outcome is directly applicable to printed words. The procedure was like that shown in Figure 6.3, except that the sample included two stimuli presented side by side. When the stimuli disappeared, several single-element choice stimuli were presented, including one of the two sample elements. Participants' responses showed that they observed only one element of the stimuli. When one of the elements was presented in the choice pool, a correct selection was highly likely, but when the other element was presented, selections were at chance levels. This effect occurred even though performance on the matching task was virtually perfect when each element was presented individually.

The reading literature contains a parallel finding that reflects a form of stimulus control so common in young children that some reading experts consider it to exemplify a phase of reading development. In this

partial-alphabetic phase (Ehri, 1992), word identification is controlled by parts of printed words. For the youngest readers, this can be the first letter. Older readers might omit letters in interior positions within a word. For example, vowel errors in consonant–vowel–consonant (CVC) words are common in struggling readers (McCandliss, Beck, Sandak, & Perfetti, 2003), or a child might omit the second letter in an onset consonant cluster, for example, reading or spelling the word *shun* as *sun* (see Birnie-Selwyn & Guerin, 1997; Treiman, 1991).

Discrimination of closely related printed words can be difficult for nonreading children even when the words are presented side by side (simultaneously). Saunders, Johnston, and Brady (2000) and Yoo (2003) showed that some preschool children who demonstrated nearly perfect simultaneous identity matching of single letters were much less accurate when the task was identity matching of two three-letter words that differed only in the onset letter (*ted/bed*; *tin/bin*, etc.). Some of the children who were able to name the two onset letters nonetheless made errors in matching three-letter words. Furthermore, Saunders and colleagues showed that when children were taught matching with individual pairs of words, the discrimination did not immediately transfer to new pairs of words with the same two onsets. These findings are important, in that words differing only in onset are often presented very early in reading instruction (e.g., in "word families" such as *cat, rat, mat*).

Establishing Stimulus Control by Whole Printed Words

The studies described in the previous section suggest that stimulus control by all of the letters in a word should not be taken for granted, even in one-syllable words. Several different procedures might be used to promote attention to all letters. In the behavioral literature on matching-to-sample procedures, such procedures have been called *differential observing responses (to the sample)*. To understand the function of a differential observing response, it might be useful to point out that matching-to-sample procedures often include a *non*differential observing response or no observing response at all; that is, participants make the same response to all samples (e.g., touching), or the sample and comparison stimuli are presented all at once, with no explicit response to the sample. Differential observing responses (i.e., making a different observing response to each stimulus) ensure that the participant discriminates the sample stimuli. For example, in procedures designed to establish identity matching of printed words that have letters in common (*cat, can, car*), participants were required to select the final (distinguishing) letter from a pool of letters before the printed-word choices were presented (Walpole, Roscoe, & Dube, 2007). In Stromer and colleagues (1993), which involved delayed matching of combinations of two "letters," the differential observing response was performance of simultaneous identity matching, with a stimulus prior to performing delayed matching with that stimulus.

Another means of promoting attention to all letters in a word is to teach learners to spell the words they are learning to read. For convenience, and to accommodate learners who cannot write, letter tiles or a computerized version of a spelling task can be used. In this task, learners spell dictated words by selecting, in the correct order, letters from a pool of letters (Mackay, 1985; Stewart, 2005). It may seem counterintuitive to coordinate reading and spelling instruction because spelling is typically not taught until after at least a year of reading instruction. Spelling instruction, however, has been shown to facilitate learning to read similarly spelled words (Ehri & Wilce, 1987). Spelling not only requires attention to each letter in a word but also encourages left-to-right scanning, another important component skill of reading. Adams (1990) pointed out that a major benefit of phonics instruction, aside from learning the letter sounds, is that it "forces the child to attend to each and every letter of the word" (p. 131).

Regardless of the means of promoting attention to letters within individual printed words, the extent to which the procedures bring the word-naming response under precise stimulus control cannot be known for certain without teaching groups of closely related words. For example, a laboratory study shows how stimulus control by both letters of a two-letter word could be established and/or tested via simultaneous identity-

matching tasks (Dube & McIlvane, 1999). In the study, the composition of the choice pool was such that responding correctly required stimulus control by each "letter." Although the study used letter-like nonsense stimuli, it is easy to translate the procedures into two-letter words. In each teaching trial, for example, one of four words—*an, at, in, it*—was presented as the sample, and all four words were presented as comparison stimuli. In this example, stimulus control by both letters of the word is required for responding correctly.

A Note on Sight Word Instruction

Although prerequisites for the acquisition of decoding skills are the main focus of this chapter, some discussion of sight word instruction is in order because a large sight word vocabulary shares with decoding the critical component skill of attention to each letter in a printed word. Moreover, sight word instruction is often recommended for students with intellectual disabilities. The sight word approach is to teach printed word naming at the whole-word level, that is, without teaching decoding skills. The literature on sight word instruction contains primarily short-term studies that teach relatively small numbers of individual words (for a review, see Browder & Xin, 1998). There may be an unfortunate by-product of selecting word sets based primarily on potential functionality. Ironically, selecting words to be taught in this way may not only overestimate what the student has actually learned but also seriously compromise the development of generalized reading skills. The words taught often do not have many overlapping letters. For example, a study that focused on recipe words included words such as *add, cup, water, hot, milk,* and *stir.*

This composition of word sets leaves open the possibility that stimulus control is not by the whole word. For example, printed words might be discriminated by the first letter only, or the first letter and the length (for example). As noted previously, even typically developing children tend toward this incomplete stimulus control early in the development of reading skills. Vellutino and Scanlon (1986) noted that a child taught only a sight word strategy "will not become sensitive to similar appearing words and generalization errors will abound" (p. 153). That is, because the controlling stimuli are restricted to only a portion of the letters in a word, a sight word–only procedure could make the expansion of the reading vocabulary increasingly difficult. This might be why the literature contains no demonstrations of large, sight word reading vocabularies in students with intellectual disabilities. Moreover, this partial-word stimulus control may be especially likely if the student does not name individual letters. Browder and Xin's (1998) review of the sight word literature noted that the students undergoing sight word instruction may not be able to name separate letters.

Sometimes the goal of sight word instruction is simply to teach a small set of words that serves as important discriminative stimuli in restricted contexts. For example, a student might be taught to differentiate the printed words *men* and *women* in the context of bathroom doors, or the words *mop* and *wash* in the context of cleaning house. In this example, it may not matter whether the words are discriminated based on only part of the printed word because the context provides an additional cue. Moreover, the need to discriminate *men* and *mop* would not arise, so incomplete discrimination would not cause the problems noted previously. Arguably, the nature of the discriminative control established in this scenario is not reading. If the ultimate goal is to develop a *large* sight word vocabulary, however, it seems wise to require students to discriminate words containing many of the same letters from a very early point in instruction.

Summary

Discriminative control by all letters of printed words should not be taken for granted, even for students who name individual letters. Stimulus control by only portions of printed words is relatively common in beginning readers, and students with persistent reading difficulties often omit interior letters. There is no reason to assume that incomplete stimulus control need occur as a matter of course, however. Explicit instructional programming for the discrimination of similar words should be given as a matter of course, before errors become persistent.

Auditory Stimulus Control

To this point in the chapter, the primary focus has been on control by visual stimuli, that is, printed letters and words. As shown in the bottom portion of Figure 6.1, a parallel set of skills occurs in the development of control by auditory stimuli. The capstone skill in this series is phonemic awareness, which I discuss in detail a little later. The discovery that phonemic awareness is a critical component of word attack has been an extraordinarily important advance in the scientific understanding of the acquisition of decoding skills.

Speech Discrimination

Speech discrimination, also called *speech perception,* is the first auditory skill to be discussed here. The National Research Council (Snow et al., 1998) defined *speech perception* as the "ability to detect and discriminate the sounds of one's language, for instance, to be able to tell the difference between spoken stimuli that have many elements in common, such as 'mail' and 'nail,' or 'back' and 'bag' " (p. 54). In the reading literature, this notion is expressed by the concept of a "complete phonological representation," which reflects the notion that there is a point-to-point correspondence between the phonemes within the word and some response (usually not overt) of the participant.

Considerable research in the area of speech perception shows that some reading-disabled children and adults perform less accurately than participants without reading disabilities on tasks that involve the perception of spoken words or phonemes (see reviews by Brady, 1997; McBride-Chang, 1995). It seems axiomatic that detecting and discriminating speech sounds is a critical prerequisite skill for learning relations between those sounds and letters. Moreover, as the National Resource Council report notes, children whose speech perception is not fully developed are likely to have difficulty acquiring phonological awareness. Thus, Figure 6.1 shows speech perception as a prerequisite to phonological awareness, which is discussed in the next section.

Difficulties in speech perception most often involve the stop consonants (i.e., /b/, /d/, /g/, /k/, /p/, /t/). A variety of procedures for assessing speech perception have been used. Most of these procedures are standard in the laboratory study of stimulus control (see Mackay, 1991; Saunders & Williams, 1998). All of the procedures involve a successive discrimination between sounds (the consonant sound is generally presented with the addition of a vowel sound). For example, in the go/no-go procedure, a single sound is presented on each trial, and two or more different sounds are presented across trials. One stimulus is the target sound; participants are required to respond to a target stimulus but withhold responses to nontarget stimuli. The same/different procedure is a conditional discrimination procedure; two sounds are presented in succession, and the participant is required to indicate whether they are the same or different. Laboratory discrimination procedures generally show more deficits in stop-consonant perception in some disabled readers as compared to nondisabled readers. Moreover, difficulties are more pronounced in stop consonants as compared to vowels (McBride-Chang, 1995). Tallal and colleagues (1996) pointed to the brief and transitory (frequency transitions occurring in milliseconds) nature of stop consonants as the property responsible for the discrimination difficulties.

Considerations in Instructional Programming of Speech Discrimination

Remediation of incomplete consonant discrimination has involved stimulus control shaping procedures that are strategically similar to those used for visual discriminations. Such procedures have been shown to improve the discrimination skills of disabled readers (Merzenich et al., 1996; Tallal et al., 1996). At the beginning of training, the speech signal is modified by increasing its duration and loudness in the portion of the phoneme that distinguishes it from closely related phonemes. Over a series of steps, contingent on high accuracy, the altered properties of the stimulus return to their typical values.

A procedure often used with whole-word or nonword stimuli is called a speech repetition task. A phoneme-by-phoneme correspondence between the word spoken by the examiner and the word spoken by the ex-

aminee (i.e., an echoic) provides evidence for accurate speech discrimination. Nonwords may provide a more conservative measure than real words because the participants' familiarity with spoken real words supplements the stimulus control by the spoken word. Arguing against the use of nonwords, however, is the result of unpublished tests conducted in our laboratory. Some adults with mild intellectual disabilities consistently produced closely related real words when nonwords were presented. A solution would be to test sets of real words with minimal differences in the targeted phonemes, for example, *cat, cap,* and *cab.*

A caveat about using the repetition task is that some learners might not be able to emit accurate echoics of some sounds, for example, substituting *wat* for *rat*. Moreover, the speech repetition task might be essentially impossible for individuals with severe articulation difficulties, such as those associated with cerebral palsy. An alternative to the speech repetition task is a spoken word-to-picture arbitrary matching-to-sample procedure in which samples differ by one phoneme. To test for discrimination of the words *mail* and *nail,* for example, two kinds of trials would be necessary. In both, the choice stimuli are a picture of mail and a picture of nail. The spoken word sample stimulus would be "nail" on some trials and "mail" on others. The importance of including words beginning with both phonemes (*n* and *m*) bears emphasis. A student might accurately repeat *mail,* but also say "mail" when asked to repeat *nail.*

Summary

Most beginning readers have an extensive history discriminating closely related spoken words. Thus, the incidence of speech-discrimination difficulties is likely to be far lower than the incidence of printed-word discrimination difficulties. Nonetheless, this is a critical skill, and it is known that some struggling readers do have deficits. A few minutes spent assessing speech discrimination could provide information that is critical for teaching success. This is especially important for individuals with limited vocabularies, and thus less practice discriminating closely related spoken words.

Phonemic Awareness: The Abstraction of Phonemes within Syllables

In the last 20 or 30 years, a revolution has occurred in the understanding of reading difficulty. It is now broadly recognized that deficits in a skill that reading experts call *phonemic awareness* underlie many (some would say most) of childrens' difficulties in learning to read. In general, prospective studies show that prereading children who do well on measures of phonemic awareness are less likely to have difficulties learning to read than children who do not do well on these tests. Moreover, studies that compare good readers with poor readers on measures of phonemic awareness find that good readers demonstrate stronger phonemic awareness (see reviews by Adams, 1990; National Reading Panel, 2000; Snow et al., 1998), a finding that has been reproduced in adults with mild intellectual disabilities (Saunders & DeFulio, 2007).

What Is Phonemic Awareness?

Experts in the reading literature define *phonemic awareness* as "the ability to focus on and manipulate phonemes within spoken words" (National Reading Panel, 2000, p. 2-10). Phonemes are the smallest unit of sound within a syllable, for example, the word *cat* contains three phonemes: /c/ /a/ /t/. A more behavior analytic definition of phonemic awareness stems from the concepts of "phoneme identity" and abstraction, as discussed by Byrne (1998) and Skinner (1957), respectively. In Byrne's tests for phoneme identity, children identified spoken words that shared a component phoneme (e.g., *bat* and *bug* start with the same sound). Thus, phonemic awareness involves the abstraction of phonemes, in the sense of being "a discrimination based on a single stimulus property, independent of other properties; thus, generalization among all stimuli with that property" (Catania, 1998, p. 378). The relevant stimulus property in this example is the phoneme /b/. Note that the "generalization" part of the definition is critical. A child might be taught directly to say that *bug, bat,* and *bone* start with the same sound. Unless the child can indicate whether an untaught spoken word, for example, *big* also starts

with that sound, abstraction has not been demonstrated.

It is important to note that the definition of phonemic awareness refers to what is *heard* in a spoken word. *It is critical to distinguish phonemic awareness from phonics instruction*. Phonics is a time-tested teaching procedure that involves (in part) teaching a beginning reader to say the sound of the individual letters within a printed word (sometimes referred to as letter-sound knowledge) and then pronounce the spoken word. There is broad consensus that phonics instruction is an effective teaching strategy. There is also consensus that, without instructional attention to phonological/phonemic awareness skills, beginning readers are much less likely to benefit from phonics instruction (National Reading Panel, 2000). Foorman and Torgesen (2001) referred to the practice of teaching letter sounds and blending without phonological awareness instruction as "the phonics of the 1960s."

Precursors to Phonemic Awareness

There are several units within a spoken word upon which discriminations can be based. Speaking very generally, the larger the unit, the earlier abstraction of the unit occurs. Studies have found that children abstract syllables within two-syllable words (i.e., *pic-nic*) at a younger age than they abstract within-syllable units, such as phonemes (Liberman, Shankweiler, Fischer, & Carter, 1974). In a typical procedure for measuring syllable abstraction, children are asked to report the number of syllables in a word by tapping once for each syllable (i.e., upon hearing *picnic,* the child taps two times). The next units, onsets and rimes, are parts of syllables. The *onset* is the initial consonant sound(s), and the *rime* includes subsequent vowel(s) and consonant(s). Examples of onset–rime units are *c-at* and *br-eak*. There is strong evidence that children perceive onset and rime units within syllables earlier than they perceive individual phonemes within syllables, and many children abstract onsets and rimes before learning to read. Thus, prereading children typically abstract single phonemes only when the phoneme is the onset, but not when the phoneme is a constituent of the rime (Kirtley, Bryant, MacLean, & Bradley, 1989).

How do some children learn onset–rime units before reading instruction? A classic study by MacLean, Bryant, and Bradley (1987) suggests that knowledge of nursery rhymes may play a role. In this study, British children, whose mean age was 3 years, 3 months, were asked to recite five popular nursery rhymes. Then the children were tested periodically until they were 4½ years old. The better children were at reciting nursery rhymes, the greater the development of other early reading skills, including measures of phonological awareness and letter and word naming (effects of IQ and socioeconomic status were controlled statistically). Why might this be? A speculative account is that reciting the nursery rhymes may reflect multiple sources of stimulus control: a combination of intraverbal control (i.e., memorization of a sequence of words) and control based on a repeating rime sound. For example, the likelihood that a child will learn that little Miss Muffet sat on a tuffet instead of a chair may be increased due to rhyming. If so, it follows that the child must have some level of sensitivity to elements rimes have in common.

Why Is the Abstraction of Phonemes Difficult?

The abstraction of phonemes is difficult due to a property of spoken syllables that is called *co-articulation*, which refers to the "smearing together" of individual phonemes within syllables; that is, there are no discrete boundaries between phonemes, and phonemes produced in isolation do not exactly reproduce their sounds when occurring within syllables. In fact, the sound of a phoneme is influenced by the preceding and following phoneme. For example, there are subtle differences in the sound of the same vowel in a simple CVC word if that vowel is surrounded by different consonants (e.g., *bat* and *ban*). Moreover, some consonants, especially the stop consonants /b/, /d/, /p/, and /t/, cannot be articulated without adding a vowel sound (e.g., saying "buh" for /b/).

Co-articulation also helps explain why many children have difficulty "blending" phonemes to pronounce a whole syllable (see Liberman, 1997). Consider the way the word *bat* often sounds when a sound is produced for each letter: "buh-a-tuh." The child's task is actually more than blending; sounds have to be removed from the consonants for

blending to occur. The route by which coarticulation was brought to the attention of the reading research community provides an interesting insight. Researchers working on the development of a reading machine for individuals with blindness found that it was impossible to create a realistic-sounding syllable by stringing together a sequence of isolated, constituent phonemes (Liberman, 1997). Some reading programs attempt to override this difficulty by recommending that teachers produce the consonant sound without the added vowel (e.g., Distar/Reading Mastery). Pronunciation of the vowel cannot be completely eliminated (Adams, 1990), however. Another strategy that reflects the difficulty of accurately pronouncing individual consonants is to begin instruction with consonants having pronunciations that can be held, such as /s/ and /m/.

Many researchers consider onset–rime awareness to be an important step toward the awareness of individual phonemes (see Treiman, 1992, for a discussion); that is, although recognition of onset and rime is critical, it is only the first step. Based on studies of typically developing children, Kirtley and colleagues (1989) concluded that learning to break rimes into phonemes also constitutes a major step in learning to read. Moreover, reading instruction may help bring about full phonemic awareness (e.g., awareness of the phonemes within the rime); that is, the best synthesis of the published literature is that the relation is reciprocal once reading instruction begins (Ehri & Wilce, 1987; Perfetti, 1992). This synthesis also is supported by a conclusion of the National Reading Panel (2000) that phonemic awareness instruction is more effective when letters are involved (see Bradley & Bryant, 1983).

Considerations in Instructional Programming for Phonemic Awareness

Although some children abstract onsets and rimes prior to reading instruction, the abstraction of phonemes is unlikely to occur outside of very explicit instructional programming. As was noted in the section on stimulus control by printed words, the extent to which teaching procedures promote abstraction cannot be known for certain without teaching groups of closely related words. Moreover, it is critical that instruction involve both examples and nonexamples. The more closely related the examples and nonexamples, the sharper the stimulus control that develops. The examples show the range of variations that are included in the phoneme class. The nonexamples ensure that generalization is constrained to the examples (Engelmann & Carnine, 1991; Skinner, 1957).

Summary

Phonemic awareness is the abstraction of phonemes within spoken syllables. Phonics instruction is much more likely to be effective when combined with phonemic awareness instruction. Moreover, children who already recognize rhyming words (words with the same rime) have an advantage in early reading instruction. It makes sense to sequence instruction in phonemic awareness in keeping with the developmental data. The precursor skills of syllable abstraction and onset and rime abstraction typically are acquired before phoneme abstraction. Reading instruction presumably facilitates the abstraction of phonemes via their association with letters. A related function of reading instruction may be that the growing repertoire of words that the student can read incorporates a range of examples and nonexamples of phonemes within the context of words.

The Alphabetic Principle: Generalization of Sound–Print Relations across Words

The *alphabetic principle* has been defined generally as knowledge that units of print map onto units of sound (Stanovich, 1992). Byrne defines the alphabetic principle more specifically as "useable knowledge of the fact that phonemes can be represented by letters, such that whenever a particular phoneme occurs in a word, and in whatever position, it can be represented by the same letter" (Byrne & Fielding-Barnsley, 1989, p. 313). The "in a word" part of the definition bears emphasis. The concept of the alphabetic principle entails more than linking isolated sounds with isolated letters. It involves relations between abstracted sounds (phonemes) within spoken words and letters within printed words. Thus, phonemic awareness is a major component of the alphabetic prin-

ciple. Figure 6.1 shows the alphabetic principle as the point at which the auditory and the visual repertoires come together, via the association of letters within a printed word to phonemes within a spoken word.

Considerations in Instructional Programming for the Alphabetic Principle

The alphabetic principle is a component process of decoding; thus, "sounding out" words that have not been taught directly demonstrates the alphabetic principle. Given its component status, however, the alphabetic principle can be taught and tested using a less demanding task. This was the logic of a series of studies conducted by Byrne and colleagues (summarized in Byrne, 1998), which sought to establish the alphabetic principle in prereading children. In a study that focused on onset letter–sound relations (Byrne & Fielding-Barnsley, 1989, Experiment 2), the test for the development of the alphabetic principle was essentially an arbitrary matching-to-sample procedure with printed word samples and two spoken word choices. For each generalization test trial, the children were shown one printed word (e.g., *sum*) and given two spoken-word choices that differed only in their onset sound (e.g., "Does this say *sum* or *mum*?"). The choice pairs were *sum/mum, set/met, sad/mad,* and *sow/mow.*

Generalization was tested after each of several consecutively presented training conditions. The results, along with the results of other studies in the series (Byrne, 1998), showed that two teaching procedures were critical to generalization: phonemic awareness training and letter-sound training. In phonemic awareness training, the children learned to identify the generalization words that had the same onset sound as the taught words *sat* and *mat*. In letter-sound training, the children learned to say the sounds of the two individual onset letters (*s* and *m*) when presented one at a time in random order. Children who mastered both phonemic awareness and letter sounds demonstrated generalization. An important qualifier, however, is that only two sessions were allotted to training, and only five of 12 children mastered the phonemic awareness task. Although this does not negate the conclusion that mastery of the phonemic awareness task and letter-sound knowledge were critical component skills, it suggests that the five children had unidentified prerequisite skills that facilitated acquisition of the phonemic awareness task. A second qualifier is that there are several possible reasons for the effectiveness of the letter-sound training. It might have promoted attention to the onset letter, or it might have served as an additional exemplar of the onset sound (teaching another word pair might have been equally effective).

The generalization tests just described demonstrate generalization of the onset sound–letter relations only. Put another way, participants essentially could ignore the rime component of the word. From an instructional programming standpoint, this could be the first step in a series of increasingly complex generalization tasks. *Recombinative generalization* is a more advanced form of generalization that involves responding correctly to new combinations of *two or more* previously learned linguistic units.

The literature on recombinative generalization shows that persons taught to name several stimuli that have some components in common can respond appropriately to new combinations of those components (see Goldstein, 1984, 1993). A procedure called *matrix training* has been used for the systematic instructional programming of recombinative generalization in the language training of students with intellectual disabilities. For example, if a child is taught to name a red square, a red cross, a green square, and a blue cross, the child may, without additional training, name a green cross and a blue square. As Figure 6.4 shows, the trained and

red square	red cross
green square	***green cross***
blue square	blue cross

FIGURE 6.4. A language-training matrix designed to promote recombinative generalization with color–object phrases. Taught phrases are shown in regular type and generalization test phrases (blue square and green cross) are shown in ***bold italics***.

generalization word components form a matrix, thus ensuring that all of the recombined components (in this example, green, blue, cross, and square) have been experienced prior to generalization tests. Note that participants must attend to more than one color and more than one shape to name correctly.

In the language-training studies, the recombined components were discrete, whole-word units (a color name and an object name). Studies conducted in Brazil with Portuguese-speaking students have demonstrated the recombination of syllables (de Rose, de Souza, & Hanna, 1996; Matos & d'Oliveira, 1992). The structure of Portuguese makes syllable recombination largely sufficient for novel word decoding. Syllables are "easier" to abstract than within-syllable units (Liberman et al., 1974), presumably because coarticulation across syllables is minimal. Reading English, however, requires the recombination of within-syllable print–sound relations.

Our laboratory has conducted studies that were modeled after those of Byrne and colleagues, described earlier, except that our generalization tests required stimulus control by both the onset and the rime component of a one-syllable word (or nonword). The first two studies used a whole-word selection task (an arbitrary matching-to-sample procedure), in which participants selected from among four choices the printed one-syllable word that corresponded to the spoken word sample. Recombination was tested within six six-word sets. An example word set, in matrix form, is shown in Figure 6.5. Within each set, four words were taught (*sat, mat, sop, sug*). Three of the taught words had overlapping onsets (*sat, sop, sug*), promoting discrimination based on the rime, and two training words had overlapping rimes (*sat, mat*), promoting discrimination based on the onset. The generalization test words were recombinations of the onsets and rimes included in the training words (*mop, mug*). If generalization was not demonstrated, the test words were taught.

sat	sop	sug
mat	***mop***	***mug***

FIGURE 6.5. A training matrix designed to promote onset–rime recombinative generalization. Taught words are shown in regular type, and generalization test phrases (mop and mug) are shown in ***bold italics***.

Three nonreading kindergarten children participated in one study (Mueller, Olmi, & Saunders, 2000), and two adults with mental retardation participated in a systematic replication (Saunders, O'Donnell, Vaidya, & Williams, 2003). None of the participants responded correctly on a single item of the Woodcock Reading Mastery Test, Word Attack (decoding) subtest. The Word Attack subtest presents a series of increasingly difficult nonwords to test generalized decoding skills. On the Sight Word subtest of the Woodcock, which presents a series of increasingly difficult real words, the adults demonstrated first grade–level skills; the children read no more than one word correctly. Beginning with their second or third word set, all of the participants demonstrated generalization to the two test words in the set after four words were taught. In order to demonstrate this generalization, the child had to recognize that the test words contained the same sounds as the taught words (i.e., abstract the onsets and rimes), and also that these same sounds were represented by the same letters.

Although these studies showed little gain in word reading after generalized spoken word to print relations were taught, this was not surprising given that there had been no reading practice. After ensuring that participants could select pictures that corresponded to the spoken real words used in the study, comprehension tests were presented. Printed word samples were presented with two pictures as choices (as in Sidman & Cresson, 1973). The participants showed high accuracy on the comprehension tests. Subsequently, participants read from 40 to 100% of the words, although they read virtually none of the words prior to the study, and few of the words before the comprehension test. It should be noted, however, that the comprehension tests might have facilitated reading accuracy via a sight word process.

A systematic replication by Stewart (2005) used a word construction task developed by Dube, McDonald, McIlvane, and Mackay (1991). Rather than selecting whole printed words, participants spelled words

by touching letters. Three adults with mild-to-moderate intellectual disabilities who had first grade–level sight word reading skills, and no measurable word attack skills, participated. In Study 1, matrix training was designed to promote the recombination of onsets and rimes. After learning to construct several pairs of words with different onsets and two rimes (e.g., *rag, led*) participants constructed words with new onsets and the same rimes (e.g., *lag, red*). Study 2 addressed the recombination of phonemes within the rimes.

Note that in Study 1, the taught rimes had no overlapping letters. Thus, the training was not designed to promote the abstraction of individual phonemes within the rime. Tests of words with the rimes *ad* and *eg* (*ed* and *ag* were in the taught words) confirmed this expectation. Although accuracy of final consonant placement was almost always at least 80%, vowel placement accuracy was very low for two of the participants (25–45%). Thus, in Study 2, word sets were composed specifically to promote abstraction of the vowel sound (e.g., *tap, tep, top, tip, tup*); that is, responding correctly required a discrimination based on the vowels. After this training, we again presented the within-rime recombination tests on which two participants had shown low accuracy at the end of Study 1 (*ag* and *ed*). Accuracy of vowel placement generally was above 80% for the two participants who previously demonstrated low accuracy. Taken as a whole, the training had promoted the abstraction of both vowel and consonant phonemes within the words, and the generalization of phoneme–print relations across words; that is, participants had demonstrated the development of the alphabetic principle. This finding is particularly noteworthy in that there is virtually no research literature on the acquisition of the alphabetic principle in individuals with intellectual disabilities (Saunders, 2007).

Summary

The *alphabetic principle* refers to the generalization of sound–print relations across words. Although reading a word that has not been taught directly demonstrates the alphabetic principle, the skill can be demonstrated receptively via the word selection and word construction tasks described earlier. The advantage of the receptive task is that it does double duty as a phonemic awareness task. Correctly constructing words that are new combinations of subsyllablic components of previously taught words involves the abstraction of the components of the spoken word. Moreover, the word construction procedures exemplify the National Reading Panel's recommendation to incorporate letters into phonemic awareness instruction.

Chapter Summary

The alphabetic principle involves relations between phonemes within spoken words and letters within printed words. The goal of this chapter has been to show that learning the alphabetic principle rests on the prerequisite and component skills shown in Figure 6.1. An instructional program that ensures the acquisition of these component skills will be more effective.

Children who name letters are much more likely to experience success in learning to read than children with weak letter-naming skills. Before teaching letter naming (or letter sounds), teachers should ensure that the printed letters are discriminated from one another.

Children who recognize rhyming words are also more likely to experience success in the early stages of reading instruction. The evidence to date suggests that it is imperative to focus on rhyming words before or at the very beginning of attempts to teach letter–sound relations within the context of printed words.

Difficulties discriminating printed words also may adversely impact reading instruction because perceiving each letter in a printed word is inherent in the generalization of sound–print relations across words. As well, fluent recognition of a large number of printed words requires stimulus control by all of the constituent letters. The only way to be certain that each letter is a functional part of the stimulus is to teach closely related words together. For example, teaching the words *tip, tap*, and *top* together promotes control by the vowel.

There is resounding evidence that underdeveloped phonemic awareness skills are

associated with difficulties learning to read. Phonemes are abstractions, in that they are units of sound within syllables that do not exist alone in a pure unadulterated form. Phonemic awareness builds on the abstraction of larger units, including the awareness of rhyming words. There is evidence that the transition from abstraction of larger units to the abstraction of phonemes does not occur until children begin learning to read. It would be consistent with the reading literature, the behavioral literature on stimulus control, and the concept of abstraction that using matrix training to teach "neighborhoods" of closely related words will facilitate the development of the alphabetic principle and its major component skill, phonemic awareness.

Additional Reading

This chapter has scratched the surface of the topic of prereading and early reading skills. The books listed below are recommended for readers interested in learning more. The first three on the list are general and frequently cited sources of scientific information on the processes involved in reading and critical components of effective reading instruction. For a start, the exceptionally readable Adams (1990) book provides an outstanding introduction to the research literature. The book was written for the educated layperson, but with no compromise in the scientific information presented.

- *Beginning to Read: Thinking and Learning about Print* (Adams, 1990).
- *Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and Its Implications for Reading Instruction* (National Reading Panel, 2000).
- *Preventing Reading Difficulties in Young Children* (Snow et al., 1998).
- *The Foundation of Literacy: The Child's Acquisition of the Alphabetic Principle* (Byrne, 1998).
- *Foundations of Reading Acquisition and Dyslexia: Implications for Early Intervention* (Blachman, 1997).
- *Reading Acquisition* (Gough, Ehri, & Treiman, 1992).

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PART III

MEASUREMENT, DESIGN, AND METHODOLOGICAL ISSUES

CHAPTER 7

Defining and Measuring Behavior

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One of the hallmarks of applied behavior analysis is the precise measurement of observable behavior (Baer, Wolf, & Risley, 1968). Measurement precision involves the reliable and accurate quantification of some dimension of the response of interest. These response dimensions, which provide the basis for systems of measurement, encompass specific characteristics of behavior, such as frequency, duration, and latency. In essence, an observation system consists of formalized rules for extracting information from a stream of behavior. These rules specify target behavior, how the events are sampled, the dimensions of the events that are assessed, and how the data are recorded along with other pragmatic issues, such as observational setting, observers, and cost (Hartmann & Wood, 1982).

Three characteristics of a measurement system—accuracy, validity, and reliability—gauge its predictive value (Poling, Methot, & LeSage, 1995). *Accuracy* in a measurement system means the values that it yields reflect the true values of the behavioral dimension under consideration. Any discrepancy between the obtained values and the true values constitutes measurement error. Implications of this relationship are considerable because observational systems that are high in measurement error produce data that fail to reflect true behavioral events and consequently may wrongly influence the decisions of data consumers. *Validity* of a measurement system refers to the extent to which the system measures what it purports to measure. In general, direct observation of the behavior of interest is likely to yield highly valid measures. However, validity can suffer if indirect measures are used, or if the behavior of interest is inferred from other events. For example, measuring the frequency of headaches by counting how often the participant complains of headaches may not be a valid measure because the person may not always complain when a headache is present, and may sometimes complain when no headache is felt. Finally, *reliability* is defined as the extent to which a measurement system yields consistent outcomes. Measurement is considered reliable if it results in the same outcome when applied repeatedly to the same behavior, or when different observers produce the same measurement outcomes while independently scoring the same behavior (Johnston & Pennypacker, 1993; Poling et al., 1995).

Given that the measurement of behavior can be affected by multiple factors (e.g., expectation bias, effects of agreement checking, and coding system complexity), one of the primary challenges for behavior analysts is to obtain a record of the individual's behavior that is both complete and accurate (Johnston & Pennypacker, 1993). Our purpose in this chapter is to provide descriptions of observation and measurement systems, as well as rationales for the use of the various systems.

Operationally Defining Behavior

General Characteristics of Behavioral Definitions

Behavioral definitions (or observational codes) are descriptions of target responses that are designed to control observers' scoring behavior. Generally, the adequacy of behavioral definitions should be judged by how consistently and accurately they control observing behavior, and the extent to which the resulting data allow the behavior analyst to take effective action (i.e., gain control of socially meaningful behavior). Attention to the following three aspects can help to increase the adequacy of behavioral definitions: (1) objectiveness—the extent to which definitions refer to observable events with which two or more people can agree (i.e., behavioral definitions should refer to observable behavior, such as hitting, rather than abstract concepts, such as anger); (2) clarity—the ability of observers to read and paraphrase the definition accurately; and (3) completeness—the definition's inclusion of all relevant instances and exclusion of irrelevant aspects (Cooper, Heron, & Heward, 1987).

Functional versus Topographical Definitions

Behavior may be defined according to either functional or topographical features. *Functional* definitions refer to the effects that responding has on some aspect of the environment. For example, opening a door may be defined solely in terms of the result of door-opening behavior (e.g., the distance between the door and the door frame is at least 2 feet). With functional definitions, the particular movements that bring this result about are not relevant; a person could open the door with his or her toes, teeth, or hands. *Topographical* definitions refer to the form of behavior, such that the physical properties of responding are specified. For instance, door opening may be defined as using one's hands to turn the doorknob while standing upright and facing forward.

Topographical definitions are often important in applied behavior analysis because socially appropriate and inappropriate behavior may be functionally identical but topographically distinct. To demonstrate, aggressive behavior and appropriate verbal requests may each result in increased control over the social environment (including other people's behavior) and access to preferred items and activities (e.g., Bowman, Fisher, Thompson, & Piazza, 1997). Because appropriate requesting is more socially desirable than aggression, topographical definitions that differentiate between these two response categories are important. Nevertheless, functional definitions are often useful in applied behavior analysis. For example, behavior that results in property destruction (regardless of topography) may often be placed in a single definitional category (e.g., Fisher, Lindauer, Alterson, & Thompson, 1998).

Humans and Machines as Observers

Humans as Observers

In applied behavior analysis, human observers are commonly employed to collect data. Human observers can collect data in a variety of manners, including marking data sheets with pencil (e.g., Taravella, Lerman, Contrucci, & Roane, 2000), operating a stopwatch (e.g., Hoch, McComas, Johnson, Faranda, & Guenther, 2002), or pressing keys on a computer keyboard (e.g., Piazza, Adelinis, Hanley, Goh, & Delia, 2000). The use of humans (as opposed to machines) as data collectors has the advantage of allowing for greater flexibility because people can be trained to collect data on a wide variety of responses and can adapt to novel environments relatively easily (Page & Iwata, 1986). However, human observers are prone to the influence of numerous errors and biases that can render data collection unreliable and inaccurate. The most common of these potential biases are described in the following paragraphs.

Errors and Biases

Expectancy Bias. Observer expectations about desirable outcomes of treatment may bias scoring toward congruence with hypothesized outcomes (Repp, Nieminen, Olinger, & Brusca, 1988). This is particularly likely if supervisor feedback to observers is related to changes in behavior rather than reliability and accuracy of measurement (O'Leary, Kent, & Kanowitz, 1975). The risk of expectancy bias can sometimes be reduced by ensuring that observers are blind to the experimental questions and conditions that are in place at a given time. However, this is often difficult in behavior analytic research because the independent variables are frequently apparent through therapist interaction patterns or environmental arrangements. Periodic reliability checks by novel observers who are trained on the behavioral code but not familiar with the experiment or the field of study can minimize this bias. Supervisors should also avoid giving feedback that describes how well the obtained data conform to expected treatment outcomes; rather, feedback should focus on the accuracy and reliability of data collection.

Observer Bias. The accuracy and reliability of data may be affected by the presence of a second observer (Kent, Kanowitz, O'Leary, & Cheiken, 1977), who is often present for the purposes of calculating interobserver agreement. In other words, reliability and accuracy may increase when such checks are conducted but remain lower at other times. One solution to this problem is to have a second observer present during all or most observations; however, this may not be practical. Alternatively, covert or unpredictable reliability checks may be conducted (Kazdin, 1977). One way to accomplish these reliability checks is to videotape all sessions and conduct subsequent agreement checks for a randomly selected sample of sessions.

Reactivity. A change in the participant's behavior as a function of being observed (e.g., Hartmann, 1984; Repp et al., 1988) is called *reactivity.* For instance, an employee participating in an organizational behavior management project may work harder and generate a higher-quality product as a function of being observed. This is undesirable for two reasons: (1) The behavior analyst cannot be sure that his or her treatment had an effect independent of reactivity, and (2) treatment gains may disappear when observation ceases. One solution is to use unobtrusive measures (i.e., arranging observations such that participants are unaware that they are being watched) or to reduce the obtrusiveness of observation (e.g., by observing from behind a one-way mirror). Another solution is to allow participants time to adapt to the presence of data collectors before the beginning of the evaluation.

Observer Drift. The control that behavioral definitions exert over observers' behavior may erode over the course of an experiment—a phenomenon referred to as *observer drift* (Kazdin, 1977). This can result from boredom, fatigue, or illness, and may negatively affect accuracy and reliability of observation. Observer drift can be reduced via periodic retraining of observers using standard behavior samples (i.e., "recalibration") and intermittent checks by newly trained observers (Hartmann, 1984). Furthermore, supervisors should ensure that observers are not required to conduct an excessive number of observations in a given day, and that they feel free to excuse themselves from observational sessions when ill.

Observer Training

Nonmechanical data collection requires human observers to react to behavior as it occurs and transduce it to written or computerized form. To reduce the previously discussed risks inherent in human transduction it is important to ensure that human observers are properly trained. The goal of observer training is to increase the control exerted by the observation code and participants' behavior over observers' scoring behavior, and reduce likelihood of control by irrelevant sources. A simple training method is to have a novice observer score a representative sample of behavior and make comparisons with a record obtained by an experienced observer. Corrective feedback should then be delivered until sufficient interobserver agreement is achieved for a prespecified number of sessions (Hartmann & Wood, 1982). For purposes of training, it may be useful

to observe videotaped behavior samples, so that instances of behavior can be viewed repeatedly if necessary. Behavior samples can be obtained from pilot studies, preliminary observations, or, if necessary, generated via role play. Computer technology may also facilitate observer training. For example, Bass (1987) described a computerized system in which observers watched videotapes and received automatic and immediate feedback on their scoring.

Interobserver Agreement

Reporting of interobserver agreement (IOA) indices is an expected standard in applied behavior analysis whenever human observers are employed (Page & Iwata, 1986). To obtain IOA scores, two persons (a primary and a secondary observer) independently score the same behavior episode, and agreement between the two records is then calculated. It is frequently recommended to obtain IOA for a minimum proportion of sessions (e.g., 25–30%) across all conditions or treatment phases (Bailey & Burch, 2002; Poling et al., 1995). It is important to note that high IOA scores (e.g., above 80 or 90%) in and of themselves do not indicate the accuracy of a measurement system; both observers could be inaccurate but still agree (Johnston & Pennypacker, 1993). However, low IOA scores indicate that adjustments are needed (e.g., additional observer training, more specific definitions) before useful data can be obtained (Poling et al., 1995). The following are several common methods of calculating IOA.

Total Agreement. The simplest index of IOA is total agreement, in which the ratio of scored occurrences by the two observers is calculated by dividing the smaller number by the larger (Poling et al., 1995). This procedure is limited, in that one cannot determine whether the two observers scored the same occurrences of behavior (Bijou, Peterson, & Ault, 1968). This index is therefore not recommended if agreement about specific instances of behavior (as opposed to overall occurrence) is important.

Interval Agreement. More stringent indices compare scoring within specified intervals (which should be relatively short, e.g., 5–10 seconds) to better evaluate whether the observers are scoring the same behavior at the same time (Bijou et al., 1968; Page & Iwata, 1986). Agreement or disagreement is determined for each interval or trial, and the number of agreements is then divided by the total number of intervals or trials. This approach is perhaps the most common IOA calculation method in applied behavior analysis (e.g., Hanley, Iwata, Lindberg, & Conners, 2003; Lannie & Martens, 2004; Thiemann & Goldstein, 2001). This approach can be used with any data that are recorded in intervals (e.g., partial and whole interval recording or momentary time sampling; see below) or trial by trial (i.e., correct vs. incorrect responses, compliance with teacher instructions). With these methods, each interval or trial typically generates one score; the behavior either occurred or not.

A conservative variant of the interval approach is *exact agreement*, in which observers must agree on the exact number of occurrences within an interval for an agreement to be counted (e.g., Hagopian, Contrucci Kuhn, Long, & Rush, 2005). While precise, this method may be too stringent for many practical purposes (Page & Iwata, 1986). *Block-by-block agreement* is a slightly less conservative but frequently sufficient method in which total agreement is calculated for each interval, and the quotients are then averaged across the whole session (Bailey & Burch, 2002; Page & Iwata, 1986; North & Iwata, 2005). The exact and block-by-block methods are only applicable when multiple responses can be scored in each interval. For instance, these methods can be used for frequency measures of instantaneous target behaviors such as hitting. Each occurrence of the target behavior is counted, and the observation period is then divided into intervals (e.g., 10 seconds) purely for purposes of IOA calculations. Agreement is then determined by comparing the number of responses scored by the observers interval by interval.

When target behavior occurs at low rates, there are likely many intervals or trials in which the behavior does not occur and few intervals in which the behavior occurs. In this case, the behavior analyst may choose to calculate *occurrence agreement*, which entails dividing the number of intervals in which both observers agreed on the occur-

rence of the behavior by the total number of intervals in which *either* observer scored an occurrence (e.g., Lerman et al., 2005). The reverse strategy, *nonoccurrence agreement,* may be employed for high-rate behavior; that is, *agreement* is defined as both observers reporting that the behavior did *not* occur during a given interval. The total number of agreements is then divided by the total number of intervals in which either observer did not score the occurrence of a response. Occurrence and nonoccurrence agreement indices eliminate the risk of artificial IOA inflation due to disproportionate numbers of intervals in which the target behavior does or does not occur (Bijou et al., 1968; Page & Iwata, 1986).

Computerized Data Collection Systems

The use of laptops or handheld computers for data collection has become increasingly common in applied behavior analysis. Computerized data collection systems operated by human observers have several potential advantages over paper-and-pencil methods, including increased efficiency of data analysis and graphing, and reduced risk of compromised reliability and accuracy due to ambiguity of written records (Dixon, 2003; Kahng & Iwata, 1998).

In addition, computerized systems that facilitate the coding of video and audio media have become available in recent years. Such systems allow for the measurement of many simultaneously occurring events, precise detection of response duration, and automatic data analysis and IOA calculations (e.g., Tapp, 2003; Tapp & Walden, 1993). This approach suffers from the limitation that each behavioral episode may need to be viewed multiple times; therefore, the time expenditure may be increased considerably. Computer programs of this kind should be used only if they provide improvements in data collection that are of sufficient importance considering the behavior of interest and the ultimate goals of data collection.

Videotapes and Other Visual Media

Human data collection may be enhanced by videotaping sessions for later viewing. Because videotapes (or digital media files) may be viewed repeatedly, scoring of a large number of simultaneously occurring responses is possible, and a convenient collection of behavioral episodes for use in observer training is created (Miltenberger, Rapp, & Long, 1999). Use of videotapes also allows for more precise duration measures than does live recording (Miltenberger et al., 1999; Tapp & Walden, 1993). Research has suggested that accuracy and reliability are generally not adversely affected by scoring videotaped sessions, although scoring of vocal responses may be affected (presumably because some systems have relatively low-quality audio recording and output; Kent, O'Leary, Dietz, & Diament, 1979). However, use of videotapes for data collection is time-consuming and can create a backlog of media to be scored, and valuable data may be lost if recorded sessions are lost or damaged before they can be viewed. Overall, these costs should be weighed against potential benefits when deciding whether to use live recording or to score behavior with the assistance of visual media.

Mechanical Recording

Much laboratory research in behavior analysis involves measures of target behaviors via mechanical devices (e.g., automatic recording of keystrokes or lever presses). Machines are free of many human shortcomings (expectancy bias, observer drift, illness, etc.). Therefore, machines may be preferred over human observers whenever the target response lends itself to mechanical recording (Johnston & Pennypacker, 1993). However, many of the responses of interest to applied behavior analysts are not easily amenable to mechanical recording with current technology. Nevertheless, mechanical recording via computer software is being used increasingly in certain areas of applied behavior analysis, especially those that make use of computer-based instruction. For example, Connell and Witt (2004) used computer-based instruction to teach relations among printed uppercase and lowercase letters, letter names, and letter sounds to kindergartners. The computer software automatically collected data during the study, obviating the need for human observers. Such recording methods may become more common as the availability of user-friendly, computer-based education and training programs in-

creases. Mechanical recording can also be used to measure non-computer-related skills. For instance, Van Houten, Malenfant, Austin, and Lebbon (2005) used an automated device to collect data on the seatbelt use of professional drivers.

Mechanical data collection systems have the advantage of completely removing human judgment from the data collection process, thereby eliminating human sources of error and increasing the reliability and accuracy of data collection. This does not mean that data gathered through these means should be trusted blindly. Machines can break, and human designers and programmers can make mistakes that render the systems inaccurate or unreliable. Replication of findings across different laboratories and with different data collection systems is therefore important. In addition, human judgment is still essential in interpreting and making sense of the data.

Indirect versus Direct Measurement

Direct observation requires measuring the behavior of interest without inferring its occurrence from other events (e.g., products of behavior, verbal recollections), usually by observing the behavior as it occurs in either a natural or a contrived setting. Direct observation maximizes the validity of measurement because it decreases the discrepancy between actual behavioral events and sampled behavior (Hersen & Barlow, 1976). In behavior analysis, direct observation is preferred whenever possible; nonetheless, situations may arise in which indirect measures are necessary. For example, the behavior of interest may primarily occur covertly, such that direct observation is difficult or impossible (e.g., Grace, Thompson, & Fisher, 1996). Furthermore, behavior analysts may wish to collect data concerning past events, in which case the only recourse may be to examine archival information or collect informant reports (e.g., via interviews, surveys, or questionnaires).

Indirect Measurement

Indirect measurement involves drawing inferences about the behavior of interest from other behaviors or environmental events. The validity and accuracy of measurement may suffer because the target behavior is not directly observed, but this approach may nevertheless be of value to behavior analysts when direct observation is impossible or impractical.

Indirect Measurement Procedures

Permanent Product Recording. Direct measurement may be supplemented or replaced by measuring outcomes of behavior, such as administrative records, completed assignments, or manufactured goods (Kazdin, 1979). In short, permanent product recording involves recording the tangible outcome of a behavior rather than the behavior itself. In some instances, the products themselves may be of primary interest. For example, completed homework may be scored for accuracy (Kelly, 1976; Miller & Kelley, 1994). In other cases, permanent products are not of primary interest but are important indicators of target behavior that is not easily amenable to direct observation. The latter approach was illustrated in a study by Grace and colleagues (1996), who conducted physical examinations to identify signs of self-injury (e.g., bruises, scratches, swelling, and tissue damage). This approach was chosen because the self-injury was covert, and observers were therefore unable to observe the behavior directly. Another example was provided by Maglieri, DeLeon, Rodriguez-Catter, and Sevin (2000), who implemented permanent product recording to evaluate covert food stealing. Observers recorded the amount of food presented at the start of session, left the participant alone in the room, and returned later to record the amount of remaining food.

Permanent product recording is limited in that it measures outcomes rather than the behavior itself. This may be problematic because the outcome could occur due to something other than the target behavior, resulting in inaccurate data. For example, measuring performance through examination of worksheets results in inaccurate measures if someone other than the participant completed the work (e.g., a parent did the homework for the child). In addition, the target behavior may not result in the measured outcome (e.g., self-injury may not result in tissue damage) (Grace et al., 1996). There-

fore, caution should be taken when implementing product recording. Noting alternative events that may produce the outcome of interest may enhance the accuracy of data collection. For example, if a child falls during outdoor playtime, the resulting bruises and scratches may be difficult to distinguish from injuries produced by self-injurious behavior.

Self-Monitoring. Self-monitoring, or self-recording of data, is similar to direct observation in that events of interest are recorded as they occur. However, the difference is that the client or participant serves as his or her own observer. Self-monitoring is particularly useful in the measurement of private events that are only directly accessible by the client, such as headaches and thinking (Hartmann, 1984; Nelson, 1977). This approach can also be used with behavior that is overt and observable by more than one person, but is not easily amenable to direct measurement due to practical constraints. For example, VanWormer (2004) obtained measures of adults' physical activity and weight loss by having his participants carry pedometers, which count the number of steps a person takes, and weigh themselves regularly. Family members and friends served as secondary observers, and the participants periodically e-mailed data to the experimenter.

Self-monitoring is desirable in that it enables data collection that otherwise would be unattainable. Nevertheless, at least two major shortcomings are inherent in this approach. First, self-recorded data may be less accurate than direct-observation data, and the accuracy and reliability of these data are more difficult to verify. Direct training of clients in the observation of their own behavior is likely to help in this matter, as is the design of measurement systems that are convenient and require little effort. One valuable training strategy is to place contingencies initially on accurate reporting rather than clinically desirable changes in behavior, such that data collection that agrees with independent sources is rewarded, regardless of other outcomes (Hartmann, 1984; Nelson, 1977). Second, observer reactivity (i.e., the effects of observation on the target behavior) is of special concern in self-monitoring. The behavior analyst should attempt to evaluate the effects of treatment via both self-monitoring and less intrusive data collection methods to ensure that the effects of the independent variable were not exclusively or primarily due to reactivity (Cooper et al., 1987). While the reactivity inherent in self-monitoring is a threat to effective measurement, it can be used as a treatment protocol. The very act of systematically keeping track of one's own behavior can be an effective tool for self-management and behavior change (Cooper et al., 1987; Critchfield, 1999).

Interviews, Surveys, and Rating Scales. Structured interviews, surveys, or rating scales may be used to collect important information about various aspects of the behavior of interest, such as topography and potential environmental correlates (Beaver & Busse, 2000; Merrell, 2000). Depending on the situation, this information may be gathered from the client or from significant others in the client's environment (e.g., parents, teachers). Indirect measures of this sort can generate information that may be helpful in the initial stages of assessment (McComas & Mace, 2000; Nay, 1979). Behavioral interviews, surveys, and rating scales have been used to generate hypotheses about potential behavioral function (e.g., Applegate, Matson, & Cherry, 1999) and to identify potential reinforcers to use in subsequent treatments (Fisher, Piazza, Bowman, & Amari, 1996; Northup, 2000). This information can then be used to determine which stimuli to include in subsequent preference or reinforcer assessments, and which environmental conditions to include in functional assessments. Importantly, because informant reports do not always correspond well with the behavior of interest, hypotheses generated through these means should always be confirmed through more stringent observation methods—preferably involving direct observation. Direct observation data are the "gold standard" against which to evaluate the accuracy of indirect measures.

Direct Observation

As mentioned earlier, direct observation is the recording of behavior as it occurs without inference from other events. Compared to indirect measures, direct observation is more consistent with behaviorism's epistemological emphases on overt behavior, pub-

lic events, quantification, low levels of inference, and the importance of environmental contingencies (Hartmann & Wood, 1982). Additional advantages of direct assessment include an increase in predictive validity as the discrepancy between sampled behavior and predicted behavior diminishes, and a close relationship between the target behavior and treatment processes (Hersen & Barlow, 1976). In light of these advantages, it is evident why methods of direct measures are preferred in the study of behavior and widely used in numerous contexts (e.g., Alevizos, DeRisi, Liberman, Eckman, & Callahan, 1978; Bijou, Peterson, Harris, Allen, & Johnston, 1969; Cordes, 1994; Doll & Elliott, 1994; Gresham, Gansle, & Noell, 1993; Odom & Ogawa, 1992; Prinz, 1982; Test & Rose, 1990; Wasik & Loven, 1980).

Direct measures can be continuous or discontinuous. *Continuous measures* record all instances of behavior, while *discontinuous measures* (also termed *intermittent measures*) sample from all possible occurrences of behavior (Johnston & Pennypacker, 1993). Continuous measures (i.e., frequency, duration, latency, and intensity) provide the most complete record of behavior but may prove expensive and otherwise impractical. Therefore, intermittent or discontinuous methods—such as interval recording and momentary time sampling—are often valuable. However, discontinuous recording results in an incomplete record of behavior and consequently raises several questions about the representativeness of the collected data. In order to respect the intrinsic characteristics of behavior, it is of great importance to design discontinuous observational procedures that appropriately sample from all possible occurrences of behavior to yield representative and accurate measures.

Continuous Recording Procedures

Continuous recording of behavior is the most rigorous and powerful measurement procedure available to behavior analysts. This approach involves recording behavior on the basis of its occurrence in an uninterrupted, natural time flow (Hartmann & Wood, 1982; Sanson-Fisher, Poole, Small, & Fleming, 1979). The application of continuous recording to relevant behavioral dimensions is discussed in the following paragraphs.

Frequency. Frequency recording (also referred to as tally method, trial scoring, and event recording) entails continuous recording of separate instances of behavior as they occur (Hartmann & Wood, 1982; Kazdin, 2001; Repp, Roberts, Slack, Repp, & Berkler, 1976). Frequency recording is most appropriate when the number of times a behavior occurs is the response dimension of interest (Hartmann & Wood, 1982; Schinke & Wong, 1977). However, frequencies obtained in different observation sessions cannot be meaningfully compared if observation times are unequal. In those instances, it is useful to convert frequencies into *response rate*, defined as the frequency of behavior per some unit of time (minute, hour, day, etc.; Kazdin, 2001). When behavior is opportunity-bound or trial-based, such that the target responses cannot meaningfully occur in the absence of specified stimuli (e.g., instructions, stimulus cards), obtained frequencies may be converted to percentages or reported outright relative to the number of opportunities for the response to occur. For example, Gutowski and Stromer (2003) measured selection of comparison stimuli that occurred in the presence of specific sample stimuli and converted the frequencies into percent correct selections.

Frequency recording is best suited to the measurement of responses that are relatively discrete and have a constant duration. Examples include hitting, throwing objects, pressing buttons or keys, and placing items in containers. In addition, responses that tend to have variable durations can be amenable to frequency recording if their onset and offset are precisely defined. However, given responses of greatly varying durations, the behavior analyst should consider the use of duration recording instead of frequency recording. Frequency recording can generate a great deal of information about behaviors to which it is suited (Repp et al., 1976) and is easily implemented provided that the number of responses to be scored is not excessive. The amount of responding, reflected in frequency measures, is important when the goal is to increase or decrease the number of times the target behavior occurs (Kazdin, 2001).

Duration. Duration involves measuring the entire amount of time that the target response is performed (Kazdin, 2001). Dura-

tion recording is appropriate when temporal characteristics of a response are of interest, and when behaviors vary in the length of time the client engages in them. This approach is best suited to continuous, ongoing responses rather than to discrete, short-duration behaviors (Hartmann & Wood, 1982). Duration is easily measured by turning on a stopwatch or a timer at the onset of behavior and turning it off at the offset of behavior. Most computerized data collection systems allow observers to press designated keys at the onset and offset of behavior, and many accommodate multiple, simultaneous duration measures. The proportion of session time that the response was performed can then be easily calculated by dividing the total duration of behavior by total observation time.

Altmann (1974) suggested that duration recording is appropriate for behavioral states as opposed to behavioral events. *Behavioral states* are those behaviors that have appreciable duration, while *behavioral events* are instantaneous occurrences of behavior. Duration recording is useful in measuring *time allocation*, defined as the amount of time spent in certain environmental areas (e.g., sitting in a chair), or engaged in certain response alternatives (e.g., doing homework, practicing a musical instrument) (Kazdin, 2001).

As with other continuous measurement procedures, duration recording is appealing because it entails the complete measurement of the response dimension of interest. Like frequency, duration is easily comprehensible, socially acceptable, and can be accomplished without complicated observational technology. The reliability of duration measures, however, may be low if onset and offset of behavior are not precisely defined. In addition, duration recording can be relatively effortful, particularly if multiple response topographies are of interest, or the behavior of many individuals must be simultaneously measured. Under these circumstances, the behavior analyst may choose to use appropriate time-sampling techniques (e.g., momentary time sampling, see below; Kazdin, 2001).

Latency. Latency refers to the amount of time that elapses between the onset of a specific cue or stimulus and the response of interest (Kazdin, 2001). Like duration, latency may be recorded with the assistance of timing devices or computerized systems that allow for designated duration keys. Latency recording is appropriate when the relationship between a certain event and the initiation of a specific response is of interest. This includes situations in which the goal is either to reduce or increase time periods between antecedent events and target behavior. For example, behavior analysts are frequently interested in reducing the latency between instruction delivery and compliance. Wehby and Hollahan (2000) measured the number of seconds that passed between the delivery of instructions to engage in academic activities and compliance with said instructions. With these measures, they were able to evaluate the effectiveness of providing a series of high-probability requests (i.e., requests in which participants were likely to engage immediately) before the delivery of academic instructions.

Like frequency and duration recording, latency measures consist of complete measurement of the response dimension of interest, and are preferred over discontinuous measures unless practical constraints dictate otherwise. In addition, latency recording is simple, relatively straightforward, and may be highly acceptable to consumers and observers alike. On the other hand, conditions under which latency recording is appropriate are limited because a specifically defined relation between antecedent conditions and target responding is required. As with other continuous measures, practical constraints (e.g., simultaneous measurement of multiple responses or observation of multiple clients) may necessitate the use of discontinuous measures.

Intensity. Intensity recording involves measures of magnitude, strength, amplitude, force, or effort of a response. Intensity can occasionally be recorded through automated mechanical devices, but without these devices, degrees of intensity may require judgments that are difficult for observers to make reliably (Kazdin, 2001). Responses that may be targeted for intensity recording include shouting, throwing an object, hitting, swearing, tantrums, and noise level. Wilson and Hopkins (1973) recorded intensity while examining the effects of quiet-contingent

music on the general noise levels of middle school classrooms. Intensity recording was particularly useful in this situation because the goal of intervention was to decrease general noise levels in the classrooms.

Discontinuous Recording Procedures

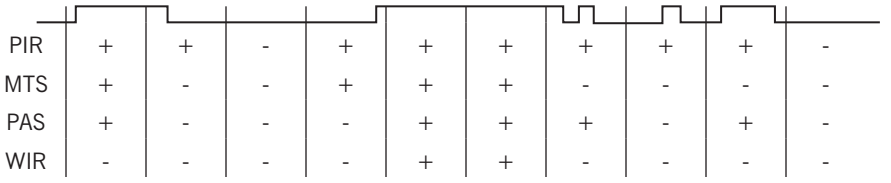
As previously discussed, continuous measures yield the most accurate behavioral data, but these methods can be labor-intensive and sometimes impractical. Therefore, behavior analysts may choose to employ discontinuous measurement procedures. The most common varieties of discontinuous recording are discussed in the following paragraphs.

Interval Recording. In interval recording, the observation session is divided into time periods of equal length (e.g., 10 seconds), and each interval is scored as positive (i.e., occurrence) or negative (i.e., nonoccurrence) according to specific criteria. Varieties of interval recording include *whole-interval recording* (WIR), in which an interval is scored as positive if the target behavior occurs for the entire observational period; *partial-interval recording* (PIR), in which an interval is scored as positive if the target behavior occurs at any point during the observational period; and *predominant activity sampling* (PAS), in which an interval is scored as positive if it occurs for more than half of a given interval (Adams, 1991; Harrop & Daniels, 1986; Poling et al., 1995; Saudargas & Zanolli, 1990; Tyler, 1979). Like other discontinuous measurement procedures, interval recording provides an estimate of behavior rather than a representation of the entire behavioral episode. Therefore, it is important to determine how to design interval recording procedures in order to minimize error and maximize accuracy of measurement.

Researchers have systematically evaluated the extent to which aspects of interval recording influence the accuracy of measurement systems when applied to behaviors of different rate and duration. Both WIR and PAS may provide accurate estimates of the amount of time long-duration behavior occurs but underestimate instantaneous behavior (Bailey & Burch, 2002; Murphy & Goodall, 1980; Powell, Martindale, & Kulp, 1975). By contrast, PIR tends to overestimate overall occurrence of long-duration behavior, but like WIR, tends to underestimate the occurrence of instantaneous, high-rate behavior (Harrop & Daniels, 1993; Murphy & Goodall, 1980; Repp et al., 1976). When overall duration is the response dimension of interest, PIR virtually always provides overestimates (Suen, Ary, & Covalt, 1991), suggesting that WIR, PAS, or momentary time sampling (discussed below) should be chosen over PIR when duration is the response dimension of interest (see Harrop & Daniels, 1993, for an alternative interpretation). More accurate estimates of the frequency of high-rate, instantaneous responses are achieved with shorter interval lengths (e.g., 5–15 seconds). However, shorter interval lengths do not systematically increase the accuracy of estimates of long-duration behavior (Sanson-Fisher, Poole, & Dunn, 1980).

Figures 7.1, 7.2, and 7.3 provide hypothetical demonstrations of the sensitivity of interval recording conventions, with behavioral streams consisting of occurrences of various rates and durations. Figure 7.1 shows that PIR overestimates and WIR underestimates both frequency and duration of responses of moderate rate and varying duration. PAS, on the other hand, provides a close estimate. Figure 7.2 shows that PIR provides a relatively accurate (but slightly conservative) estimate of the frequency of an instantaneous response of moderate rate but grossly overestimates its duration. Both PAS and WIR are completely unable to detect any responses in a behavioral stream of this sort. Figure 7.3 shows that PIR somewhat overestimates both duration and frequency of long-duration behavior, whereas PAS and WIR slightly underestimate its duration and overestimate frequency.

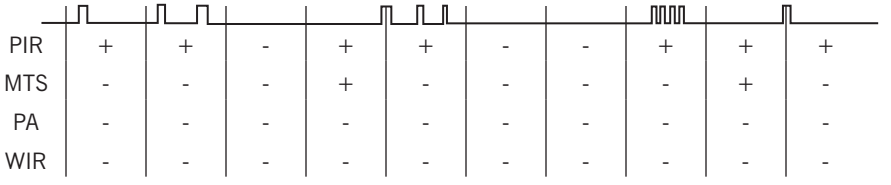
It is apparent that interval measures frequently introduce substantial error into the estimates of behavior, and the amount and type of error is dependent on the relative rate and duration of behavior, as well as the parameters of the interval recording system (Powell, Martindale, Kulp, Martindale, & Bauman, 1977). Nevertheless, interval recording (particularly PIR) is among the most frequently used measurement procedures in applied behavior analysis (Bailey & Burch, 2002). A likely reason for its popularity is both the convenience of recording and the



	Percentage time spent	No. of occurrences
Actual	47%	5
Estimates		
PIR	80%	8
MTS	40%	4
PAS	50%	5
WIR	20%	2

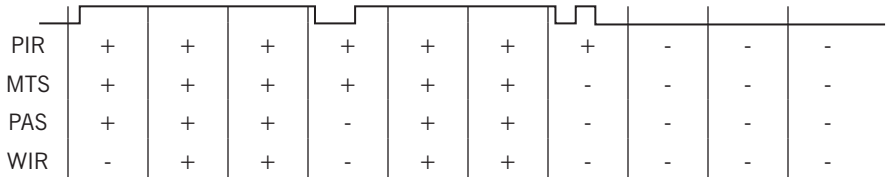
FIGURE 7.1. A demonstration of hypothetical results obtained with different time-sampling conventions by means of an analysis of an event recorded tape. The width of the figure represents a period of 150 seconds, and the vertical lines represent time intervals of 15 seconds. The results of an analysis of this tape are presented. PIR, partial-interval recording; MTS, momentary time sampling; PAS, predominant activity sampling; WIR, whole-interval recording. Adapted in part from Tyler (1979). Copyright by Elsevier. Adapted by permission.

fact that it is frequently sensitive enough to detect changes in the relevant dimensions of behavior as a function of treatment (Harrop & Daniels, 1986, 1993). For example, even though PIR is likely to underestimate the magnitude of change in high-rate, instantaneous behavior, providing for a conservative estimate of behavior change (Harrop & Daniels, 1986; Suen et al., 1991), this is not necessarily a limitation of the procedure (i.e., the probability of type II errors is diminished).



	Percentage time spent	No. of occurrences
Actual	7%	11
Estimates		
PIT	70%	7
MTS	20%	2
PAS	0%	0
WIR	0%	0

FIGURE 7.2. A demonstration of hypothetical results obtained using different time-sampling conventions by means of an analysis of an event recorded tape. The width of the figure represents a period of 150 seconds, and the vertical lines represent time intervals of 15 seconds. The results of an analysis of this tape are presented. Abbreviations as in Figure 7.1. Adapted in part from Tyler (1979). Adapted by permission.



	Percentage time spent	No. of occurrences
Actual	57%	3
Estimates		
PIT	70%	70
MTS	60%	6
PAS	50%	5
WIR	40%	4

FIGURE 7.3. A demonstration of hypothetical results obtained using different time-sampling conventions by means of an analysis of an event recorded tape. The width of the figure represents a period of 150 seconds, and the vertical lines represent time intervals of 15 seconds. The results of an analysis of this tape are presented. Abbreviations as in Figure 7.1. Adapted in part from Tyler (1979). Adapted by permission.

Momentary Time Sampling. This procedure consists of scoring an interval as positive if the target behavior occurs exactly at the conclusion of a predetermined interval (Harrop & Daniels, 1986). For example, observers may be assisted by a timer that is set to beep every 10 seconds, and is inaudible to the client. When the timer goes off, the observers look at the client and score whether he or she is engaged in the target behavior at that precise moment (hence the term *momentary*).

Momentary time sampling (MTS) is particularly useful in providing estimates of duration of behavior (Harrop & Daniels, 1986; Suen et al., 1991). Unlike interval measures, MTS does not make assumptions about portions of observations that were not sampled. With PIR, if a response occurs early in a period, the entire period is scored as positive, regardless of whether the behavior occurred again within that period. With WIR, the whole interval is treated as negative unless the behavior occurred during the entire period, regardless of whether the behavior occurred during portions of the interval. MTS, on the other hand, only makes assumptions about the momentary periods during which behavior is sampled, and proportional duration estimates are calculated by dividing the number of scored occurrences by the total number of intervals. A potentially unbiased estimate of duration is thus obtained (Suen et al., 1991).

Research has shown that MTS does not systematically overestimate or underestimate behavior. In other words, errors in estimates tend to be close to random, leading to fairly accurate average estimates (Brookshire, Nicholas, & Krueger, 1978; Green & Alverson, 1978; Harrop & Daniels, 1986; Mudford, Beale, & Singh, 1990; Murphy & Goodall, 1980; Powell et al., 1975, 1977; Repp et al., 1988; Suen et al., 1991; Tyler, 1979). Harrop and Daniels (1993) caution that although MTS estimates typically match actual duration of behavior, unbiased estimates are not necessarily accurate when based on a single session of observation. Although definitive guidelines for the use of MTS do not exist, there are situations in which it is advisable to use this method over others, such as when high-rate, long-duration behaviors are of interest, and when it is necessary to observe multiple responses or organisms (Murphy & Harrop, 1994). MTS is not recommended for responses that have a short duration or occur infrequently (Arrington, 1943).

Figures 7.1, 7.2, and 7.3 provide hypothetical demonstrations of the sensitivity of MTS in behavioral streams with response

occurrences of various rates and durations. Figure 7.1 shows that MTS provides a slight underestimate of behavior of varying duration and moderate rate. Figure 7.2 demonstrates how MTS may grossly underestimate both frequency and duration of instantaneous responding of moderate rate. However, MTS is likely to provide a close estimate of the overall duration and an overestimate of the frequency of relatively long-duration behavior that occurs for a large portion of the observation period, as demonstrated in Figure 7.3.

There are several advantages associated with MTS. Cameron, Crosbie, and Crocker (1988) suggested that MTS is an attractive choice because data may be analyzed with inferential statistics, thus providing communicative aid to behavior analysts when presenting results to psychologists and other professionals subscribing to non-behavior-analytic paradigms. Another key benefit of MTS is the ease of implementation (Brookshire et al., 1978; Brulle & Repp, 1984). While MTS is not an error-free method of observation, Murphy and Goodall (1980) suggested that it might be the best available option when continuous recording is not feasible.

There are several potential limitations of MTS, including inadequate representation of certain behavioral dimensions, as well as insensitivity to actual duration, frequency, and changes in behavior (Repp et al., 1976). Several authors have reported that MTS may not be as sensitive to small changes in actual rates of behavior as PIR (Harrop & Daniels, 1986; Harrop, Daniels, & Foulkes, 1990). Tyler (1979) discussed the difficulty in using MTS when the behavior of interest is not amenable to instant recognition. Despite these reservations, several researchers have shown that MTS measures correlate highly with continuous measures (e.g., Brulle & Repp, 1984; Harrop & Daniels, 1986; Powell et al., 1977).

A number of researchers have compared the accuracy of MTS and interval recording. Green, McCoy, Burns, and Smith (1982) compared WIR, PIR, and MTS, and reported that MTS provided greater representativeness of the actual behavior and involved fewer observer errors than other interval recording methods. As with interval recording, shorter interval length yields more accurate data (Brookshire et al., 1978; Brulle & Repp, 1984; Harrop & Daniels, 1985; Kearns, Edwards, & Tingstrom, 1990; Mansell, 1985; Saudargas & Zanolli, 1990). Brulle and Repp (1984) examined different interval lengths and found that 10-second, 20-second, 30-second, and 60-second intervals provide accurate estimates of the average duration of the target behavior, while a 120-second interval is accurate only when the target behavior occurred for more than 10% of the session, and a 240-second interval is accurate only when behavior occurred for more than 20% of the session. Thomson, Holmberg, and Baer (1974) examined interval length and the rotation of observation intervals when observing behaviors of multiple organisms. They suggested that the smallest percent error occurs when behavior is widely dispersed across the observation schedule.

Conclusion

Our purpose in this chapter has been to review observational recording methods, to examine the characteristics of each method, and to provide readers with a method of selecting the optimal observational techniques. To aid clinicians and researchers in this task, decision flowcharts have been developed (Figures 7.4 and 7.5). Note that pathways leading to measures of intensity and latency have not been included on the chart due to the descriptive nature of the measurement labels. The reader should further note that references to interval recording invariably refer to the PIR method, but WIR and PAS may sometimes be appropriate for responding that is also relatively well captured by momentary time sampling. To simplify the task of the reader, we have included separate flowcharts describing recommended decision pathways that are applicable when frequency (Figure 7.4) and duration (Figure 7.5) are the behavioral dimensions of interest.

In deciding which measurement system to use, one must first ask which dimension of behavior, frequency, or duration is of primary interest in the investigation. Investigations focusing on frequency of behavior can be further subdivided into three categories, each of which relies on a different form of observation (see Figure 7.4). Permanent products are ideal for instances when behav-

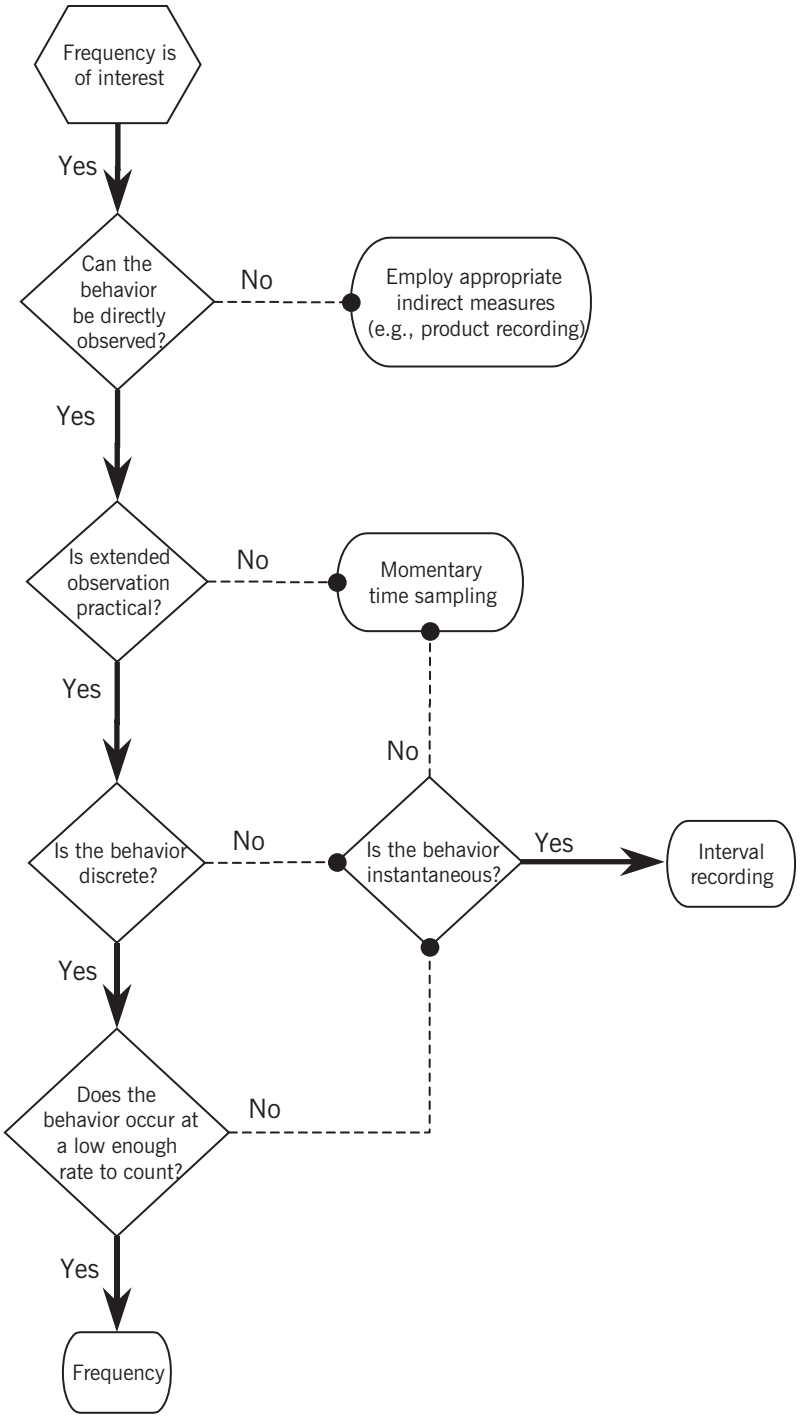


FIGURE 7.4. Decision flowchart for observational method selection when frequency is the behavioral dimension of interest.

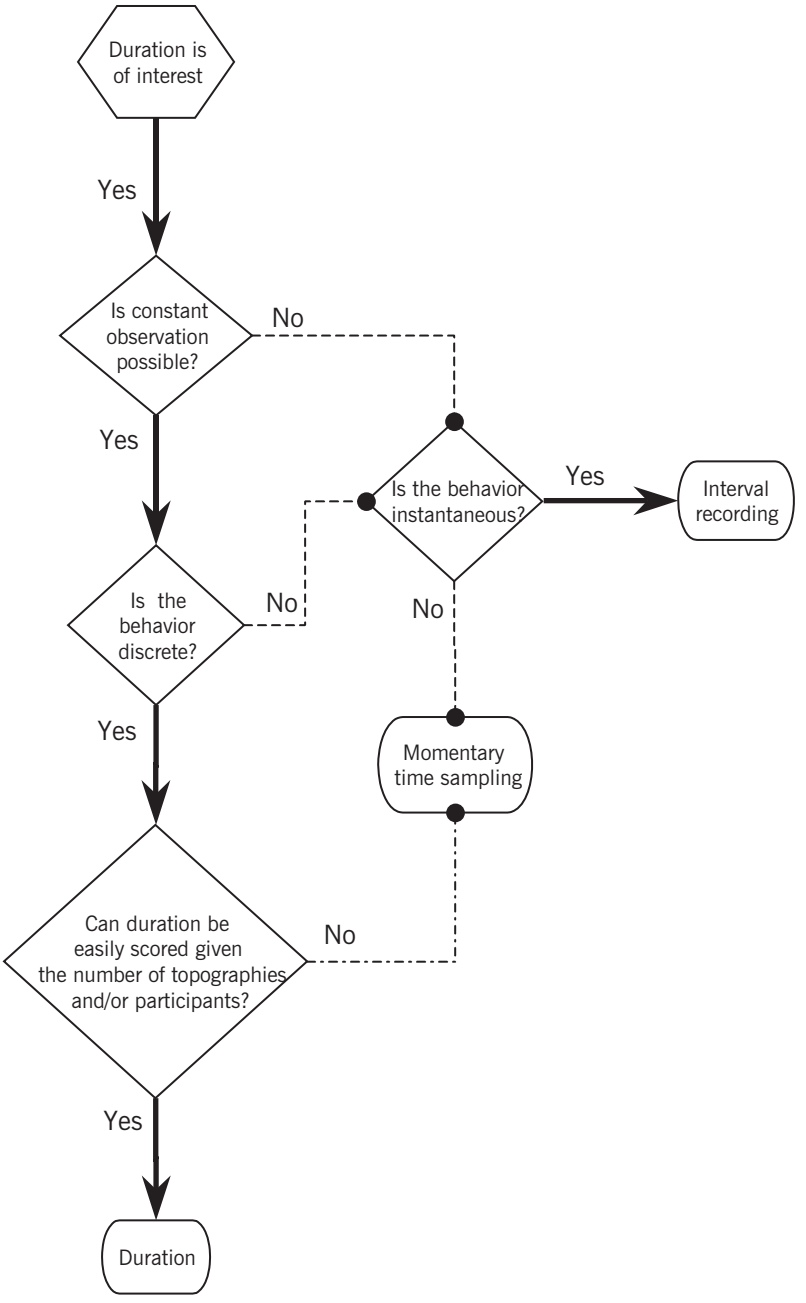


FIGURE 7.5. Decision flowchart for observational method selection when duration is the behavioral dimension of interest.

ior results in a tangible product that can be measured. Event recording (i.e., a frequency count) is best suited for instances in which behavior has a clear, definable onset and offset that can be counted. Finally, for investigations that focus on behavior that lacks a delineated onset and offset or that occurs at such high rate that responses cannot be easily (and accurately) tallied, a PIR method is most appropriate, but momentary time sampling may be used when continuous observation is not possible or if responses are of unequal duration. On the other hand, investigations requiring duration measures require slightly different decision pathways (see Figure 7.5). Duration measures are merited when behavior is discrete and a data collector observes a manageable number of response topographies in one person constantly throughout the entire observation period. Momentary time sampling is best suited for instances in which nondiscrete, ongoing behavior is targeted, when observations are continuous or discontinuous, and/or when the data collector is observing multiple responses at one time, or the same behavior in more than one person. However, interval recording should be employed if the behavior is nondiscrete but instantaneous (i.e., responses that do not have a clearly delineated onset or offset but nevertheless have short durations). Finally, it should be noted that a rough estimate of both frequency and duration may be obtained via an interval recording method.

Because observational methods are widely used in behavior analysis and matching recording procedures to target behaviors is key, the methods discussed in this chapter are of paramount importance. Correct selection of observation systems is likely to result in more efficient and effective treatments. Given a comprehensive understanding of measurement methods, researchers and clinicians are better prepared to bridge the language barrier between behavior analyst and caregiver as they are able to provide precise information about measurement methods, including their benefits, limitations, and characteristics.

The preceding discussion makes clear that selecting a system of measurement can be a challenging task, and choices among various measurement systems can greatly impact the outcome of data collection and subsequent treatment decisions. A delicate balance must be struck between identifying methods to provide the most efficient and representative means of sampling, while still honoring the behavior's unique characteristics. Therefore, it is imperative for researchers and clinicians to understand fully the nuances among these different recording methods.

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CHAPTER 8

Single-Case Experimental Designs

Henry S. Roane, Joel E. Rihgdahl, Michael E. Kelley, and Ashley C. Glover

Use of single-case experimental designs is not unique to the field of applied behavior analysis (Kazdin, 1982). However, single-case experimental designs are well suited to applied behavior analysis for a number of reasons. The best way to understand the unique relation between applied behavior analysis and single-case design it to reflect back on the central dimensions of applied behavior analysis reviewed by Fisher, Groff, and Roane (Chapter 1, this volume): applied, behavioral, analytic, technological, conceptually systematic, effective, and generalizable (Baer, Wolf, & Risley, 1968). As described by Baer and colleagues (1968), the focus of applied behavior analysis is on the analysis and modification of socially important behavior in individuals, and single-case designs provide a technologically sound approach for studying the effects of independent variables on the behavior of individuals.

As reviewed by Fisher and colleagues (Chapter 1, this volume), the ability of the single-case design to evaluate the effects of an intervention for an individual has several important implications for applied behavior analysis. First, although the results of group experimentation might show a statistically significant difference for an intervention, it is often difficult or impossible to discern whether clinically significant improvements have occurred for individual participants in the study. For example, if an individual participant displays self-injurious head banging at a rate of 13 times per minute during the pretest and three times per minute during the posttest, it is not possible to determine whether the intervention produced the reduction, or whether the two different response rates reflect normal variation that would have occurred without the intervention. In addition, head banging at the rate of three per minute (or 180 times per hour) is probably not a clinically acceptable level of head banging. By contrast, the single-case design provides information about the extent to which the intervention was effective for a given individual, and whether the level of effectiveness was clinically acceptable. This is not to suggest that one methodology is superior to another, but merely that single-case design is an important component of the applied behavior analyst's toolkit.

As such, single-case experimental designs have utility as both a research tool and a tool for clinical evaluation. Single-case research consists of manipulating a variable or variables, known as the independent variable (IV) and measuring the effect on an outcome variable or variables, known as the depen-

dent variable (DV). The DV is typically some sort of behavior or permanent product of a behavior (e.g., completed math problems). The purpose of a single-case experimental design is to reveal the extent to which one has adequately demonstrated functional control, or a relation in which a change in the DV is due to the implementation of the IV.

Our purpose in the current chapter is to provide an overview of research designs that are representative of a single-case approach. The topics covered include data collection, visual inspection of single-case data, and experimental designs used in single-case research. The discussion of single-case designs includes illustrative hypothetical examples, as well as clinical cases from our own work and that of others.

Data Collection

Data collection is central to single-case methodology. For the purposes of this chapter, the process is broken into three subsections: defining behavior, measuring and recording behavior, and interobserver agreement. These topics are included here to serve as a basis for the various design strategies (for a full review of data collection procedures, see Kahng, Ingvarsson, Quigg, Seckinger, and Teichman, Chapter 7, this volume).

The linchpin of the data collection process is defining the behavior(s) of interest. This process is important because it drives the subsequent steps in single-case methodology. Operational definitions should be concise, detailed, and unambiguous descriptions of *observable* behavior (in contrast with unobservable behavior, such as emotional states). Morris (1985) provided three questions to consider when evaluating the quality of an operational definition:

1. Can the number of times the behavior occurs in a minute or the number of minutes the behavior was done be counted?
2. Would a stranger know exactly what to look for?
3. Can the behavior be further broken down?

Once the target behavior has been defined operationally, the measurement parameters (how the behavior is measured) should be delineated. Four primary strategies can be used to measure behavior (described in greater detail by Kahng et al., Chapter 7, this volume). These include (1) event recording, (2) duration recording, (3) interval recording, and (4) permanent product recording. The strategy that is used depends, in part, on the behavior that is being measured.

Once the type of data collection system is determined, it is typically advisable to collect baseline data on the occurrence of the behavior under observation. Baseline data provide a frame of reference for the occurrence of behavior in the absence of the programmed intervention. These data are critical for evaluating the relative change in behavior, particularly in the context of an experimental design. Without such data, it is difficult to determine how well (or poorly) an individual is responding to treatment. Consider a parent who reports, "My child only hit his teacher 14 times this week." These data are meaningless without a context with which to compare them. Baseline data give us such a context.

As noted earlier, operationally defining behavior, selecting an observation system, and collecting baseline data are important initial steps in the use of single-case design strategies. These procedures are necessary prerequisites to conducting a thorough single-case evaluation of behavior. However, the crux of single-case experimentation lies in the selection of designs that are most likely to reflect functional control and the methods used in the analysis of that control. Thus, the following sections address the visual inspection of data and the most common types of single-case experimental designs.

Visual Inspection

One unique difference between group and single-case designs is the method used for evaluating data. Typically, group designs produce data from treatment and control groups that are compared using a variety of parametric and nonparametric statistical procedures. Alternatively, single-case experimental designs result in baseline and treatment data for one or more individuals that are analyzed using visual inspection. Visual inspection involves reaching a con-

clusion about the effects of various IVs on DVs by visually examining the graphed data. Meaningful changes in the DV should be apparent when displayed graphically, and an emphasis is placed on the believability of the observed change in behavior (i.e., was the observed behavior change associated with a consistently applied IV?). One drawback is that visual inspection introduces the potential for bias into the data-analysis process. Specifically, because visual inspection can be a subjective exercise, the possibility exists that individual differences will influence interpretation.

DeProspero and Cohen (1979) evaluated four factors that could influence reviewers' agreement during visual inspection: (1) patterns of mean shift, (2) degree of mean shift, (3) variability, and (4) trend. They found that agreement among visual inspections of single-case data across independent raters was low, particularly when intervention effects were not dramatic (i.e., when changes in behavior were relatively small). However, Kahng and colleagues (2010) replicated and extended the results of DeProspero and Cohen by reexamining the consistency of visual analysis across raters recruited from the Board of Editors and associate editors for the *Journal of Applied Behavior Analysis*. Raters evaluated graphs using a scale of 0 to 100 of "experimental control" and a dichotomous response ("yes" or "no") for a series of ABAB graphs. In contrast to the results of DeProspero and Cohen, raters in the Kahng and colleagues sample were able to produce high interrater agreement, which suggested that visual inspection can produce consistent interpretation of single-case data among well-trained raters.

A simple way to think about visual inspection of single-case graphs is that the behavior analyst should be able to use the data from the single-case graph to predict what will happen next (e.g., predictive function; Kazdin, 1982). The three critical elements of a single-case graph that allow prediction of future performance and should be the focus of visual inspection include (1) the level of behavior, (2) the stability of behavior, and (3) the trend in behavior. The level of behavior should serve a descriptive function, in that it should reflect or describe the extent of the problem. Said another way, do the data on the graph and what you the behavior analyst observe in the environment seem to "match"? Hypothetical data showing levels from Baseline to Intervention are shown in Figure 8.1. The stability of the behavior has an even more important role in predic-

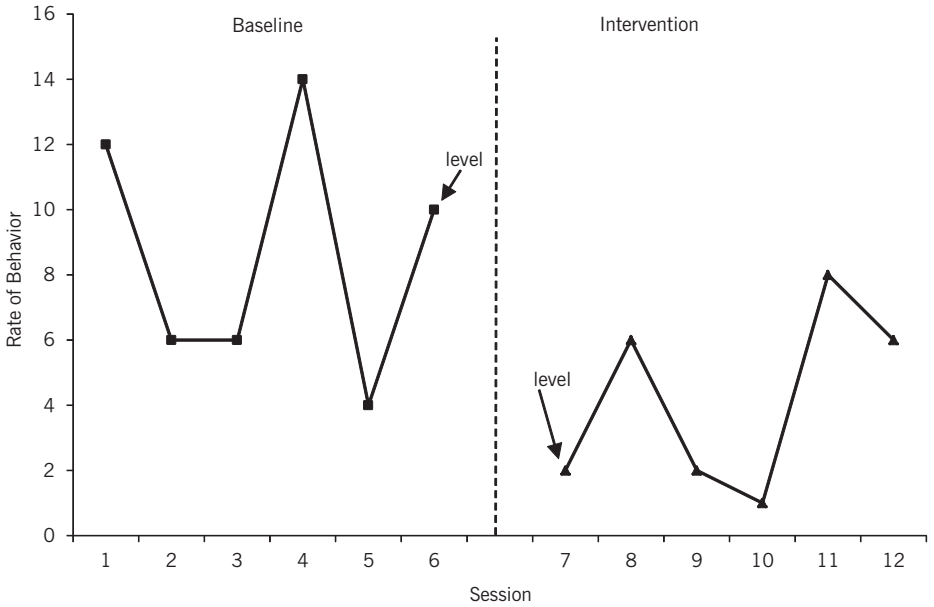


FIGURE 8.1. Hypothetical changes in levels across baseline and intervention phases.

tion. If responding is unstable (e.g., occurs irregularly, at varying levels from moment to moment), it will be more difficult to predict "what will happen next." Unstable levels of performance usually require longer periods of data collection to fulfill the predictive function. Data showing different patterns of stability across baseline and intervention phases are shown in Figure 8.2. Finally, the trend of the behavior provides information about the extent to which the behavior is improving or worsening independent of intervention. The trend in behavior provides a final indicator of whether the behavior is "ready" for intervention. For example, if aggression is the target of intervention and it is decreasing, then it would make most sense to delay intervention to determine if aggression will improve on its own. By contrast, a worsening of aggressive behavior might suggest the need for implementation of an intervention. Hypothetical data showing changes in the trend of the data are depicted in Figure 8.3).

Another method tool for assisting in visual analysis is plotting the mean line. The *mean* is a measure of central tendency that can be defined as the average of a set of numbers, such as the average level of behavior reported across a number of observations. Plotting the mean line on a graph is an easy way to evaluate visually whether there are overall changes between conditions. A mean line is placed on the graph to represent the mean for each condition. Hypothetical data depicting mean lines for an ABAB design are depicted in Figure 8.4, which demonstrates a clinically effective treatment. Mean lines make visual inspection easy to justify whether treatment is effective relative to baseline. Some problems with mean lines are that variable data may produce similar means, and means can obscure important trends. For example, behavior may be stable in one phase and initially higher but then rapidly decreasing in another. Both might produce the same mean but very different descriptions of behavioral stability.

Fisher, Kelley, and Lomas (2003) developed and tested a visual inspection technique called the conservative dual-criterion (CDC) method for improving the accuracy

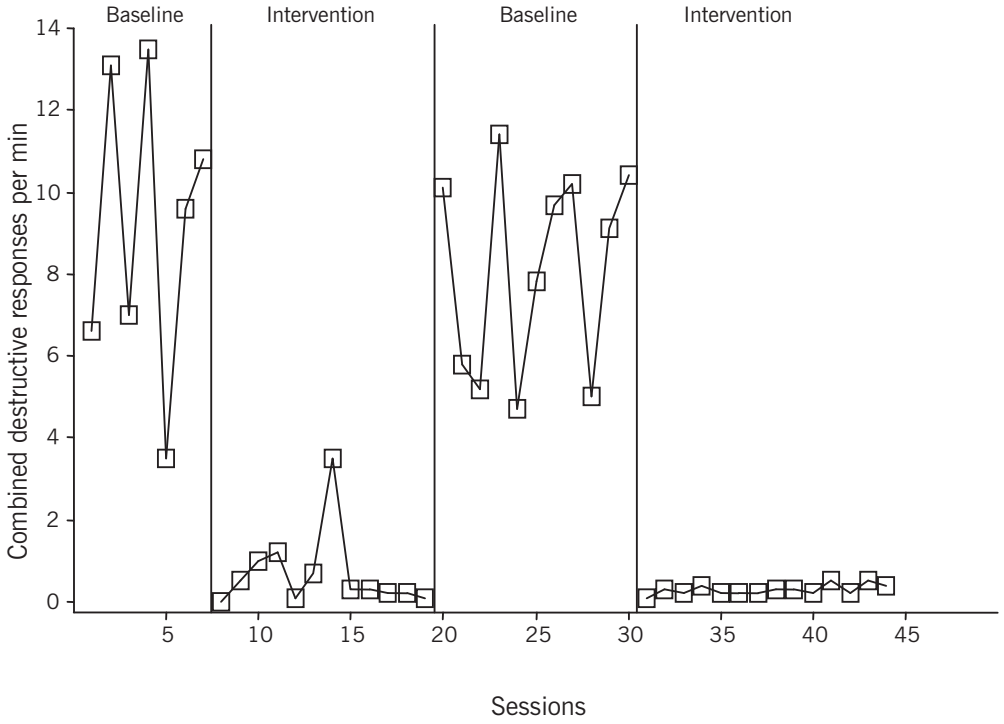


FIGURE 8.2. Data depicting differences in stability across baseline and intervention phases.

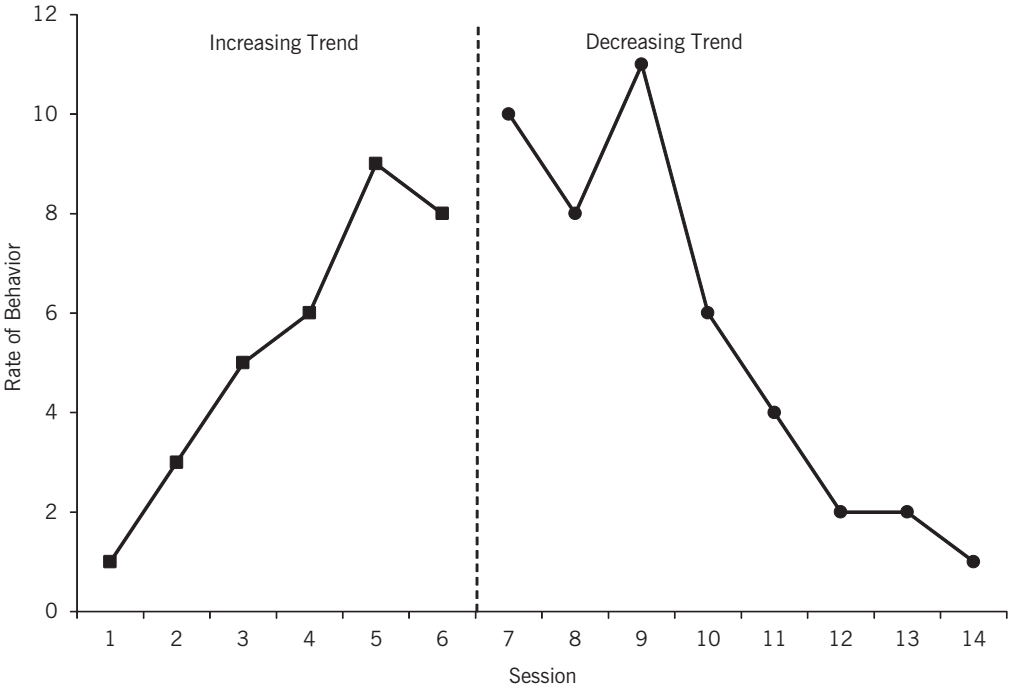


FIGURE 8.3. Hypothetical data showing changes in trends across phases.

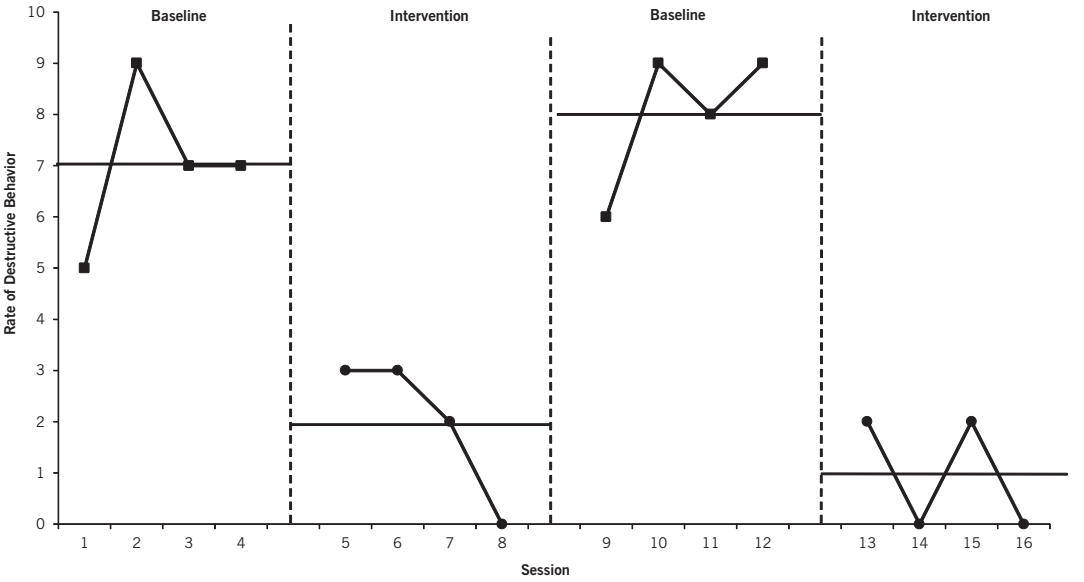


FIGURE 8.4. Hypothetical data showing the use of mean lines for visual inspection.

of interpretation of single-case graphs. The CDC method involved creating visual aids for each graph, which included a regression line from the baseline data that was superimposed on the treatment data, and a second criterion line that was generated from the baseline mean and superimposed on the treatment data. The CDC method used two criteria to interpret treatment effects: (1) a prespecified number of treatment points had to fall above (or below) the trend line, based on the binomial test, as in the split middle technique; and (2) the same number of data points had to fall above (or below) the mean line. Using this technique, Fisher and colleagues were able to train rapidly five bachelor's-level employees who worked in a facility that specialized in the assessment and treatment of severe behavior problems to interpret single-case graphs accurately.

Single-Case Research Designs

Within applied behavior analysis, it is critical to demonstrate in as convincing a fashion as possible which events are responsible for the occurrence (or nonoccurrence) of a targeted behavior (Baer et al., 1968). As stated earlier, a focus of single-case research designs should be on believability; independent assessors of the data should be able to draw similar conclusions about the effects of the intervention. This is accomplished through the analysis of behavior in one of several various single-case research designs. There are several variations of research designs one can use when conducting single-case research. Each design has its benefits and drawbacks, and is more useful under certain situations. In this section, an overview of some of the more common single-case experimental designs is provided and a brief description of less common techniques is presented. The reader should keep in mind that, as mentioned earlier, the primary purpose of the single-case design is to demonstrate that implementation of the IV (e.g., intervention) was responsible for the change in the DV (e.g., target behavior), which is also referred to as *demonstration of functional control*. Thus, each design is discussed in relation to the degree to which its use permits demonstration of functional control.

ABAB Reversal Design

The ABAB reversal (also known as a *withdrawal design*; see Kennedy, 2005, for further handling of this distinction) design is the most basic experimental design in single-case research (Kazdin, 1982). Within an ABAB design, the investigator alternates between a baseline (A phase) in which treatment is not in effect, and the intervention (B phase) in which treatment is in effect. The baseline phase is conducted to determine a level or rate of behavior prior to the implementation of the treatment (i.e., the IV). Once a stable rate of behavior has been established, treatment is introduced. Depending on whether treatment is effective, the rate of behavior may change in a specific direction. For example, if the goal is to decrease a target behavior (e.g., aggression) and treatment was effective, then the data path would show a decreasing trend in the behavior after introduction of the intervention. If the goal is to increase a target behavior (e.g., appropriate communication), then the data path would show an increasing trend in the behavior after introduction of the intervention. After establishing a stable rate of behavior during the intervention (B phase), the treatment is then removed, and the conditions or contingencies "reverse" back to those of baseline. Reversing back to baseline determines whether behavior would have continued along the predicted path of the first A phase if an effective treatment not been introduced. Once rates from the first A phase are reestablished, the intervention is introduced again. Behavior change in the desired direction supports that conclusion that the treatment is responsible for the behavior change. Each subsequent introduction and removal of the treatment (and the corresponding reversal to the baseline condition) further strengthens this conclusion; however, it is most practical and generally only necessary to have one such reversal to the baseline condition that is followed by one reintroduction of the treatment condition.

A demonstration of an ABAB reversal design is shown in Figure 8.5. These data depict an initial baseline phase in which the participant was prompted to walk every 30 seconds. However, if she withdrew her feet, the therapists support her weight and continued to deliver prompts to walk indepen-

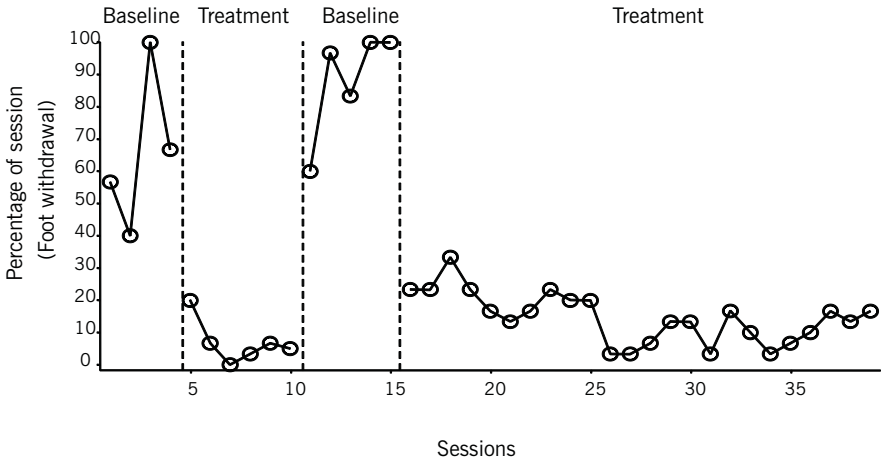


FIGURE 8.5. ABAB reversal design. From Roane and Kelley (2008). Copyright 2008 by the Society for the Experimental Analysis of Behavior, Inc. Reprinted by permission.

dently. Following baseline, an intervention was developed in which the therapists move away from the participant for a period of 10 seconds, such that the participant could not physically interact with the therapists. A decrease in the target behavior was observed in this B phase. The next phase consisted of a return to baseline (i.e., the intervention was removed). The target behavior increased in this return to baseline. Once a stable rate of behavior was observed, the intervention was reintroduced, and the target behavior again decreased, thus confirming that the introduction of treatment was responsible for the reduction of the target behavior.

As demonstrated in Figure 8.5, a reversal (ABAB) design can provide clear evidence of a functional relation. Ideally, behavior would only change when contingencies are altered between the A and B phases. The more times this change is demonstrated, the greater the demonstration of believability regarding experimental control (i.e., more reversals between respective contingencies associated with the A and B phases enhances the demonstration of a functional relation). Thus, a primary benefit of the reversal design is its ability to demonstrate clearly the effects of turning a behavior "on" and "off" repeatedly, in a fairly simple manner. Nevertheless, several potential limitations of the reversal design bear upon consideration of its use.

A primary limitation of a reversal design concerns the possible ramifications of conducting an extended baseline condition in which a potential treatment is withheld for the purpose of establishing stable levels of behavior. Related to this is the concern with "reversing" to the baseline condition once an effective treatment has been identified. Recall that the purpose of a reversal to the baseline condition is to verify the effects of the IV on changes in the DV. One must balance this necessity against the potential impact it has on the safety of the individual being observed, especially if the reversal to the baseline condition will expose that individual to harmful conditions (e.g., contingencies that may increase the likelihood of serious self-injurious behavior). In general, one should avoid reimplementing a baseline condition for extended periods of time if this will result in potential harm to the participant. Alternatives to this practice might include evaluating the treatment in a design that does not require extended exposure to a baseline condition, blocking the response during baseline (Lerman & Iwata, 1996), or reversing for very brief period of time (i.e., probes). Powers, Roane, and Kelley (2007) observed increases in self-restraint behavior following the application of arm splints to reduce self-injurious behavior. In an attempt to evaluate functional control within the context of a reversal design, the arm splints had to be removed periodically. However, the participant engaged in a high rate of self-injury and could have physically harmed her-

self during an extended reversal to baseline. Consequently, the authors conducted one- or two-point reversals to the baseline condition to assess the occurrence of the target behavior in a relatively brief manner. These data are presented in Figure 8.6. Although these probes do not permit an analysis of trend and variability, their rate clearly falls outside of the range of those data observed during the intervention, which provides some evidence of functional control.

The previously mentioned limitation has the potential to affect the individual under observation. Other potential limitations of the reversal design might affect the extent to which this design affords a demonstration of functional control. For example, there are behaviors that, once learned, cannot be "reversed." To illustrate, in our clinical practice, we once encountered an 8-year-old boy with Asperger's syndrome who became physically aggressive when he was teased by his schoolmates. The source of the teasing centered on class trips to the restroom. Our client had a tendency to stand at a urinal and drop his pants down to his ankles (thus exposing his buttocks). This particular stance became the source of his classmates' teasing, which in turn occasioned his aggressive outburst. After taking the child to the toilet in our clinic and conducting baseline observations of his toileting behavior, we taught him to hold up the front of his pants while standing at the urinal. Once learned, we could not simply "reverse" this new skill in the return to the baseline condition. In such cases, the primary limitation is one of "irreversibility" of behavior, and practitioners might consider employing an alternative design (e.g., multiple-baseline design).

Despite these limitations, one might argue that the reversal design provides the clearest demonstration of experimental control. The sequential demonstration of turning a behavior "on and off" clearly influences the believability of the intervention effects and represents the strength of this approach. Nonetheless, the limitations mentioned earlier have led to the development of other single-case designs that offer their own unique strengths and limitations.

Multiple-Baseline Design

The multiple-baseline design is often implemented when a reversal design is undesirable

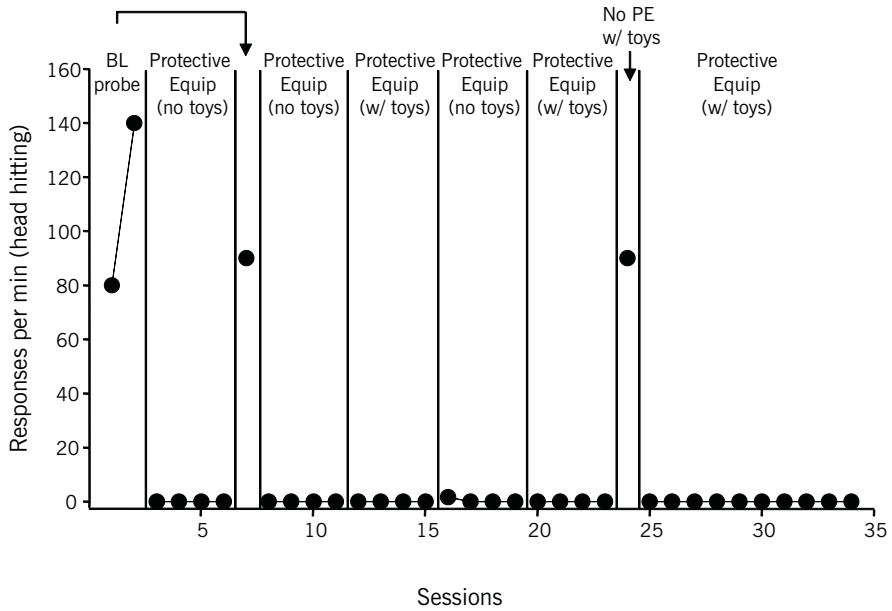


FIGURE 8.6. The use of brief reversals ("probe data") to avoid extended baseline conditions. From Powers, Roane, and Kelley (2007). Copyright 2007 by the Society for the Experimental Analysis of Behavior, Inc. Reprinted by permission.

or impractical. In this design, one identifies several different behaviors, settings, or individuals across which the effects of the intervention will be observed. Data collection begins across all conditions, and as additional data accrue, the intervention is introduced sequentially across those conditions. For example, if behavior were observed across three settings, the intervention would first be introduced in that setting with the most stable data. Thereafter, data collection would continue in all three settings. If there is a change in the setting in which the intervention was introduced, that procedure would then be introduced into another setting (i.e., two of the three settings now would be exposed to the treatment). If, following introduction of the intervention, a similar change is noted in the second setting, greater evidence has been obtained regarding the efficacy of the intervention on that behavior. Finally, the intervention would be introduced into the third setting, at which point all three settings would have received the intervention at various points in time.

Data demonstrating the use of a multiple-baseline design are shown in Figure 8.7. The graph depicts three contexts in which baseline data were collected. The intervention (providing noncontingent access to preferred stimuli to decrease the occurrence of object mouthing) was introduced for one context (the classroom) while collection of baseline data continued in the other two contexts. The intervention was then introduced sequentially for the playroom and outdoors. As can be seen in Figure 8.7, the occurrence of object mouthing changed in a similar manner across all three contexts and, importantly, these changes were only observed following the introduction of the IV in each of those contexts.

To reiterate, several features of the multiple-baseline design distinguish it from other designs. A multiple-baseline design consists of targeting two or more behaviors, settings, or individuals. Baseline data are typically collected at the same time, though data on each baseline–intervention pairing might in some cases be collected at different points in time (referred to as a *noncon-current multiple-baseline design*; Watson & Workman, 1981). With the introduction of treatment staggered over time (i.e., the treatment is introduced for target behavior A at

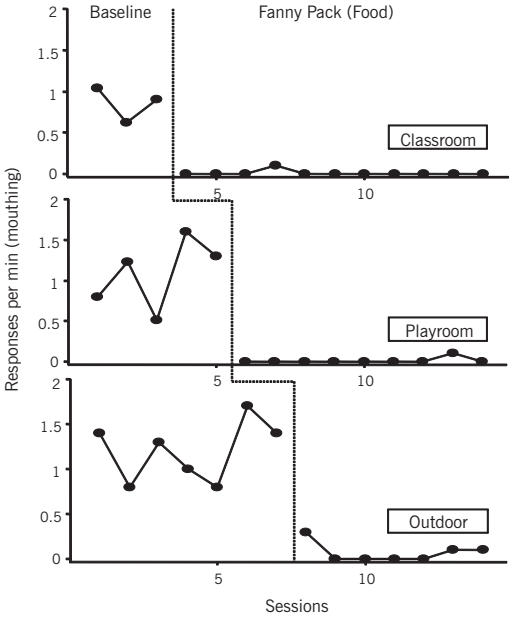


FIGURE 8.7. Multiple-baseline design (across settings). From Roane, Kelly, and Fisher (2003). Copyright 2003 by the Society for the Experimental Analysis of Behavior, Inc. Reprinted by permission.

Time 1, target behavior B at Time 2), there should be at least three or more data points between each separate introduction of intervention for each target behavior. Thus, the effectiveness of treatment is demonstrated by a change in the target behavior at the point in which the intervention is implemented and not at any other point in time. Although the treatment is not withdrawn, replication of the treatment effect is demonstrated by repeating the experimental effect (i.e., behavior change with introduction of the intervention) across the successive baselines.

Multiple-baseline designs are often used when the focus of intervention is skills acquisition. Demonstration of functional control of skills acquisition using a reversal design is more difficult because once a skill is acquired, it often does not "go away" (i.e., irreversibility). For example, Mayfield and Vollmer (2007) used a multiple-baseline design to evaluate the effects of a peer-tutoring procedure on the math skills of three individuals. An approach using a multiple baseline was appropriate in this investigation because the newly acquired skills could not be

withdrawn. Multiple baselines also may be appropriate when concerns are raised about withdrawing an effective treatment.

Although the multiple-baseline design may be useful for demonstration of functional control for skills acquisition and situations in which reversals of intervention are not acceptable, they are limited in that the effects of intervention may carry over to the untreated target behavior, setting, or therapist. Figure 8.8 is illustrative of such as situation. In this clinical example, an intervention was developed to treat the perseverative speech of an 8-year-old boy with autism. In one component of the intervention, the participant was required to engage in "appropriate" conversation for progressively longer intervals before he could engage in conversation about one of his perseverative topics (e.g., *Star Wars*). Using a multiple-baseline design, the treatment was sequentially introduced across various sets of staff. As shown in Figure 8.8, consistent increases in appropriate conversation and corresponding decreases in inappropriate conversation did not occur in either of the first two baselines until the intervention was introduced. By contrast, in the third baseline, appropriate conversation increased without the programmed intervention in place. Although this outcome was useful for establishing the generality of behavior change, it does limit the extent to which functional control for the intervention was demonstrated, in that the associated change in the DV following introduction of the IV was only replicated in one baseline.

An additional limitation is that the multiple-baseline design may require prolongation of the baseline for some targets, which could delay the introduction of a seemingly effective intervention. For example, it would be unethical to observe a student fail multiple tests before introducing a treatment for academic skills. One alternative to this limitation is to conduct "probe" observations of the behavior under baseline conditions until the subject nears the point at which the

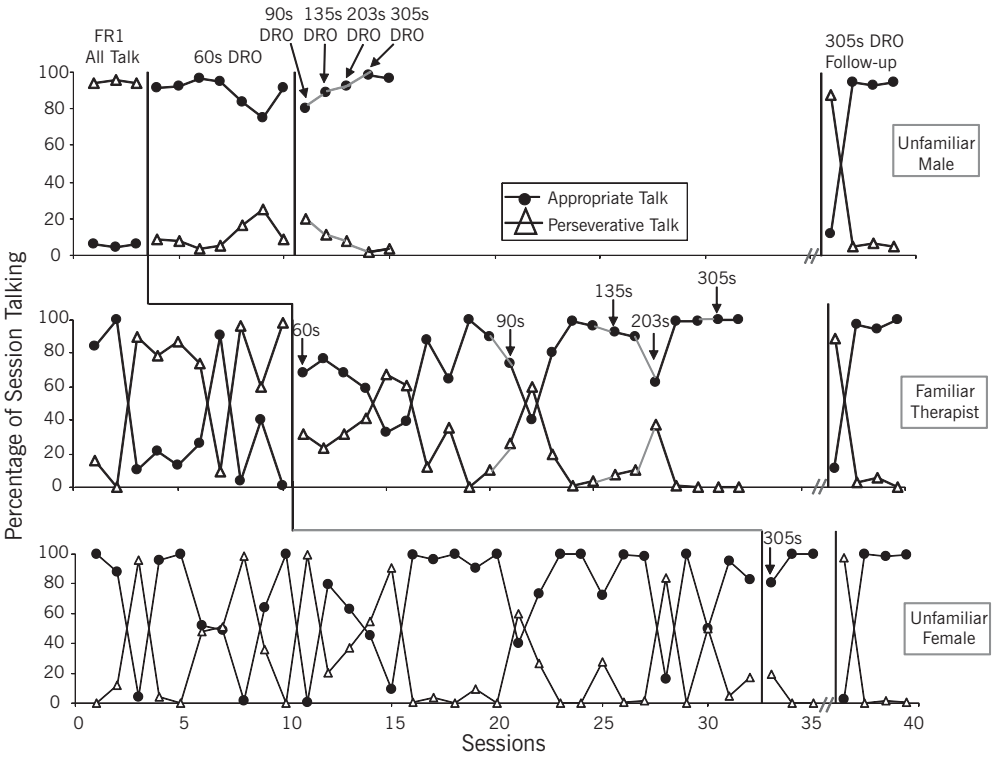


FIGURE 8.8. Example of carryover effects from targeted to untargeted behaviors within a multiple-baseline design.

intervention might be applied (see Hanley, Heal, Tiger, & Ingvarsson, 2007, for an illustrative example).

Changing-Criterion Design

The critical element of the changing-criterion design is the demonstration that behavior or performance matches a prespecified criterion, and that behavior changes in conjunction with changes in the criterion (Hartmann & Hall, 1976). The changing-criterion design begins with baseline data collection. When intervention is implemented, a criterion is set for expected behavior, and this criterion changes across sequential "subphases." Once the criterion is met for the first subphase, the criterion is altered for the second subphase, and so on, until the ultimate or goal target performance for behavior is met. Again, the demonstration of functional control is achieved by showing that behavior or performance changes in conjunction with the change in the criterion and not at any other time. A critical element of the changing-criterion design, and one that is often missed by novice researchers and clinicians, is that the opportunity to meet or *exceed* the criterion is available for each subphase of the intervention. For example, suppose that the target behavior of interest is acceptance of bites of food, and the ultimate goal of intervention is acceptance of 15 bites. The criterion for reinforcement is acceptance of 1, 3, 5, 10, and 15 bites, respectively, for each subphase of the intervention. During each subphase of the intervention, all 15 bites should be available for the child to accept in order to demonstrate functional control for the intervention. If bite presentation is terminated after the child has earned reinforcement (e.g., after acceptance of one bite in the first subphase), then the conditions of the changing-criterion design have not been met, and demonstration of functional control is not possible.

Data demonstrating a changing-criterion design are shown in Figure 8.9. In this study, Warnes and Allen (2005) used biofeedback to teach an adolescent girl to control paradoxical vocal fold motion (a type of muscle tension that interferes with breathing). The target for intervention was to teach the participant to gain control of muscle tension around her vocal cords. Initially, baseline data were collected by measuring the participant's muscle tension (in microvolts). During treatment, the participant could see a visual representation of her muscle tension (represented as a green line) and was instructed

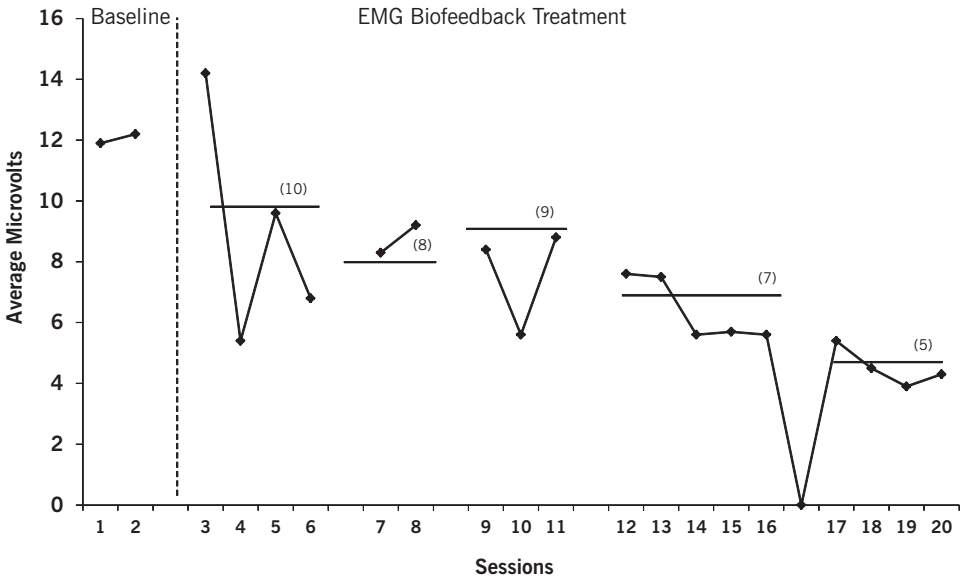


FIGURE 8.9. Changing-criterion design. From Warnes and Allen (2005). Copyright 2005 by the Society for the Experimental Analysis of Behavior, Inc. Reprinted by permission.

to lower her muscle tension below a specific criterion point. Initially, the criterion was similar to that observed in baseline. However, over twenty 10-minute biofeedback sessions, the participant learned to control her muscle tension. As can be seen in Figure 8.9, the horizontal lines represent the criterion levels; data that fall at or below these lines indicate those sessions in which the participant met the goal for that session. There are some cases in which the performance falls slightly above or below a specific criterion level, though the trend is generally downward and appears to be in conjunction with the programmed changes in those criteria.

One advantage of the changing-criterion design is that no withdrawal of treatment is required. In addition, the changing-criterion design also does not require maintaining behavior(s) in baselines, as in the multiple-baseline design. The primary disadvantage of the changing-criterion design is that behavior may not correspond closely to the criterion. The demonstration of multiple shifts in behavior (at least two shifts are required for demonstration of functional control) over time also may be less acceptable when the goal is to effect a rapid change in behavior. In addition, through this is not a limitation per se, changing-criterion designs have been used less frequently by behavior analysts relative to the other designs discussed here. One possibility for this might be that the behaviors often targeted by behavior analysts (e.g., severe, destructive behavior) are those for which criterion-related changes are not desirable. For example, one would typically want an immediate reduction in aggressive behavior as opposed to the gradual changes in level often associated with a changing-criterion design. However, the advent of many programs that focus on response acquisition in individuals with autism spectrum disorders sets the occasion for the emergence of more changing criterion-evaluations in future research.

Multiple-Treatment Designs

Although the previously discussed experimental designs are most commonly used in single-case research, they may not be suited for investigating the effects of multiple treatments due to sequencing effects that arise when one treatment is implemented for a period of time prior to another (i.e., a history with one treatment might influence responding under the other treatment). Thus, when an investigator is interested in examining multiple treatments, other design options may be employed. In this section we discuss multiple-treatment designs.

Perhaps the most common approach to evaluating multiple treatments is the alternating-treatments designs (often referred to as a *multielement design*; Barlow & Hersen, 1984). Alternating-treatments designs allow for the comparison of two or more differing interventions, or one or more interventions and a baseline condition. The different conditions are presented during the same phase and are evaluated within a single individual. The various conditions are alternated in some manner (i.e., across observational sessions, or across different days) and the order of the conditions is typically applied in a randomized fashion. Consequently, the conditions are not associated with a particular time of day or a particular person implementing the intervention.

The effects of each condition in an alternating-treatments design are evaluated by comparing response patterns in the separate conditions to one another. Functional control is shown through the changes in the occurrence of behaviors across each condition; that is, the relatively rapid alteration of conditions is similar to conducting a series of "mini-reversals," in which different independent variables are systematically introduced or withdrawn. Consistency of behavior in the presence of a specific variable (i.e., in one condition) relative to other conditions is the index of functional control. Of additional importance is the extent to which the data paths associated with each condition separate from one another (Hagopian et al., 1997). Thus, a response pattern that is less consistent and characterized by a lack of differentiation across conditions provides a more ambiguous demonstration of functional control.

Data depicting the use of an alternating-treatments design are shown in Figure 8.10. In this analysis, two conditions were compared: (1) a control condition in which the participant was prompted to stay seated, received contingent praise for completing academic tasks, was prompted using a least-to-most hierarchy, and received no escape

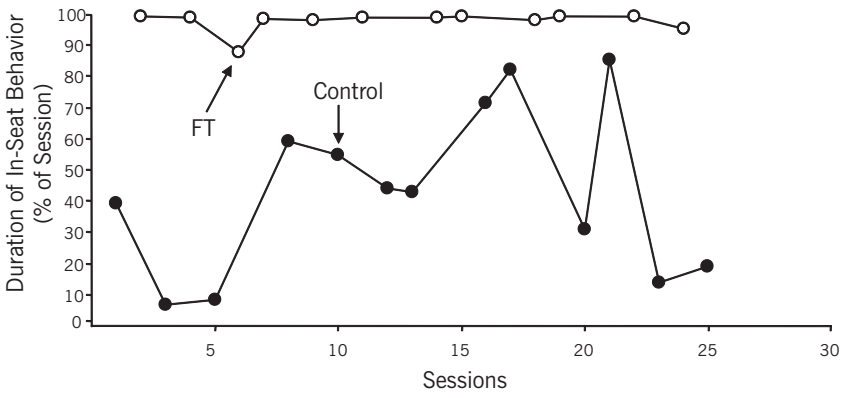


FIGURE 8.10. Alternating-treatments design. From Roane, Fisher, and Sgro (2001). Copyright 2001 by the Society for the Experimental Analysis of Behavior, Inc. Reprinted by permission.

for engaging in destructive behavior; and (2) an intervention condition (deemed fixed-time [FT]), which was identical to baseline with the exception that the participant also received access to a preferred edible on an FT 20-second schedule of reinforcement. As demonstrated in Figure 8.10, differences were observed across the two conditions, with higher levels of in-seat behavior occurring in the FT condition (M = 97.6% of each session) relative to the control condition (M = 42.9% of each session). Evidence of experimental control is demonstrated by the rapid change in the occurrence of in-seat behavior associated with introduction of either condition.

Alternating-treatments designs often include a comparison of one or more interventions compared to a baseline (no treatment) condition. An alternative to this approach is to compare two of more interventions following a separate phase of baseline data collection, which is particularly informative when comparing the effects of two different interventions. Figure 8.11 depicts an example of this approach. An initial baseline was conducted to measure the occurrence of destructive behavior in the absence of an ac-

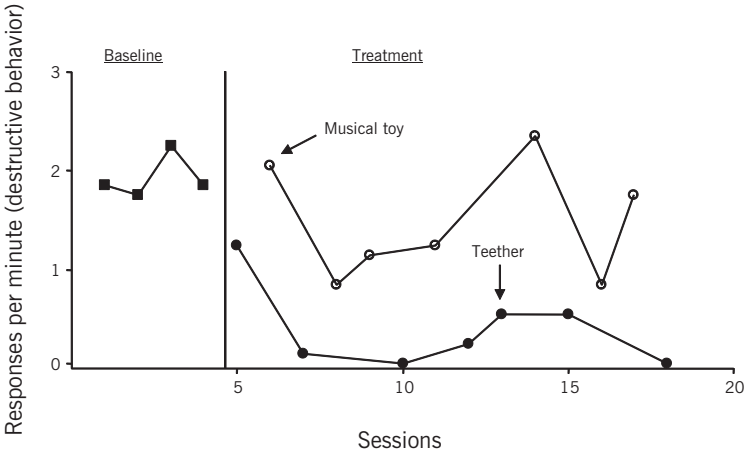


FIGURE 8.11. Alternating-treatments design that is preceded by an initial baseline phase. From Roane, Lerman, and Vorndran (2001). Copyright 2001 by the Society for the Experimental Analysis of Behavior, Inc. Reprinted by permission.

tive treatment component. Once stable rates of behavior were obtained, two treatments were compared in an alternating-treatments design. As can be seen in Figure 8.11, one of the procedures (continuous access to a music toy) was less effective than another (continuous access to a teether) in reducing the occurrence of destructive behavior.

There are several issues to consider when evaluating the effects of multiple IVs in an alternating-treatments design. Because alternating-treatments designs involve the introduction and removal of treatments very rapidly across sessions or days, the target behavior must be one that can also shift rapidly, rather than a behavior that requires a longer time period in which to change. For example, because weight loss requires a long period of treatment to achieve a change, it would not be suitable for this type of experimental design. Furthermore, if the target behavior occurs too infrequently, too few opportunities for the intervention to be applied may result in difficulties comparing treatments.

Alternating-treatments designs are also subject to carryover effects across conditions, commonly referred to as *multiple-treatment interference*. Multiple-treatment interference occurs when the effects of one treatment influence the effects of another (Kazdin, 1982). Although this is a potential problem for all single-case designs, the rapid alternation of conditions within an alternating-treatments design makes such effects particularly troublesome. For example, consider a situation in which an experimenter is evaluating the effects of attending to problem behavior versus ignoring problem behavior. The experimenter might spend 10 minutes responding to the child's inappropriate behavior. Thereafter, the experimenter might ignore the child's inappropriate behavior for 10 minutes. In such situations, the recent history of exposure to one set of contingencies might influence responding under another set of contingencies. One potential solution for this issue it to include a period of time in which neither contingency is in place (e.g., a "break" period) or a period of time in which an innocuous procedure is employed (e.g., having a child play with toys in between observation periods).

Related to this concern, it is possible that participants might become sensitive to the order in which different contingencies are presented within an alternating-treatments design. For example, if an experimenter always follows 10 minutes in which problem behavior produces access to a preferred toy by 10 minutes in which problem behavior produces a break from academic tasks, responding might be influenced by this contiguous relation. To control for this potential concern, it is recommended that the various conditions be implemented in a random order. An important caveat to this recommendation concerns situations in which the order of conditions affects the underlying motivating operation that influences the occurrence of a target behavior. For example, Iwata and colleagues (1994) proposed conducting each condition of a functional analysis in a prescribed order to take advantage of various motivational variables inherent in the procedures (e.g., deprivation of attention, preferred materials).

Discrimination among conditions also is a consideration with alternating-treatments designs. One potential method of enhancing discrimination within this design is to pair each condition with unique discriminative stimuli (sometimes referred to as a *multiple-schedule design*). In addition, the frequency with which the participant encounters the different treatments may affect his or her ability to discriminate the treatments; that is, the more exposure the participant has to the contingencies in effect in a certain intervention, the more likely he or she will be able to determine which treatment is being applied.

Despite these potential concerns, there are several benefits to evaluating interventions in an alternating-treatments design. Alternating-treatments designs are particularly useful when one is interested in quickly evaluating the effects of two or more interventions. Because the baseline condition can be extended and alternated with the treatment conditions, a prolonged baseline phase is not necessary, and intervention can be initiated sooner. In addition, this design is particularly suited for examining behaviors that are less likely to reverse back to baseline levels following a prolonged intervention phase. Furthermore, this type of design does not necessitate a reversal of conditions; thus, reinstating a baseline condition with dangerous or destructive behaviors is avoid-

ed. Another advantage of the alternating-treatments design is that a stable baseline prior to initiation of intervention is not required (Kazdin, 1982; Sulzer-Azaroff & Mayer, 1991). Because this design depends on comparing changes in behavior associated with the different treatments, changes can still be revealed when trends are present in the data.

Summary

As previously described, several single-case experimental designs examine the effects of treatments on an individual's behavior. However, the types of designs we have discussed do not comprise an exhaustive list of methods for analyzing behavior. Aspects of two or more of the previously discussed experimental designs can also be combined during an investigation of interventions. Because each experimental design is aimed at showing the effects of an intervention on an individual's behavior, combining experimental designs adds incremental evidence that changes in behavior are due to the intervention being applied. In addition, combining experimental designs may help to address disadvantages associated with a particular design. Single-case designs are essential tools for analytically and technologically conducting a systematic evaluation of effective socially and clinically important interventions for individuals.

With regard to evaluating interventions in a single-case design, ongoing behavioral observation with precisely defined target behaviors is the first step in evaluating effectiveness. Although visual inspection has been subject to criticism, recent studies have shown that well-trained and novice behavior analysts can be trained to produce high interrater agreement during visual inspections tasks (Fisher et al., 2003; Kahng et al., 2010). The type of design depends on the question under study; commonly used designs are the ABAB reversal, multiple-baseline, changing-criterion, and multiple-treatment designs. Each has its own unique strengths and weaknesses. Multiple-treatment designs are useful for evaluating several interventions simultaneously and have the advantage of producing information over a short time frame. Most importantly, the behavior analyst uses the single-case design as a tool with which to adhere to the central dimensions of applied behavior analysis.

That said, questions arise as to which design is best suited for a particular clinical or research question. There are no formal guidelines for making such decisions. There are, however, practical considerations that arise when deciding on which single-case design to utilize. For example, evaluating an intervention for severe self-injurious behavior might nullify the use of a reversal design because of the necessary removal of the treatment to establish experimental control. A similar situation occurs when teaching skills acquisition and attempting to do so in a reversal design. Also, two procedurally similar interventions might be subject to carryover effects if evaluated in a multiple-treatment design.

Considering these issues, a general decision-making model to determine which type of design to employ may proceed as follows. First, one must question what kind of design will answer the question under evaluation (e.g., a reversal design may be impractical for establishing functional control over skills acquisition). Once this is determined, additional clinical considerations might affect the selection of a specific design. For example, is participant availability sufficient to use a reversal design, or would a multiple treatment design be more appropriate? Likewise, are there sufficient settings or behaviors affected by the behavior under question to permit a multiple-baseline design?

However, a good rule to follow in the consideration of a design is to permit flexibility of the design during data collection. Recall that one key feature of a design is the ability to demonstrate a believable change in behavior following implementation of the IV. Single-case design strategies are quite flexible, in that various design elements might be combined to answer an experimental question. A study by Kelley, Shillingsburg, Castro, Addison, and LaRue (2007) provides an example of such design flexibility. The authors collected baseline data on the occurrence of several topographies of verbal behavior. These responses were then randomly assigned to be trained under either mand or tact conditions. After mastery in the training condition, probes of the untrained condition of the same topography, were conducted, and mastery was assessed by having two

consecutive sessions in at least 80% correct responding. Failing to meet this criterion resulted in additional training. The purpose was to assess generalization of the trained responses. Importantly, the final design selected was not indicative of a specific design per se; rather, it contained elements of different single-case designs. This work is illustrative of the adaptability of single-case experimental designs. Although an exhaustive list of all potential combinations of designs is beyond the scope of this chapter, the ease with which aspects of various elements can be altered or combined is one of the most advantageous features of these single-case designs in applied behavior analysis.

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PART IV

BEHAVIORAL ASSESSMENT

CHAPTER 9

Identifying and Enhancing the Effectiveness of Positive Reinforcement

Cathleen C. Piazza, Henry S. Roane, and Amanda Karsten

Positive reinforcement is used frequently as a key component in programs focused on increasing appropriate behavior. A common misconception in the lay population is that certain stimuli (e.g., activities, items, food) are "inherent" positive reinforcers. The assumption is that a stimulus functions as positive reinforcement simply based on the topography of the stimulus. For example, we might hear a parent say, "I used M&Ms as positive reinforcement for my child during potty training." The astute behavior analyst recognizes the potential fallacy in this statement because positive reinforcement is defined by its effect on behavior (not on the topographical characteristics of the stimulus). More specifically, *positive reinforcement* is defined as delivery of a stimulus contingent on a response that increases the future likelihood of that response (Cooper, Heron, & Heward, 2007). Said another way, if the response increases in the future, the stimulus that was presented following the response is a positive reinforcer, and if the response does not increase in the future, the stimulus that was presented following the response is a not a positive reinforcer. Given that positive reinforcement cannot be identified by the topography of a stimulus, the behavior analyst is faced with the challenge of how to identify stimuli that will function as positive reinforcement.

Does Preference Predict Reinforcer Efficacy?

Prior to 1985, investigators either assessed stimulus preference in the absence of assessment of the reinforcing efficacy of the preferred stimuli or selected potential positive reinforcers somewhat arbitrarily (i.e., without using a method to predict whether the stimuli would function as reinforcement). In 1985, Pace, Ivancic, Edwards, Iwata, and Page (1985) described a procedure for assessing the preferences of individuals with developmental disabilities, then tested the extent to which the preferred stimuli functioned as reinforcement. Since the publication of the Pace and colleagues study, investigators have evaluated a variety of different methods for identifying preferred stimuli and have tested the extent to which these assessments predict the efficacy of preferred stimuli as positive reinforcement.

Single-Stimulus Preference Assessment

Pace and colleagues (1985) assessed the preference of six individuals with developmen-

tal disabilities. During the single-stimulus preference assessment, the therapist presented 16 stimuli, one at a time. Observers scored approach responses (i.e., reaches) as the measure of preference. If the participant approached the stimulus within 5 seconds of presentation, the therapist gave the stimulus to the participant for 5 seconds. If the participant did not approach the stimulus within 5 seconds, the therapist prompted the participant to touch the stimulus. If the participant did not touch the stimulus within 5 seconds after the therapist prompt, the therapist ended that trial and moved on to the next stimulus. Stimuli approached on at least 80% of presentations were labeled preferred, and stimuli approached on 50% or less of presentations were labeled nonpreferred.

The second step of this procedure involved evaluation of the preferred stimuli as reinforcers. During baseline, a simple, free-operant response (e.g., hand raise) resulted in no differential consequence. The investigators then delivered either a high- or low-preference stimulus identified during the preference assessment following the free-operant response. Results indicated that contingent presentation of preferred stimuli increased responding when compared to baseline and nonpreferred conditions; that is, stimuli approached more frequently in the preference assessment were more likely to function as reinforcement than were stimuli not approached as frequently.

Although the preference assessment method developed by Pace and colleagues (1985) relies on direct observation of interaction, this method has limitations. The most notable is that participants may approach all or most stimuli, which would preclude the development of a hierarchy of preferences (Mazaleski, Iwata, Volimer, Zarcone, & Smith, 1993). For example, two of the three participants in the Mazaleski et al. study approached almost all of the stimuli presented. As a result, most items presented appeared to be "preferred." A second limitation of the single-stimulus procedure is that some stimuli identified as highly preferred may not function as effective reinforcers (Paclawskyj & Vollmer, 1995); that is, the single-item method may result in the identification of *false-positive stimuli* (i.e., stimuli that appear highly preferred but do not function as effective reinforcers).

Paired-Choice Preference Assessment

In an attempt to address the limitations of the Pace and colleagues (1985) procedure, Fisher and colleagues (1992) evaluated a variation of the preference assessment developed by Pace and colleagues. Specifically, the paired-choice preference assessment was one in which participants could choose between two stimuli presented concurrently. In this "choice" assessment, the therapist presented 16 stimuli in pairs. Participant approaches toward one of the two stimuli produced access to that stimulus for approximately 5 seconds. The therapist blocked simultaneous approaches toward both stimuli. If 5 seconds elapsed without an approach, the therapist prompted the participant to choose a stimulus (e.g., "Pick one"). If another 5 seconds elapsed without an approach, the therapist removed both stimuli and presented two other stimuli. The choice assessment identified a hierarchy of preferences for all participants.

Fisher and colleagues (1992) compared the results of the paired-choice assessment with the results of the single-stimulus assessment developed by Pace and colleagues (1985). Results showed the stimuli identified as preferred in the paired-choice assessment were also identified as preferred in the single-item assessment. The single-stimulus assessment identified several stimuli as preferred that were not identified as preferred in the paired-choice assessment (similar to the findings of Mazaleski et al., 1993). Next, Fisher and colleagues used a concurrent operants paradigm to compare the reinforcing effectiveness of stimuli identified as highly preferred on both assessments (i.e., high-high stimuli) with stimuli identified as highly preferred on the single-stimulus assessment only. Results showed that the high-high stimulus maintained greater levels of responding than the stimulus identified as highly preferred only on the single-stimulus assessment. Thus, the paired-choice assessment produced greater differentiation among stimuli and better predicted which stimuli would function as reinforcers when evaluated in a concurrent-operants arrangement. In addition, the choice assessment procedure developed by Fisher and colleagues has been modified for individuals with visual impairments (Pa-

clawskyj & Vollmer, 1995) and individuals with attention-deficit/hyperactivity disorder (ADHD) (Northup, Fusilier, Swanson, Roane, & Borrero, 1997).

Multiple Stimulus Assessment

Although the paired-choice preference assessment developed by Fisher and colleagues (1992) represented advancement over the method developed by Pace and colleagues (1985), choice preference assessments also have limitations. First, choice assessments may require longer administration times than other assessments (Roane, Vollmer, Rihgdahl, & Marcus, 1998; Windsor, Piché, & Lock, 1994) A prolonged administration time may preclude frequent updates of preferences, particularly in settings where participants have competing schedules (e.g., schools) or limited visitation times (e.g., clinics). A second limitation is that choice assessments may produce aberrant behaviors due to stimulus withdrawal, particularly in individuals whose aberrant behaviors are maintained by access to tangible reinforcers (Vollmer, Rihgdahl, Roane, & Marcus, 1997). Thus, choice preference assessments may result in increased occurrence of aberrant behavior.

Based on these two limitations of the paired-choice preference assessment, a number of other preference assessments have been investigated. Windsor and colleagues (1994) presented multiple stimuli to determine preferences for individuals with severe developmental disabilities. The therapist presented six items simultaneously to a participant over a series of five sessions, each containing 10 trials. Each trial began with a therapist asking "Which one do you want?" as he or she presented the stimuli. The therapist allowed 20 seconds for participants to emit a selection response (i.e., attempting to grasp an item). If the participant selected an item, he or she was allowed to access the item, and the trial ended. If the participant did not respond within 20 seconds, observers scored "no response," and the trial ended. Results demonstrated that the multiple-stimulus assessment was an effective method for determining stimulus preferences. However, Windsor et al. did not evaluate the reinforcing efficacy of the preferred stimuli.

Multiple Stimulus without Replacement Assessment

DeLeon and Iwata (1996) evaluated an extension of the procedures described by Windsor and colleagues (1994). Whereas Windsor and colleagues replaced stimuli in subsequent trials following those in which they were selected, DeLeon and Iwata did not replace previously chosen stimuli. As a result, participants were required to choose among less preferred alternatives, which resulted in a more discrete ranking of preferred stimuli (based on comparisons between less preferred stimuli). All participants showed increases in responding when the experimenter presented preferred stimuli contingently.

DeLeon and Iwata (1996) compared the multiple stimulus without replacement (MSWO) assessment to the assessments described by Windsor and colleagues (1994) and Fisher and colleagues (1992) along three dimensions: (1) rank order of preferred stimuli, (2) time required for administration, and (3) number of potential reinforcers identified. For four of seven participants, all three assessments identified the same stimulus as the most preferred. For the remaining three participants, high correlations were found between the most preferred stimuli in each assessment. The multiple stimulus with replacement (MSW) assessment required the least amount of time to administer (M = 16.5 minutes), followed by the MSWO (M = 21.8 minutes) and the paired-choice assessment (M = 53.3 minutes). Finally, participants selected fewer items in the MSW assessment, whereas the MSWO and paired-choice assessments produced a discrete ranking of preferred stimuli. Researchers also have used the MSWO assessment successfully for children in general education classrooms (Daly et al., 2009).

Free-Operant Assessment

Roane and colleagues (1998) developed a "free-operant" preference assessment in which participants had continuous access to an array of stimuli for 5 minutes. The participants were free to interact with the stimulus(i) of their choosing at any time throughout the assessment, and no stimuli were withdrawn from the participants throughout the pref-

erence assessment. Roane and colleagues compared the results of the free-operant preference assessment to the paired-choice assessment developed by Fisher and colleagues (1992) along two dimensions: (1) length of administration and (2) occurrence of problem behavior. These results showed that the mean length of the free-operant assessment was shorter than that of the paired-choice assessment (5 minutes vs. 21.7 minutes). Moreover, 84.6% of the participants displayed significantly higher levels of problem behavior during the paired-choice assessment. Similarly, Kahng and colleagues (2010) showed that the free-operant assessment was associated with less problem behavior than the MSWO assessment.

Activity Restriction

Although single-stimulus, paired-choice, MSWO, and free-operant assessments appear to be effective for reinforce identification, Hanley, Iwata, Lindberg, and Conners (2003) noted that these procedures are associated with limited access to stimuli and demonstration of exclusive preference for a limited number of stimuli. Hanley and colleagues hypothesized that these limitations might be addressed by a response restriction (RR) method that combines free-operant and trial-based assessment procedures. The RR method provided participants with an array of stimuli, then restricted individual stimuli in the array based on participant interaction with these stimuli. In general, the rules associated with restricting stimuli were based on the participant's level of interaction with the target stimulus relative to other stimuli. Results showed that the RR assessments produced a high degree of consistency for highly ranked items. A comparison of the RR assessment with an extended free-operant assessment showed that the RR assessment produced more differentiated patterns of preference and more complete information about engagement with all of the target stimuli.

Duration Assessment

Hagopian, Rush, Lewin, and Long (2001) suggested that duration of engagement might be an alternative to approach responses as measure of preference. The experimenters presented stimuli singly and measured participants' level of engagement with each stimulus. Subsequent reinforcement assessments showed that the stimuli identified as highly preferred based on duration of engagement functioned as effective reinforcers. In addition, the experimenters compared the results of the duration assessment with those of a paired-choice assessment. Results of the comparison suggested that the duration assessment took less time to administer than the paired-choice assessment but produced less stable preference rankings across administrations.

Vocal Report

Vocal report or self-nomination is most appropriate for individuals who have the vocal repertoire to identify preferred stimuli. A number of studies have incorporated self-nomination procedures for identifying preferences. For example, Clements and McKee (1968) used a one-page brochure (i.e., the reinforcing event [RE] menu) to identify preferred work activities for 16 inmates. Results showed increases in the amount of daily work completed by the inmates when their work resulted in access to activities selected on the RE menu.

Although researchers have used surveys to identify highly preferred stimuli for elementary school students (Fantuzzo, Rohrbeck, Hightower, & Work, 1991), children with developmental disabilities (Tourigny Dewhurst, & Cautela, 1980) and adults with developmental disabilities (Fox & DeShaw, 1993), it is not clear whether the results of these surveys identified stimuli that functioned as reinforcement. More recent research has indicated that self-nominations of preference may be limited in several ways. First, self-nomination of preference may not match observed preferences. For example, Northup, George, Jones, Broussard, and Vollmer (1996) used a survey of common classroom reinforcers to identify differential preferences for four children diagnosed with ADHD and showed that the survey was effective at identifying differential preferences for all participants. However, when child preferences for the stimuli presented in the survey were evaluated using direct observa-

tion, the results of the survey did not match observed preferences for the stimuli. Thus, self-nomination of preferences may not identify preferred reinforcers accurately in some cases.

Second, self-nomination procedures also may be limited to individuals who possess sufficient expressive and receptive language skills to indicate their preferences vocally. Therefore, using vocal nominations to identify preferences for individuals who lack the prerequisite vocal or verbal skills to communicate their preferences (e.g., some individuals with developmental disabilities; Pace et al., 1985; Rotatori, Fox, & Switzky, 1979; Wehman, 1976) may not be appropriate.

Caregiver Nomination

Some investigators have asked caregivers (e.g., staff members, parents) to nominate preferences for individuals who cannot express their own preferences. In an early comparison of caregiver opinion and observed individual preferences, Favell and Cannon (1976) showed that caregivers were unable to predict preferences reliably. Their results have been replicated with different types of caregivers (e.g., teachers) and different populations of participants (e.g., students) (Fantuzzo et al., 1991; Green et al., 1988; Parsons & Reid, 1990; Windsor et al., 1994).

Although previous research has shown that caregiver report has not always been an effective method of identifying preferences for some individuals, it seems logical that caregiver input would be helpful in determining preferences, particularly for those individuals who lack the capability to report their preferences vocally. To that end, Fisher, Piazza, Bowman, and Amari (1996) developed the Reinforcer Assessment for Individuals with Disabilities (RAISD), a structured interview that prompts caregivers to generate a list of potential reinforcers from the visual, audible, olfactory, edible, social, and tactile domains and toys. In the Fisher and colleagues study, caregivers generated a list of potential reinforcers and rank-ordered those stimuli from most to least preferred based on their predictions of child preference. Caregivers also ranked predicted child preferences for a "standard" list of stimuli described by Pace and colleagues (1985). Fisher and colleagues conducted paired-choice assessments with caregiver-generated stimuli and with the stimuli from the standard list. Caregiver predictions of child preference were slightly better for the stimuli identified via the RAISD relative to the standard list. In addition, the most preferred stimuli identified via the RAISD were more effective reinforcers than the most preferred stimuli from the standard list. These results suggested that the combination of caregiver report and systematic (choice) preference assessment predicted the efficacy of the preferred stimuli more effectively than caregiver report alone. Cote, Thompson, Hanley, and McKerchar (2007) replicated and extended the study by Fisher and colleagues with teachers and young children in an early intervention setting. The authors suggested that incorporating teacher nomination with direct assessment (e.g., paired-choice assessment) may result in the identification of more effective reinforcers for young children in classroom settings.

Pictorial Representations

Another alternative method of identifying preferred stimuli for individuals who lack a vocal response is to use pictures (Conyers, Doole, Vause, Harapiak, Yu, & Martin, 2002; Daly, 1969; Northup et al., 1996). Daley (1969) used a menu in which REs were depicted as pictures rather than words. The five children with developmental disabilities in the Daly study were able to identify activities as differentially preferred. Northup and colleagues (1996) evaluated the accuracy of a reinforcer survey, a verbal paired-choice questionnaire, and a pictorial paired-choice assessment for preference identification. The verbal and pictorial paired-choice assessments identified high- and low-preference categories for three of the four participants in the study. By contrast, the survey was not an accurate method of identifying preferences.

Concurrent Chains

The majority of preference assessment procedures described earlier focused on identification of preferred stimuli that could be used as reinforcement. Researchers also have used preference assessments to measure participants' preferences for positive reinforce-

ment treatments (Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997), motivational systems (Heal & Hanley, 2007), punishment and extinction components of interventions (Hanley, Piazza, Fisher, & Maglieri, 2005), and preferences for choice and no-choice arrangements (Tiger, Hanley, & Hernandez, 2006), among others. For example, Hanley and colleagues (1997) described a concurrent chains procedure for evaluating participant preferences for functional communication training (FCT), noncontingent reinforcement (NCR), and extinction as treatments for destructive behavior. The concurrent chains procedure consisted of pairing each treatment with a colored card that participants selected to enter a room in which they received their chosen treatment. The results of Hanley and colleagues showed that the concurrent chains procedure produced a sensitive measure of participant preferences.

Group Arrangement

As described earlier, investigators have sought ways of making stimulus preference assessment more time efficient. Most studies have focused on shortening the amount of time it takes to evaluate the preferences of individual children. By contrast, Layer, Hanley, Heal, and Tiger (2008) assessed the accuracy of an assessment of preferences of multiple children simultaneously. First, the authors assessed the preference of each child individually. After identifying a hierarchy of preferred stimuli for individual children, the investigators evaluated preference in groups of three children simultaneously. During the group assessment, each child in the group privately selected a colored card that the experimenters had paired previously with specific food reinforcement. After each child selected a colored card, the experimenter placed the three cards in a box. Next, the experimenter drew one of the cards out of the box, and each child in the group received the food that was associated with that color card. Comparisons of individual and group preference assessment data showed that the two assessment methods produced similar preference rankings. Importantly, the group assessment was a more efficient method for determining preference.

Hanley, Cammilleri, Tiger, and Ingvarsson (2007) showed that a momentary time-sampling (MTS) procedure could be used to assess the activity preferences of 20 children in a preschool classroom. A MTS of 120 seconds was associated with less than 10% measurement error for preferences. Subsequent analyses showed that observers preferred a 90-second MTS procedure relative to other MTS intervals, and that the 90-second MTS procedure could be used to describe activity preferences of a classroom of children.

Correlation between Preference and Reinforcement Efficacy

Researchers have sought to evaluate whether the effectiveness of reinforcement varies positively with the degree of preference (i.e., whether the relative preference based on the results of preference assessments predicts relative reinforcer effectiveness). Piazza, Fisher, Hagopian, Bowman, and Toole (1996) conducted preference assessments of four individuals with severe behavior problems to identify high-, medium-, and low-preference stimuli. Subsequent concurrent operants reinforcement assessments showed that the results of the preference assessment predicted the reinforcing efficacy of the high-, medium-, and low-preference stimuli. However, DeLeon, Iwata, and Roscoe (1997) and Taravella, Lerman, Contrucci, and Roane (2000) showed that lower-ranked stimuli may function as reinforcement under some circumstances.

In the investigation described earlier, Piazza and colleagues (1996) evaluated the extent to which the results of a preference assessment could be used to predict the reinforcing efficacy of stimuli. Lee, Yu, Martin, and Martin (2010) took a slightly different approach to examining the correspondence between preference and reinforcement effects. They identified stimuli that sustained a range of response rates (i.e., high to low) during a reinforcer assessment. Next, they conducted stimulus preference assessments to determine the participants' preferences for those identified reinforcers. The results suggested that there was almost perfect correspondence between the reinforcer and preference assessments for one participant and partial correspondence for the other participant. The lowest levels of correspondence between the two assessments were for the weakest reinforcers.

Methods for Evaluating Reinforcement Effects

Simple versus Complex Responses

The majority of investigators have used simple, free-operant responses (e.g., hand raise, in-chair behavior) to assess the effectiveness of stimuli as reinforcement (e.g., DeLeon & Iwata, 1996; Fisher et al., 1992; Pace et al., 1985; Piazza, Fisher, Hagopian, et al., 1996). Piazza, Fisher, Hagopian, and colleagues (1996) suggested that the use of a simple, free-operant response during reinforcement assessment has several advantages. The goal of the reinforcement assessment is to evaluate whether the stimulus functions as reinforcement rather than teach a specific response; therefore, simple responses are ideal for these types of evaluations. Individuals with a variety of different functional levels typically can discriminate the contingencies rapidly with a simple response as the target. Thus, use of a simple response usually results in a time-efficient assessment. In addition, failure to emit a more complex response during a reinforcement assessment could be the result of a skills or a motivational deficit. Using a simple response reduces the probability that the absence of a reinforcement effect is due to a skills deficit. There may be situations, however, in which the use of a more complex response (e.g., on-task behavior) is desirable (Paramore & Higbee, 2005).

Single versus Concurrent Operants

Fisher and colleagues (1992) used a concurrent operants arrangement to evaluate the reinforcing efficacy of preferred stimuli. The advantage of the concurrent operants arrangement is that the magnitude of responding for each operant is a function of the magnitude of reinforcement and the schedule (interval or ratio) of reinforcement and is not related to response competition or interference (Catania, 1963; Fisher et al., 1992). In most natural environments, it is likely that multiple sources of reinforcement are available simultaneously, and the concurrent operants arrangement is ideal for assessing the relative strength of the available reinforcement.

In some cases, the behavior analyst may be interested in assessing absolute reinforcement effects (e.g., Does Stimulus A function as reinforcement?). For example, Roscoe, Iwata, and Kahng (1999) showed that the most effective reinforcer during a concurrent operants schedule was the stimulus identified as highly preferred on both the single-stimulus and paired-choice assessments. However, stimuli identified as highly preferred only by the single-stimulus assessment functioned as reinforcement during the single-operant schedule. Roscoe et al. suggested that concurrent schedule procedures are useful for the assessment of relative reinforcement effects (preference for one reinforcer over another), and single-schedule arrangements may be ideal for assessing the absolute effects of reinforcement.

Progressive Ratio Schedules

Roane, Lerman, and Vorndran (2001) used progressive ratio (PR) schedules to assess relative response output for two items identified as similarly preferred in a stimulus preference assessment (Fisher et al., 1992). In a PR schedule, the requirement to access reinforcement increases within the course of a single observation (Hodos, 1961). For example, the initial response requirement might be working one math problem to receive a preferred toy for 20 seconds. The preferred toy would be removed and the response requirement might increase to two math problems to access 20 seconds of reinforcement. This progression might continue (three problems, four problems, etc.) until responding ceases for some amount of time.

Roane and colleagues (2001) showed that concurrent fixed ratio (FR 1) failed to differentiate higher from lower preference stimuli, but that increasing the schedule requirements using PR schedules made the differences in reinforcer effectiveness much more apparent. Roane and colleagues also showed that accurate identification of higher preference stimuli using PR schedules was critical to treatment development because the higher preference stimuli were associated with much greater reductions in problem behavior when incorporated into reinforcement-based treatments. Moreover, they suggested that the within-session increase in response requirements provided a more expeditious evaluation of relative reinforcer efficacy than evaluating stimuli across multiple phases of different FR requirements (e.g., DeLeon, Iwata, Goh, & Worsdell, 1997).

PR schedules have been used with increased frequency in applied research. These applied applications have typically fallen into two categories: bridging basic and applied research, and developing procedures of therapeutic significance (Roane, 2008). Examples of "bridge" research with PR schedules include evaluating the effects of assessing reinforcers under single and concurrent PR arrangements (Glover, Roane, Kadey, & Grow, 2008), assessing the relative effects of highly preferred and less preferred stimuli under increasing response requirements (Francisco, Borrero, & Sy, 2008; Penrod, Wallace, & Dyer, 2008), and evaluating the extent to which extrasession access to reinforcement affects rates of academic responding (Roane, Call, & Falcomata, 2005). Along a more applied front, PR schedules have been used to evaluate preferences for different staff members in a residential setting (Jerome & Sturmey, 2008), the relative efficacy of different durations of reinforcement (Trosclair-Lasserre, Lerman, Call, Addison, & Kodak, 2008), and the extent to which stimuli that function as differentially effective reinforcers under PR schedules are also differentially effective when incorporated into reinforcement-based treatments for destructive behavior (Roane et al., 2001; Smith, Roane, & Stephenson, 2009). Despite these potential benefits of PR schedules, their utility has been questioned (Poling, 2010). Thus, additional research is needed to evaluate the relative utility of PR schedules in applied settings.

Issues Related to Specific Stimuli as Reinforcement

Choice as Reinforcement

The results of numerous studies have shown that a variety of stimuli (e.g., social praise, edible items, activities, leisure items) may function as reinforcement. In addition, researchers have investigated the extent to which choice functions as reinforcement. Although initial studies on the effects of choice suggested that the opportunity to make choices functioned as reinforcement (Dunlap et al., 1994; Dyer, Dunlap, & Winterling, 1990; Powell & Nelson, 1997), this work was limited, in that the participants gained access to highly preferred stimuli (e.g., activities) via the choice response. Thus, the opportunity to choose was confounded with the individual's preferences for the chosen items in these investigations.

Fisher, Thompson, Piazza, Crosland, and Gotjen (1997) sought to address this confound by yoking the choice and no-choice conditions. In Experiment 1, participants could choose from two available preferred stimuli as reinforcement in the choice condition. The reinforcement delivered in the no-choice condition was yoked to the choices the participants made in the choice condition. For example, if the participant chose Gummy Bears on the first trial, Skittles on the second trial, and M&Ms on the third trial of the choice condition, then the investigator delivered Gummy Bears on the first trial, Skittles on the second trial, and M&Ms on the third trial in the no-choice condition. The results of the study showed that higher levels of responding occurred in the choice relative to the no-choice condition. In Experiment 2, participants could choose from among lower-preference stimuli in the choice condition or could gain access to higher-preference stimuli in the no-choice condition. Under these arrangements, participants generally allowed the investigator to choose the reinforcer.

Although yoking provides one control in studies on choice, the yoking procedure does not control for momentary fluctuations in preference over time (Tiger et al., 2006). For example, earning Skittles in the previous choice condition may reduce the reinforcing effectiveness of the Skittles in the subsequent no-choice condition. An alternative control for examining the effects of choice is to offer identical options in choice and no-choice conditions (Tiger et al., 2006). For example, Thompson, Fisher, and Contrucci (1998) provided one young boy with autism the opportunity to choose between three identical cups of soda in the choice condition or gain access to the same soda in a cup in the no-choice condition. Their results showed that the child preferred the choice arrangement when rates of reinforcement were equal, and when choice produced lower rates of reinforcement. Choice has been demonstrated to function as reinforcement for children with disabilities such as mental retardation and autism (Fisher et al., 1997; Thompson et al., 1998), preschool-age children (Schmidt,

Hanley, & Layer, 2009; Tiger et al., 2006), and individuals with traumatic brain injury (Tasky, Rudrud, Schulze, & Rapp, 2008). Finally, Graff and Libby (1999) showed that participants preferred to make choices within the session as opposed to prior to it.

Edible Stimuli

DeLeon and colleagues (1997) hypothesized that some individuals may be more likely to select food items during preference assessments relative to other available stimuli. To that end, they assessed the extent to which edible items displaced leisure item and activities during a preference assessment. DeLeon and colleagues conducted separate MSWO assessments consisting of a food-only assessment, a leisure-only assessment, and a combined food and leisure assessment. The participants displayed a general tendency to select food over nonfood items in the combined preference assessment, even though highly preferred food and highly preferred leisure items (from the leisure-only assessment) functioned as reinforcement. Bojak and Carr (1999) found that the preference for edible items was maintained even after mealtimes. DeLeon and colleagues noted that these results suggest that caution must be taken when interpreting the results of preference assessments that include both edible and leisure items.

Factors That May Influence the Effectiveness of Reinforcement

Reinforcement Rate, Quality, and Delay

Neef and colleagues conducted a series of studies (Mace, Neef, Shade, & Mauro, 1994; Neef, Mace, & Shade, 1993; Neef, Mace, Shea, & Shade, 1992; Neef, Shade, & Miller, 1994) to evaluate how rate, quality, and delay to reinforcement affect responding. Results from these studies suggested that participants prefer schedules of reinforcement associated with higher-quality (Neef et al., 1992) and shorter delays to reinforcement (e.g., Neef et al., 1993).

Stimulus Variation

Stimulus variation is one method that researchers have used to enhance the effectiveness of reinforcement (Bowman, Piazza, Fisher, Hagopian, & Kogan, 1997; Egel, 1980, 1981; Wine & Wilder, 2009). For example, Bowman and colleagues (1997) found that four of six participants preferred varied versus constant presentation of preferred stimuli; the other two participants preferred the constant condition. Wine and Wilder (2009) extended the work of Bowman and colleagues by examining the effects of varied versus constant reinforcement. Participants could earn access to (1) constant high-preference stimuli, (2) constant medium-preference stimuli, (3) constant low-preference stimuli, or (4) varied stimuli (the experimenter randomly selected a high-, medium-, or low-preference stimulus to deliver to the participant on each trial). The greatest increases in work output for both participants occurred in the constant high-preference condition, and the varied-presentation condition resulted in work output comparable to constant delivery of medium-preference stimuli.

Changes in Preference over Time

One important issue that behavior analysts need to consider is the extent to which preferences change over time, and whether preference assessments need to be repeated. The results of a number of studies have shown that preferences appear to vary over time (e.g., Carr, Nicholson, & Higbee, 2000; Mason, McGee, Farmer-Dougan, & Risley, 1989; Zhou, Iwata, Goff, & Shore; 2001). Hanley, Iwata, and Roscoe (2006) attempted to replicate and extend the literature on the stability of preferences over time by evaluating preferences for leisure activities over 3 to 6 months with 10 adults with developmental disabilities. Contrary to the results of previous studies, their results suggested that preferences were relatively stable for the majority (80%) of participants. Hanley and colleagues also showed that preference stability was disrupted by naturally occurring changes in establishing operations or conditioning histories. When preferences do change over time, DeLeon and colleagues (2001) showed that daily brief preference assessments could be used to accommodate changes in preferences.

Satiation versus Deprivation

Limiting access to reinforcement outside of training or treatment situations is a com-

monly recommended strategy. Kodak, Lerman, and Call (2007) evaluated the extent to which access to postsession reinforcement influenced responding. It is not surprising that the results of the study showed that all participants engaged in higher levels of responding when access to the reinforcer was restricted postsession. Hanley, Tiger, Ingvarsson, and Cammilleri (2009) showed that satiation could be used to alter preschoolers' free-play activity preferences. Preschoolers reallocated responding to less preferred but important activities (instructional zone, library, and science) when the experimenters applied a satiation procedure to highly preferred activities. Zhou, Iwata, and Shore (2002) examined effects of both satiation and deprivation of food as reinforcement on the pre- and postmeal responding of nine adults with severe to profound mental retardation. Less than half of the participants had higher response rates pre-relative to postmeal. The remaining participants had response rates that were comparable pre- and postmeal. Satiation and deprivation effects may be somewhat idiosyncratic depending on the individual and the type of reinforcement (e.g., Sy & Borrero, 2009).

Conclusion

Since 1985, the literature on stimulus preference and reinforcement assessment procedures has advanced markedly. Investigators have demonstrated that a number of methods can be used to assess preference, and each of these methods has strengths and weaknesses in terms of time efficiency and accuracy. Single-stimulus assessments may be most appropriate for individuals who do not make choices or show approach responses when multiple stimuli are available, although the disadvantage is that some individuals may show high levels of approach responses to all or most of the stimuli. Paired-choice assessments may produce a more differentiated hierarchy when individuals demonstrate choice-making behavior. The MSW, MSWO, and free-operant procedures have the advantage of time efficiency. Concurrent chains procedures have been used most often to identify individuals' preferences for procedures (e.g., treatments). Duration assessments may be useful for assessing levels of inappropriate behavior in the presence of specific stimuli (e.g., Piazza, Fisher, Hanley, Hilker, & Derby, 1996; Rihgdahl, Vollmer, Marcus, & Roane, 1997). Activity restriction combines aspects of both trial- and free-operant-based assessments and may produce a more discrete hierarchy of preferences. Vocal assessments may be most appropriate for individuals who can vocalize their preferences, although the correspondence between vocal and observed preferences is questionable. Pictorial preferences appear to be as accurate as presentation of actual stimuli. The results from the vast majority of research have demonstrated that preference is a relatively good predictor of reinforcement efficacy; however, preference assessments may underestimate the effectiveness of lower-preference stimuli as reinforcement.

The most accurate method of reinforcer identification is to conduct an assessment to test the effectiveness of preferred stimuli as reinforcement. Researchers have used a variety of methods to conduct reinforcer assessments. Single-operant schedules are well suited for evaluating the absolute effects of a stimulus as a reinforcer. By contrast, concurrent-operants schedules provide information about the relative effects of a stimulus as a reinforcer. Most studies have employed simple, free-operant responses as the target for ease and time efficiency, with the rationale that if a stimulus does not function as reinforcement for a simple response, then it is not likely to function as reinforcement for a more complex one. PR schedules have been implemented to evaluate relative reinforcer efficacy across a variety of contexts, and provide some promise for additional research.

There are a variety of methods for maximizing the effectiveness of reinforcement. Stimulus variation may be beneficial under some circumstances. At a minimum, preferences should be assessed periodically to avoid satiation. Satiation also can be minimized by restricting access to reinforcement outside of learning or treatment contexts. In addition, reinforcement should be delivered immediately, and the behavior analyst should assess the quality of potential competing reinforcers in the environment to ensure that programmed reinforcement is of higher quality than available alternative reinforcement. Studies have shown that edible items may be

selected more often than leisure items, and the behavior analyst should be cognizant of this fact when assessing preferences for leisure and edible items simultaneously. Finally, research has shown that choice in and of itself may function as reinforcement.

In summary, the existing literature offers a number of procedures to identify successfully effective positive reinforcers. Some questions that still arise from this subfield of applied behavior analysis included:

1. What procedures are most effective for which individuals?
2. What are the considerations a practitioner might consider when choosing which type of preference assessment procedure to employ?
3. How does one control for various motivational variables when identifying preferred reinforcers?
4. What is the best approach for progressing between preference assessments that yield inconclusive outcomes?
5. Finally, how does one identify potential negative reinforcers?

Answers to these questions, among others, will further refine our methods for identifying and enhancing positive reinforcers.

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CHAPTER 10

Functional and Structural Approaches to Behavioral Assessment of Problem Behavior

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Applied behavior analysts view behavior as occurring within a given context because individuals interact with their environments. Thus, behavior occurs in response to both individual and environmental variables. *Individual variables* are those variables that are unique to the person and include an individual's genetic and biologic makeup and reinforcement history. *Environmental variables* refer to stimuli that (1) occur antecedent or subsequent to a response, (2) are discriminable to the individual, and (3) alter responding. To better understand why target behavior (e.g., problem behavior) occurs, applied behavior analysts seek to identify environmental variables that are associated with or that lead to an increased probability of the future occurrence of the target behavior. Environmental variables are emphasized because they are both observable and amenable to change, unlike many variables, such as genetic makeup, that are associated with the individual. Thus, a primary goal of behavioral assessment is to identify environmental variables that are related to increases or decreases in target behavior.

In the following sections, we describe a specific type of behavioral assessment, experimental analysis; two variations of the procedures (functional and structural); and applications of the procedures across subgroups (with and without disabilities), settings (home, school, and clinic), and target behavior (e.g., self-injury, aggression, and noncompliance).

Experimental Analysis of Behavior

A distinguishing feature of experimental analysis is that observations are conducted within tightly controlled, single-case designs to demonstrate that environmental variables affect or change the responding of target behavior. This emphasis on causal relations, either antecedent–response or response–consequence, contrasts with more descriptive methods, such as antecedent–behavior–consequence (A-B-C) assessments, in which behavior is recorded in relation to naturally occurring antecedent or consequence events (e.g., Bijou, Peterson, & Ault, 1968; Mace & Lalli, 1991). Descriptive analyses may show a strong relation between antecedents or consequences and problem behavior, but they cannot identify specific operant relations because experimental (causal) manipulations are not conducted. In most applied situations, descriptive analyses are conducted first to identify potential operant

relations, which are then verified via an experimental analysis. For example, Mace and Lalli (1991) conducted A-B-C assessments of an individual's bizarre speech and recorded multiple antecedent and consequence variables that occurred in close temporal relation to the target behavior. This descriptive analysis resulted in hypotheses regarding the maintaining consequence variables, which were subsequently tested directly within an experimental analysis.

Experimental analyses are based on the conceptual model proposed by Carr (1977), who suggested that both social (positive and negative reinforcement) and nonsocial (automatic reinforcement) variables maintain problem behavior. Specifically, displays of problem behavior may produce outcomes (e.g., attention, preferred items, breaks from demands, or stimulation) that function to reinforce the problem behavior. To understand why problem behavior continues to occur, it is critical to understand its operant function. Distinct topographies of problem behavior may occur for the same operant reason (to gain or to escape specific environmental events), and similar topographies may be maintained by different environmental events.

The clinical or applied benefit of an experimental analysis is that the results of assessment serve as a guide to the selection of treatment. For example, if an experimental analysis shows that the operant function of self-injury is to gain attention, then treatment is matched (Iwata, Pace, Dorsey, et al., 1994) to the results of assessment by eliminating or reducing attention following self-injury and providing attention, either contingently for appropriate responses, such as mands, or noncontingently to reduce the individual's motivation to engage in the target behavior. The advantage of this functional approach to treatment is that the clinician can choose from a menu of treatment options as long as the treatments match the results of assessment. This matching process has led to (1) the development of innovative treatments (e.g., functional communication training [FCT]: Carr & Durand, 1985; noncontingent presentation of identified reinforcers: Rihgdahl, Vollmer, Marcus, & Roane, 1997) and (2) an increased understanding of the conditions under which different treatments (e.g., different types of extinction: Iwata, Pace, Cowdery, & Miltenberger, 1994) may be effective for any given individual.

The results of experimental analyses are more prescriptive for treatment than are the results obtained via descriptive assessments because the former are conducted within tightly controlled experimental designs. As discussed by Wacker, Berg, and Harding (2006), analyses of operant relations within well-controlled experimental designs help to reduce the ambiguity of assessment results. Although the results of descriptive analyses often suggest operant relations, these results can be difficult to interpret (Borrero & Borrero, 2008; Lerman & Iwata, 1993; Thompson & Iwata, 2007) because multiple environmental variables may be correlated with target behavior. For example, problem behavior may produce multiple outcomes for the individual at different points in time during naturalistic (uncontrolled) observations, and many of these outcomes may co-occur (e.g., removal of demands and increased attention). In these situations, as shown by Mace and Lalli (1991), an experimental analysis is often needed to clarify the results. In addition, although the correspondence between the results of descriptive and experimental analyses has been high in some studies (e.g., Borrero & Borrero, 2008; Sasso et al., 1992), it has been low in others (e.g., Lerman & Iwata, 1993; Thompson & Iwata, 2007).

The methodological rigor of experimental analysis, coupled with the clinical outcomes achieved, makes this model the preferred approach to assessment of problem behavior. Two generic versions of experimental analysis procedures have been described in the literature (Hanley, Iwata, & McCord, 2003), with numerous permutations (e.g., brief experimental analysis, Cooper, Wacker, Sasso, Reimers, & Donn, 1990). The most common version, functional analysis (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994), evaluates response–reinforcer relations. The alternative version, structural analysis (Carr & Durand, 1985), evaluates antecedent–response relations.

Functional Analysis

Functional analysis is a direct assessment of response–reinforcer relations. This assessment is termed a *functional analysis* because

the results are used to identify the operant function of target behavior. The functional analysis model of assessment was first described by Iwata and colleagues (1982/1994) and consisted of a series of control (play) and test (attention, demand, and alone) conditions conducted within a multielement design. The play condition provided noncontingent and continuous access to attention, toys, and breaks from demands, thus providing a control for social and sensory variables that might reinforce and maintain target behavior. Behavior that functions to obtain or maintain attention or tangibles, escape from demands, or sensory stimulation should not occur during this control condition, or it should occur at very low rates. As described by Smith and Iwata (1997), the remaining test conditions of a functional analysis are conducted in two phases: establishing operations (EO) and reinforcement. Each test condition begins with the EO, which is matched to the reinforcer provided for target behavior. Thus, in the attention condition, the attention of the clinician or care provider is diverted from the participant and is then provided contingently for displays of target behavior in the consequence phase. In the demand condition, the EO phase consists of the presentation of the demand and prompts to complete the demand, and the reinforcement phase consists of breaks from the demand. In the alone condition, the EO phase consists of the absence of social stimulation, and the consequence phase consists of the sensory stimulation accessed via displays of the target behavior. Repeated presentations of each condition, either in a counterbalanced order within a multielement design or in a fixed order within a reversal design, were used by Iwata and colleagues (1982/1994) to show both the responsiveness of target behavior to the reinforcer being tested and the stability of behavior across sessions. An operant function was identified by inspecting both (1) the overall rate of behavior in one test condition versus the other conditions and (2) the trend (accelerating or decelerating) of behavior across sessions.

The clinical benefits of conducting functional analyses prior to implementing treatment are well documented in the literature (e.g., see the special issue of the *Journal of Applied Behavior Analysis*, 1994), with applications of the procedures conducted across diverse subgroups and settings. Iwata, Pace, Dorsey, and colleagues (1994) provided strong evidence that functional analyses are often successful in identifying operant functions of destructive behavior in inpatient and laboratory settings with persons who have developmental disabilities. Kurtz and colleagues (2003) reported the successful application of functional analysis procedures in an outpatient clinic with young children who displayed self-injurious behavior. Very similar findings were reported in Wacker, Berg, Harding, and colleagues (1998), in which parents were coached to use the procedures in their homes with young children with disabilities, and by Derby and colleagues (1992), who showed that very brief versions of functional analysis procedures could be used in outpatient clinics during one 90-minute session. Asmus and colleagues (2004) showed that functional analysis procedures could be used with typically developing children on an inpatient unit who displayed severe problem behavior, and Call, Wacker, Rihgdahl, Cooper-Brown, and Boelter (2004) showed that brief outpatient assessments were possible with this same subgroup of children. The collective results of these studies show the heuristic value of conducting functional analyses of problem behavior.

Structural Analysis

Structural analyses are similar to functional analyses in that direct assessments of responding are conducted within tightly controlled analogues, and single-case designs are used to show causal relations. However, the focus of assessment is on antecedent–response rather than response–reinforcer relations (Axelrod, 1987). Determining the responsiveness of behavior to the presence of others, to particular items or objects, or to other features of the environment is often the purpose of assessment. Just as a functional analysis is an experimental analysis of consequences, a structural analysis is an experimental analysis of antecedents.

Experimental analyses of antecedents have not kept pace with functional analyses because much more is known about response–reinforcer relations than about antecedent–response relations (Vollmer & Van Camp, 1998). Carr and Durand (1985) provided one of the first demonstrations of

structural analysis using procedures very similar to those of Iwata and colleagues (1982/1994). Carr and Durand varied the levels of two antecedent variables (amount of attention and difficulty of task demand) across three assessment conditions, while placing problem behavior on extinction for four children with autism. Occurrence of problem behavior was compared across a control condition (easy task/high attention) to two test conditions in which the same easy task was presented with low levels of attention, and a difficult task was presented with high levels of attention. A reversal design was used to evaluate the relative effects of attention and task difficulty on behavior. If, for example, problem behavior increased when the level of attention was reduced even though the task demand remained the same, then low amounts of attention were shown to be related to increases in problem behavior. This identified antecedent–response relation was used to infer operant function and to develop highly effective treatments. As with functional analysis methods, numerous replications (e.g., Durand & Carr, 1991) established structural analysis as a valid approach to assessment, and its heuristic value was shown by brief applications to outpatient clinics with typically developing children who displayed problem behavior (e.g., Cooper et al., 1990). Thus, although not as parsimonious as the functional analysis because of the need to infer operant functions, the clinical usefulness of the structural approach has been clearly established.

One extension of structural analysis is the evaluation of interactions between antecedent and consequence variables. Several studies have shown that highly individualistic or idiosyncratic antecedent variables, such as the presence of specific items (Carr, Yarbrough, & Langdon, 1997), can alter the results of a functional analysis. Harding, Wacker, Berg, Barretto, and Rihgdahl (2005) showed that the positioning of a child during a functional analysis could disrupt the identification of specific operant functions. These studies and others (e.g., Conners et al., 2000; Rihgdahl & Sellers, 2000) have shown that separate experimental analyses of antecedents, when combined with functional analyses, can provide highly specific information on how antecedent and consequence variables interact to influence the rate of target behavior.

Wacker, Berg, Asmus, Harding, and Cooper (1998) suggested conducting an experimental analysis of antecedents when responding is highly variable. Variability in responding might be related to the effects of discriminative stimuli (S^Ds) or the effects of motivating operations (MOs; Luiselli, 1998). For example, Carr and colleagues (1997) demonstrated how S^Ds in the form of specific items influenced responding, and Rihgdahl and Sellers (2000) showed similar results for S^Ds in the form of different people.

Relative to the effects of MOs (Laraway, Snycerski, Michael, & Poling, 2003) on variable responding, a number of authors reported that changes in states of deprivation or satiation altered subsequent responding within a functional analysis or treatment condition. For example, Vollmer and Iwata (1991) showed that deprivation or satiation of different classes of reinforcement (food, social interaction, and music) influenced subsequent responding during work tasks. The authors identified these relations by systematically altering changes in the EO prior to the work task and showing that variability in responding during the work task was, in fact, due to changes in the EO. Similar variability in functional analysis results were shown by Berg and colleagues (2000) and O'Reilly and colleagues (2007) for children with developmental disabilities, and by Call and colleagues (2004) for typically developing children in an outpatient clinic.

Antecedent variables control subsequent responding via their association with reinforcement, either by signaling the availability of reinforcement (S^Ds; Catania, 1998) or by momentarily altering the value of a reinforcer (MOs; Michael, 1982). Thus, it makes intuitive sense to conduct antecedent analyses in conjunction with functional analyses to determine more precisely the operant relations that control responding. These types of antecedent procedures can increase our understanding of why specific response–reinforcer relations occur for any given individual (Kennedy & Becker, 2006). For example, O'Reilly (1995, 1997) and Kennedy and Meyer (1996) showed that behavior maintained by negative reinforcement might be occasioned by distinct biological events (allergies, otitis media, and sleep deprivation). Identifying both the antecedent and consequence conditions permits the clinician

to consider a wider range of treatments involving antecedent variables, as well as consequence variables.

In the following sections, we describe how experimental analysis methods have been applied to the assessment of problem behavior maintained by both social and nonsocial events; for individuals both with and without developmental disabilities; and within home, clinic, and school settings. Our purpose in providing these examples is to show the heuristic value of conducting experimental analyses and to describe variations of experimental analysis procedures and augmentative assessments based on experimental analyses reported in the applied literature.

Assessment in Home Settings for Young Children with Developmental Disabilities

Researchers have used antecedent analyses (Asmus et al., 1999; Berg et al., 2000), functional analyses (Deaver, Miltenberger, & Stricker, 2001; Harding et al., 2001; Najdowski, Wallace, Doney, & Ghezzi, 2003), and combinations of these procedures (Derby et al., 1997; Harding et al., 1999; Wacker, Berg, Harding, et al., 1998; Wacker et al., 2005) to identify functional relations (Hanley et al., 2003). Assessments have focused on a range of behavioral topographies, including hair twirling (Deaver et al., 2001), food selectivity (Najdowski et al., 2003) and crying (Harding et al., 2001), and on problem behavior such as aggression and self-injury (Asmus et al., 1999; Derby et al., 1997; Harding et al., 2001; Vaughn, Clarke, & Dunlap, 1997; Wacker, Berg, & Harding, 1996).

For the past 17 years, our research team at The University of Iowa has received funding from the National Institute of Child Health and Human Development to conduct research involving the assessment and treatment of children's problem behavior in home settings. The participants in these projects have been young children (age 6 years or younger) who displayed developmental disabilities and severe problem behaviors (e.g., aggression, self-injury, property destruction). All procedures have been conducted in the children's homes with their parents serving as therapists.

The results of our previous research projects (reported in Berg, Wacker, Harding, Ganzer, & Barretto, 2007; Wacker, Berg, Harding, et al., 1998; Wacker et al., 2005) demonstrated that experimental analyses can be conducted by parents in home settings with coaching from investigators. To date, we have enrolled a total of 103 children in these projects (Wacker et al., 2009). We conducted functional analyses of problem behavior with 96 children and identified social functions for 85 of these children.

During our most recent project (Wacker, Berg, & Harding, 2004), we selected structural and functional analyses to identify relations between environmental variables and a child's behavior. The following is a brief summary of the multiphase assessment methodology we currently use to assess problem behavior, to develop interventions, and to evaluate intervention effects in home settings.

Experimental Analysis (Phase 1)

In a functional analysis of the child's problem behavior we use procedures similar to those described by Iwata and colleagues (1982/1994). The functional analysis consists of a series of brief (5-minute) analogue conditions in which reinforcement is provided contingent on the occurrence of problem behavior. These test conditions are compared to a control condition (free play) in which the child has noncontingent access to parental attention and toys, and no demands are placed on the child. A multielement design is used to evaluate patterns of child responding during these conditions to determine whether the problem behavior is related to specific social events. In the majority of cases, a function for problem behavior is identified.

In some cases, when target behavior occurs across all conditions in an undifferentiated fashion, the initial functional analysis does not demonstrate a clear relation between problem behavior and social contingencies. Although this outcome suggests an automatic reinforcement hypothesis (Iwata, Pace, Dorsey, et al., 1994), an alternative explanation is that antecedent variables are influencing behavior. To test this possibility further, we have conducted structural analyses following inconclusive functional

analyses. For example, Harding and colleagues (2005) conducted a structural analysis with a child who engaged in undifferentiated levels of self-injury while seated in her wheelchair during a functional analysis. To identify a control (free play) condition, the authors conducted an antecedent analysis in which the child's location (in a wheelchair or next to her mother) and toys were manipulated during play. Results showed that self-injury was substantially reduced when the child was removed from her wheelchair and sat next to her parent on a couch, but that the type of toy presented to her did not affect her behavior. This change in location was incorporated into a second functional analysis by conducting all test conditions on the couch next to her mother. The change in location during the second functional analysis resulted in high levels of self-injury across test conditions but low levels during the free-play condition. Thus, in this case, an antecedent (structural) analysis was conducted to identify a free-play condition that could be used as a control condition for a subsequent functional analysis.

Choice Assessment (Phase 2)

After completing an experimental analysis, we often conduct a direct assessment of reinforcers for appropriate behaviors, such as a choice (concurrent operants) assessment (Harding et al., 1999). The purpose of a choice assessment is to identify the child's relative preference for positive and negative reinforcement within a concurrent-operants arrangement (Fisher & Mazur, 1997). In this procedure, a room in the child's home is divided in half with masking tape, and each half of the room is associated with different stimuli (e.g., more or less preferred toys). The child is allowed to move freely to either side during a session, and the child's time allocation to each side is measured. For example, to evaluate the child's preference for parental attention or preferred toys (positive reinforcers), during the first test condition, the parent is located on one side of the room with a less preferred toy, and more preferred toys are on the other side. In a subsequent condition, the child chooses between being with the parent with a more preferred toy and being alone with a less preferred toy. A combination concurrent schedules and reversal design is used to evaluate the child's preference for available choice options. The results of the choice assessment augment the results from the functional analysis by identifying reinforcers for appropriate behavior during treatment. For children whose problem behavior is maintained by negative reinforcement, we often provide breaks for compliance. The choice assessment identifies what activities or stimuli should be available during these breaks. Thus, the functional analysis identifies the response–reinforcer relations for problem behavior, and the choice assessment identifies the class of reinforcers for appropriate behaviors.

Extinction Probes (Phase 3)

The prior assessment procedures identify specific classes of reinforcement that maintain problem and appropriate behavior, and antecedents that are correlated with the occurrence of problem behavior. In Phase 3, we use a structural analysis to assess whether problem behavior persists under the relevant antecedent condition even though reinforcement is no longer provided (Nevin & Wacker, in press). For example, if problem behavior is correlated with demands, a specific demand is presented to the child in a series of trials during 5-minute sessions. In this procedure, the parent asks the child to complete the task (e.g., "Put this block in the bucket") during a 30-second trial. If the child complies, the parent thanks the child, then begins a new trial. If the child does not comply, the parent repeats the request until the trial is concluded, then initiates a new request. This condition is compared to a free-play condition within a multielement design.

Another reason to conduct structural analyses is to assess stimulus generalization. Wacker and colleagues (2005) conducted pretreatment extinction probes across a selection of tasks (e.g., dressing, tooth brushing, academic tasks), community settings (e.g., home, relative's homes, school), and persons (e.g., parents, teachers). After a reduction in destructive behavior was achieved during FCT with a designated person, setting, and task, the probes were repeated across untrained stimulus conditions to evaluate changes in problem behavior, manding, and task completion. In this way, a structural

analysis was used to augment functional analysis and treatment procedures to assess whether stimulus generalization occurred prior to treatment for problem behavior and following treatment for appropriate behavior.

Case Example

The following case example shows how experimental analysis results are used to develop individualized treatment packages. Ray was a 4-year-old boy diagnosed with autism and mild mental retardation. Destructive behavior included aggression (scratching, hitting, biting) and property destruction. Ray was able to emit several words and manual signs (e.g., "More"), but he often required prompting to do so. A functional analysis was conducted by Ray's parent with coaching from investigators. A 6-second partial-interval recording system was used to measure destructive behavior during 5-minute sessions. Results of Ray's functional analysis (left panel of Figure 10.1) showed that destructive behavior was elevated during both demand and tangible conditions, whereas little or zero destructive behavior occurred during attention and free-play conditions. During the choice assessment, Ray allocated most of his time to choice options that included parental attention, even though attention was not shown to be a reinforcer for destructive behavior during the functional analysis. This outcome suggested that parental attention might be a reinforcer for appropriate responses during treatment.

An FCT program was designed to teach Ray to follow his parent's directions during a work task (stacking colored blocks) and to mand for a break to play with his parent. During each training session, Ray was directed to stack one block. If he completed this task appropriately, his parent presented a microswitch with a "play" picture/word card. Ray was prompted to touch the switch for a break from work. After 2 minutes of play with his parent, this procedure was repeated. Problem behavior at any time resulted in a return to the work task.

Treatment probe data over a 4-week period are displayed in the right panel of Figure 10.1, which shows percentage of intervals of Ray's destructive behavior and independent manding, and percentage of independent task completion. Ray's destructive behavior decreased to zero or near-zero levels with the introduction of FCT. He independently used the microswitch to request breaks and completed most of his work tasks.

Assessment of Problem Behavior Not Maintained by Social Reinforcers

The functional and structural analyses discussed thus far showed differentiation in behavior across assessment conditions,

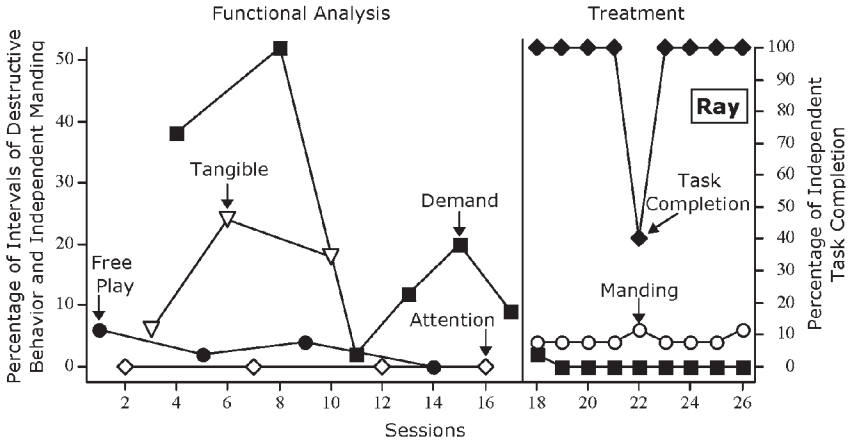


FIGURE 10.1. Percentage of intervals of destructive behavior during functional analysis (left panel) for Ray. Percentage of intervals of destructive behavior and independent manding, and percentage of task completion during treatment probes for Ray (right panel).

with elevations in behavior occurring in some conditions and not in others. In these analyses, behavior increased in response to the delivery or removal of one or more social events (i.e., attention, tangible, or escape) manipulated within test conditions and remained at low or zero occurrences in the control condition, in which the social events were available on a continuous basis. When experimental analyses fail to identify a social event whose presence or absence is associated with increases and decreases in problem behavior, the behavior is described as nonsocial or automatically reinforced. The term *nonsocial* is used because manipulations of social events typically identified as reinforcers for problem behavior do not appear to affect occurrence of the behavior. As a result, we would not expect treatments based on manipulations of social events to be effective in reducing target behavior. The term *automatic* refers to the hypothesis that the behavior produces its own reinforcement (Vaughn & Michael, 1982). Behavior that produces its own reinforcement by providing stimulation was referred to by Rapp and Vollmer (2005) as automatic positive reinforcement, and behavior that reduces undesired sources of stimulation was referred to as automatic negative reinforcement. For the purposes of this chapter, we use the term *automatic reinforcement* to refer to reinforcers that remain unidentified or unknown following an experimental analysis.

Two patterns of experimental analysis results are typically interpreted as suggesting an automatic function for problem behavior. The first pattern (top panel of Figure 10.2) is one in which problem behavior is observed primarily within an alone or ignore condition, and little or no problem behavior is observed within the conditions that test for social functions. Alone and ignore conditions are typically conducted such that no

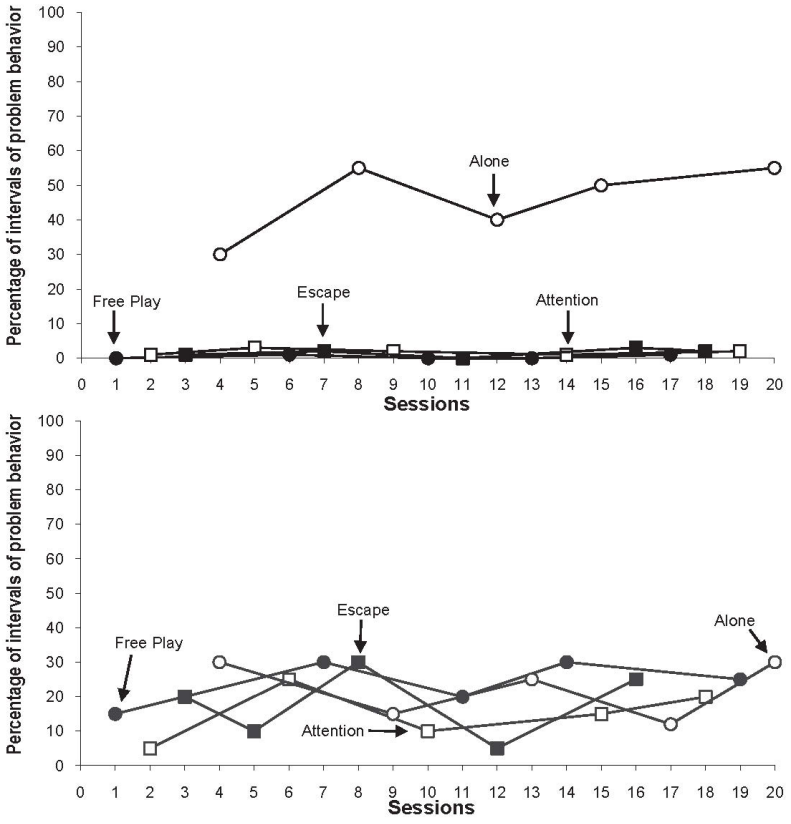


FIGURE 10.2. Percentage of intervals of problem behavior across functional analysis analogue conditions showing differentiated (top panel) and undifferentiated (bottom panel) automatic functions.

social stimuli are available, and no social consequences are provided for the behavior. Persistence of the behavior in the absence of social contingencies supports the hypothesis that the behavior provides its own source of reinforcement.

In the second pattern of results, undifferentiated behavior occurs across all experimental analysis conditions, including the control condition (bottom panel of Figure 10.2). In contrast to the first pattern of results, behavior occurs regardless of the presence or absence of different social events. An undifferentiated pattern of results may be obtained from both structural and functional analyses. A structural approach consists of manipulating the presence or absence of social reinforcers, while keeping the target behavior on social extinction. In this case, the presentation and removal of social reinforcers does not affect the occurrence of problem behavior. For example, occurrence of the target behavior is compared across analogue conditions in which a dense schedule of attention is provided on a fixed-time schedule and attention is withheld. The presence or absence of task demands or preferred activities can be manipulated in a similar manner. If target behavior is not responsive to social reinforcers, then behavior should continue to occur in both the presence and the absence of those reinforcers. The structural analysis can be conducted in isolation or within a functional analysis of a separate behavior. In the latter case, the delivered social contingencies are contingent on a separate response, and the target behavior remains on social extinction. When multiple topographies of problem behavior occur, social contingencies might be delivered contingent on a response such as aggression, but the occurrence of the target responses (e.g., stereotypy) would not affect the delivery or removal of the social reinforcers.

Regardless of the pattern of responding obtained within an experimental analysis, results indicating an automatic function are troublesome because they do not identify social reinforcers that can be manipulated within function-based treatments designed to reduce problem behavior. If we are not able to identify or directly observe the reinforcer maintaining problem behavior, then we might not be able to control the delivery or removal of that reinforcer. As a result, treatments to reduce problem behavior maintained by automatic reinforcement often involve sensory extinction. Sensory extinction focuses on the elimination or removal of the sensation provided by the client engaging in the problem behavior through the use of response blocking, physical restraints, and protective equipment, such as gloves and helmets. With these treatments, the response–reinforcer relationship of the target behavior producing automatic reinforcement is weakened because the target response no longer results in the same sensory effects. These treatments, although often effective, are difficult to execute because care providers are not able to block every instance of the target response or the automatic reinforcement produced by that response. Even occasional contact with the response–reinforcer contingency may be sufficient to maintain the target behavior (Smith, Russo, & Le, 1999).

Because of the inherent difficulties in matching treatment to function for automatically maintained problem behavior, augmentative assessments based on experimental analyses are often conducted and have proven to be promising in the development of effective treatments. One such approach has been the use of preference assessments to identify tangible stimuli that compete with the automatic reinforcement maintaining problem behavior (Ahearn, Clark, DeBar, & Florentino, 2005; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Rapp, 2007). For example, Shore, Iwata, DeLeon, Kahng, and Smith (1997) conducted preference assessments for tangible stimuli for three adults following functional analyses that resulted in undifferentiated patterns of responding across test and control conditions. In this study, tangible stimuli were presented individually for 10-minute assessment sessions, and data were recorded on the percentage of intervals in which the participant engaged with tangible stimuli, in self-injury, or both. The results of this assessment identified at least one item for each participant that was associated with high levels of engagement with the tangible item and reduced levels of self-injury when the item was available on a continuous, noncontingent basis. Rihgdahl and colleagues (1997) reported similar findings for a young girl whose problem behav-

ior appeared to be maintained by automatic reinforcement.

Shore and colleagues (1997) and Rihgdahl and colleagues (1997) used arbitrary stimuli for their preference assessments. Other researchers selected stimuli that appeared to match the sensory stimulation hypothesized to occur as a result of the behavior maintained by automatic reinforcement. For example, Piazza and colleagues (2000) showed that continuous, noncontingent access to sensory stimuli that matched the sensory consequences hypothesized to maintain a variety of dangerous behaviors effectively reduced the occurrence of those behaviors better than unmatched, arbitrary stimuli. Rapp (2006, 2007) reported similar findings.

Berg, Rihgdahl, Wacker, and Bosch (2003) proposed a three-phase assessment model based on the results reported by Rihgdahl and colleagues (1997) and Shore and colleagues (1997) to guide treatment selection when results of an experimental analysis of problem behavior show that behavior is maintained by automatic reinforcement. Phase 1 of the assessment is a functional analysis of problem behavior (Iwata et al., 1982/1994). In Phase 2, a pairwise comparison is conducted to evaluate the occurrence of problem behavior within the free-play (control) and alone conditions. A preference assessment is conducted to identify preferred tangibles to include within the free-play condition. During the alone condition, the participant does not have access to tangible stimuli or attention. If problem behavior is restricted to sessions in which the participant is alone with nothing to do (i.e., the results match those shown in the top panel of Figure 10.2), then we would expect noncontingent access to the stimuli available within the free-play condition to be an effective treatment to reduce problem behavior.

If the results of the pairwise comparison between the free-play and alone conditions show that problem behavior occurs across both conditions, a third phase of assessment is conducted to identify relative preferences between gaining access to different social stimuli and to automatic reinforcement. Similar to Harding and colleagues (1999), Phase 3 is a concurrent operants (choice) assessment in which the room is divided in half. Various combinations of preferred toys and adult attention are present on one side of the room, and the other side of the room is void of alternative stimuli. The participant is allowed to enter either side of the room and is free to cross back and forth between sides throughout the session. However, the participant has access to the reinforcers available on each side of the room only when he or she is in that side of the room. For example, if the participant enters the side of the room that contains access to attention and preferred toys, attention and toys are provided on a continuous basis, but attempts to engage in problem behavior are blocked. In contrast, if the participant enters the alone side of the room, he or she may engage in problem behavior without interruption (except to prevent tissue damage), but toys and attention are not available.

If the participant consistently selects the side of the room that contains access to social reinforcers and excludes problem behavior, then we infer that those social stimuli are relatively more preferred than the automatic reinforcement gained through problem behavior. In these cases, we implement a differential reinforcement treatment program in which the social stimuli identified in Phase 3 are provided contingent on the absence of problem behavior. If the participant selects the side of the room that provides access to problem behavior and automatic reinforcement to the exclusion of social stimuli, then we implement the default treatment of sensory extinction. Thus, the results of this three-phase assessment identify the function of behavior (automatic) and further identify treatments (NCR, differential reinforcement of other [DRO] behavior, sensory extinction) that match the results of assessment. For example, Stricker and colleagues (2005) conducted a concurrent-operants analysis as part of the three-phase assessment to identify social reinforcers (i.e., preferred toys, adult attention, preferred toys with adult attention) that were relatively more preferred than the automatic reinforcement that was hypothesized to maintain destructive behaviors for a young boy with autism and mental retardation. The results of the concurrent-operants analysis showed that the participant selected access to preferred toys and attention over gaining access to opportunities to engage in destructive behavior. Access to preferred toys and attention was made contingent on completing an appropriate play

response with a nonpreferred toy (e.g., placing a toy car on a car ramp), and preferred toys and attention remained available unless destructive behavior occurred. Destructive behavior resulted in the removal of the toys and attention for a brief period of time. The differential reinforcement of alternative behavior (DRA) treatment resulted in a greater than 90% reduction in problem behavior.

Assessment with Typically Developing Children

The research reported thus far has focused almost exclusively on persons with developmental disabilities; however, a growing body of research has shown that experimental analyses of problem behavior are equally effective in identifying the variables influencing problem behavior for children without disabilities (Asmus et al., 2004). In this section, we describe how we applied experimental analysis methods to young, typically developing children who were evaluated in a pediatrics outpatient clinic, and how similar procedures have been applied in school settings.

When a child is referred for an outpatient evaluation, the evaluation must often occur within a 1- to 2-hour period, which is typically related to coverage by third-party payers. Cooper and colleagues (1990) and Northup and colleagues (1991) developed brief, direct outpatient assessment procedures based on experimental analysis procedures to evaluate the effects of antecedents (e.g., preference for tasks, task difficulty) and consequences (e.g., attention, escape from tasks) on the behavior of typically developing individuals or those diagnosed with developmental disabilities. Cooper and colleagues evaluated typically developing children by having parents vary the levels of attention and demands presented to the children, much like Carr and Durand (1985) reported for individuals with autism. Cooper and colleagues showed that most of the children were responsive to changes in one of these antecedent variables, and could infer the operant functions of their behavior.

The Cooper and colleagues (1990) study and subsequent replications (Cooper et al., 1992; Harding, Wacker, Cooper, Millard, & Jensen-Kovalan, 1994; Millard et al., 1993; Reimers et al., 1993) demonstrated the heuristic value of experimental analysis. The assessment procedures were clinically useful, even though population, setting, and duration of assessment were different than the original experimental analyses reported by Carr and Durand (1985) and Iwata and colleagues (1982/1994). Because outpatient assessments are limited to the amount of time available for direct assessment, we usually narrow the scope of possible assessment variables in order to complete the evaluation during one 2-hour period. This is done by collecting descriptive information from parents and teachers or child care providers prior to the child's visit to clinic. Descriptive information is then used to identify the primary behavioral concerns, define target behaviors, and develop hypotheses regarding operant variables that may control the child's behavior. When the child arrives in clinic, the clinic evaluation focuses directly on testing these hypotheses.

Experimental control is achieved by conducting the assessment within brief, multielement designs (Wacker, Berg, Harding, & Cooper-Brown, 2004). Following a free-play control condition, the hypothesized test condition is conducted. If a change in behavior occurs, then either the free-play and the test condition are repeated, or the relevant test condition is alternated with a different test condition (see top panel of Figure 10.3). Donna was a 4-year-old referred for severe tantrums at home. During the clinic evaluation, Donna's mother conducted all assessment conditions following brief instructions from therapists. The top panel of Figure 10.3 shows the percentage of 10-second intervals during each of the 5-minute conditions in which Donna's tantrum behaviors occurred. The first condition, child-directed play, was the control condition, and no tantrum behaviors occurred. The second condition, demand–escape, consisted of parent-directed play in which Donna's mother chose the toy and directed Donna on how to play with it. Tantrum behaviors resulted in brief escape from parent-directed play. Tantrum behaviors occurred during 83% of the intervals. The third condition, diverted/contingent attention, evaluated the effects of attention on Donna's tantrum behaviors. In this condition, Donna's mother instructed Donna to "find a toy to play with" and sat

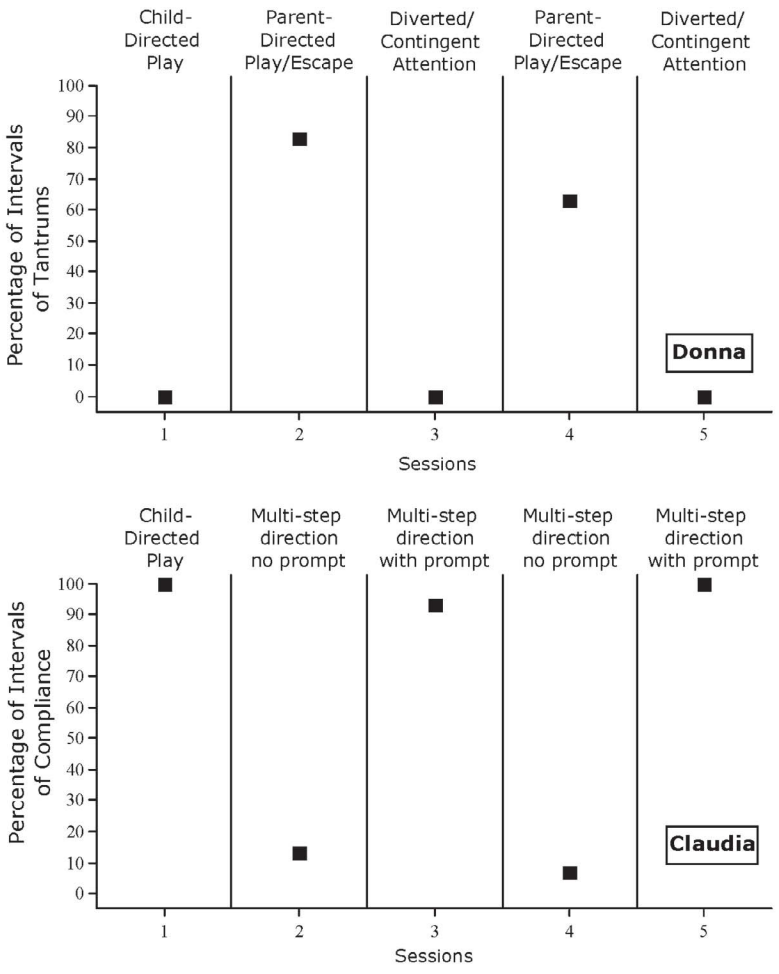


FIGURE 10.3. Top panel: Percentage of intervals of tantrums during functional analysis for Donna. Bottom panel: Percentage of intervals of compliance during structural analysis for Claudia.

away from her reading a magazine. Parent attention was delivered only for tantrum behavior. The demand–escape condition (parent-directed play) and the diverted/contingent attention condition were repeated to replicate the findings. Once again, tantrum behaviors occurred during the demand–escape condition (63%), but not during the diverted/contingent attention condition. The results of the analysis suggested that escape from demands likely maintained Donna's tantrum behaviors. Additional variables might have contributed to her tantrum behaviors, but the results of the brief analysis were sufficient for the therapists to provide treatment recommendations to Donna's mother for use at home.

Of most concern is when possible false-negative results occur during brief experimental analyses. In the Derby and colleagues (1992) study, approximately half of the children did not show problem behavior during an outpatient clinic evaluation, even though problem behavior was reported to occur at home and/or school. In these cases, researchers have conducted more extended experimental analyses (Vollmer, Marcus, Rihgdahl, & Roane, 1995) or brief experimental analyses that blend both antecedents and consequences (Call, Wacker, Rihgdahl, & Boelter, 2005). For example, if the hypothesized function of problem behavior is negative reinforcement, several distinct demand conditions might be conducted. Each

condition provides escape from demands contingent on problem behavior, but the antecedent variables are changed. Call and colleagues (2005) combined two antecedent variables (demand and restricted tangible, and demand and diverted attention) during the MO phase and provided one consequence (escape or attention) for problem behavior for each participant. Results demonstrated greater increases in rates of aggression during the MO phase when the two antecedent variables were combined versus when only one antecedent variable was provided.

Richman and colleagues (2001) also described a procedure to blend antecedent and consequence analyses. They noted that a large percentage of typically developing children evaluated in our pediatrics clinic had learning difficulties, such as receptive language delays. One question addressed during assessment was whether noncompliance varied as a function of the way instructions were provided to the children. Keeping consequences the same, researchers varied the type of directives provided to the children (e.g., visual vs. verbal, one step vs. three steps, inclusion of conjunctions, discrimination of group membership). Accuracy of task completion varied across children based on the complexity of the directives provided. Results suggested that "noncompliance," or failure to respond, might have been related to ineffective directives.

An example of this type of evaluation is provided in the bottom panel of Figure 10.3. Claudia, a 6-year-old who attended a regular education kindergarten classroom, was previously diagnosed with a learning disorder. The primary behavior of concern was tantrums. We hypothesized that Claudia's tantrum behavior might be related to how directives were presented to her. Figure 10.3 shows the percentage of 10-second intervals during each of the 5-minute conditions in which compliance occurred. Following a control condition (child-directed play), Claudia's mother vocally directed Claudia to make a tower of four blocks in a specific order by color (e.g., green, yellow, red, blue). No visual prompts were provided to Claudia, and she was told to complete a new tower in a different order following compliance, or approximately every 30 seconds, if she was noncompliant. During this condition, Claudia was compliant during 13% of the intervals. The third condition was the same as the previous condition except that a visual prompt was presented to Claudia with the vocal instruction. With the inclusion of the visual prompt, Claudia was compliant during 93% of the intervals. These conditions were repeated with similar outcomes. Results suggested that inclusion of visual prompts increased Claudia's compliance with directions.

Researchers have also described ways to extend experimental analysis procedures to school-based settings. This is related, in part, to the reauthorization of the Individuals with Disabilities Education Act (IDEA; Public Law 105-17), which identified the use of functional behavioral assessments (FBAs) in school settings when a child displays significant challenging behaviors. School-based models for conducting FBAs have suggested the use of descriptive assessments, functional and structural analyses, treatment evaluation, and parent and teacher training (e.g., Asmus, Vollmer, & Borrero, 2002; Olympia, Heathfield, Jenson, & Clark, 2002; Sterling-Turner, Robinson, & Wilczynski, 2001). Roberts, Marshall, Nelson, and Albers (2001) included curriculum-based procedures to identify antecedent events related to off-task behavior. Participants were three students enrolled in general education classrooms. A descriptive assessment was first conducted to generate hypotheses concerning variables related to the off-task behavior (e.g., math tasks vs. nonacademic tasks). Following the descriptive assessment, instructional- and frustration-level math tasks were alternated with nonacademic tasks, with results suggesting that off-task behavior was maintained by escape from difficult math tasks.

Hoff, Ervin, and Friman (2005) described the results of a functional behavioral assessment by the teacher of an adolescent student in a general education classroom. In the first phase, a descriptive assessment generated hypotheses about the effects of classroom environmental variables and disruptive behavior (access to peer attention, escape from a nonpreferred activity). These hypotheses were evaluated within the context of routine classroom activities. Each of these hypotheses translated into an intervention strategy and was directly assessed with a multielement design. The entire assessment was con-

ducted by the student's teacher. The results from these and others studies (e.g., Boyajian, DuPaul, Handler, Eckert, & McGoey, 2001; Jones, Drew, & Weber, 2000; Northup, Kodak, Lee, & Coyne, 2004) demonstrate that experimental analysis methods can be applied to classrooms, as well as to outpatient clinics and inpatient settings, for typically developing children who display problem behaviors.

Summary

In this chapter, we have described how experimental analysis procedures can be applied across diverse subgroups of individuals and settings. Both antecedent- and consequence-based analyses have shown the responsiveness of behavior to environmental events and can be used to develop effective treatments. A wide range of experimental analysis procedures are currently available in the literature, and new procedures are being reported. In addition, procedures, such as choice assessments, are being used to augment the results of experimental analyses to provide more information on the variables controlling and maintaining target behavior.

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CHAPTER 11

Indirect Behavioral Assessments

Interviews and Rating Scales

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Functional behavioral assessment (FBA) is an essential part of understanding the variables that affect the occurrence of maladaptive behavior. The importance of FBA is highlighted by the fact that the right to an FBA is guaranteed in the 1997 Amendments to the Individuals with Disabilities Education Act (IDEA), which was created (and subsequently amended) to ensure free, appropriate public education for students with disabilities. An FBA is part of a comprehensive package designed to create a learning setting in which the individual's specific needs are addressed in the least restrictive environment. The law requires that public schools provide necessary learning aids, testing modifications, and other educational accommodations to children with disabilities, including an FBA when appropriate.

The definition of an FBA may be summarized as a process of gathering information, observing, and/or manipulating environmental variables to develop effective, function-based treatments. There are three general components of an FBA: indirect assessment, descriptive assessment, and experimental functional analysis. Regardless of the level of assessment (e.g., indirect or direct; descriptive or experimental), the assessment process must begin with gathering information about the target behavior(s) and the relevant environments in which the behaviors occur; that is, the assessor must determine (1) the operational definition of the target behavior(s), (2) the situations under which the target behaviors are likely and unlikely to occur, and (3) the potential environmental events that may affect the likelihood of a future response. In this chapter, we focus on indirect behavioral assessments, including interviews and rating scales.

Indirect Behavioral Assessment

Indirect functional assessment may be better understood by contrasting it with direct functional assessment. Direct functional assessment includes strategies in which an assessor conducts (1) naturalistic or contrived observation of an individual (e.g., descriptive analyses) (Lerman & Iwata, 1993; Mace & Lalli, 1991) or (2) experimental manipulations of environmental events (e.g., functional analysis; Carr & Durand, 1985; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). In both cases, the purpose is the same: identification of the environmental variables that are likely to occasion a behavior (i.e., antecedents) and factors that affect the future

likelihood of a response (i.e., consequences). Direct functional assessment techniques have many advantages. For example, descriptive analyses allow for direct observation of a client and the environment in which the client engages in the target response. Thus, the assessor may collect data on the frequency of a behavior, the environmental conditions that preceded the response, and the consequences immediately following the behavior. Experimental manipulation provides even more information about the conditions under which a response will occur because the assessor manipulates specific environmental antecedents (e.g., deprivation of attention, presentation of demands) and consequences (e.g., delivery of attention, removal of demands). Thus, results of experimental manipulation determine whether a functional relationship exists between a response and a particular consequence.

Such procedures include several disadvantages as well. Direct functional assessment methods are often costly, in that they require specialized staff training and other resources that may not be readily available. Direct methods may also be time-consuming, thus competing with ongoing educational or habilitative services. Although direct functional assessment methods may provide more detailed, accurate information regarding the function of behavior, these methods are often unavailable to assessors in naturalistic environments (e.g., special education classrooms).

Indirect functional assessment methods may attenuate some of the limitations of direct functional assessments. For example, indirect functional assessment usually includes (and may be limited to) conducting a structured interview, completing a rating scale, and/or having a parent, teacher, or other caregiver complete a rating scale. Thus, indirect functional assessment typically requires less training to conduct such procedures. In addition, indirect functional assessments can be less time-consuming than direct functional assessment. To illustrate, the time requirement for indirect functional assessments may range from a matter of minutes (to complete a single rating scale) to several hours (to compare the results of several scales and to conduct an interview). Direct functional assessment, on the other hand, may take several days, weeks, or even months.

Despite these potential benefits, indirect functional assessment may provide less, or perhaps even erroneous, information relative to direct behavioral assessment about the function of a behavior. For example, indirect functional assessment often does not include direct observation of a client or the targeted behaviors. Thus, the assessor is dependent on caregiver recollections of the frequency of a target behavior, the settings and conditions in which the target behaviors are likely or unlikely to occur, the consequences that typically follow the target behavior, and so forth. Results of indirect functional assessment may also be compromised in several ways. First, some indirect assessments methods have not been evaluated for psychometric soundness. In fact, results of some studies have shown that indirect measures may lack appropriate evaluations or acceptable levels of *reliability* (the stability of measurement over time or across stimulus parameters) and *validity* (the extent to which an assessment measures that which it was designed to measure). For example, the Motivation Assessment Scale (MAS; Durand & Crimmins, 1988) has been reported to have both high and low levels of reliability, depending on the manner in which reliability is calculated and the topography of behavior being assessed. Nevertheless, probably because of their ease of implementation, such structured interviews and rating scales are commonly used to assess operant functions of problem behavior. In the remainder of the chapter, we provide descriptions and analyses of several of the most common interview and rating scales for indirect behavioral assessment.

Interviews

Regardless of the level of assessment, the assessment process is likely to begin with a structured interview. In a structured interview, the assessor focuses on gathering as much information as possible about the prevalence and topography of target behavior, the environments in which the behavior is likely or unlikely to occur, specific events immediately prior to the response, and consequences that typically follow the behavior's occurrence. The interview format ensures that each interviewee (e.g., parent,

teacher, caregiver) is provided with identical questions in the same order. Structured interviews are delivered by an interviewer rather than being self-administered (e.g., in the case of a questionnaire).

Interviews may be a useful way to gather anecdotal information about a target behavior from people with whom the client most often interacts. For example, an interviewer may include questions designed to glean information about the topography of the target behavior (i.e., the operational definition), situations in which the client has been likely to engage in the behavior in the past (e.g., when left with nothing to do; when nonpreferred tasks are presented), and consequences that are most likely to occur either contingent on or contiguous with the problematic response (e.g., parental reprimand; escape from tasks). The interview format is also flexible because it provides the assessor with the opportunity to ask follow-up questions to clarify a response. For example, consider a situation in which a caregiver responds that a client engages in the problem behavior "all day." Simply asking more specific questions (e.g., "Can you think of a time in which Joey does not engage in aggression?") may provide an opportunity for the caregiver to define more clearly the environmental events that are likely to occasion a response.

The interview format has some disadvantages. The interview may present biases in both the questions and the answers. For example, the caregiver who does not fully understand a question may provide misleading or erroneous information. Furthermore, responding may be subject to biases in which the reporter provides the information he or she suspects the interviewer expects to hear rather than accurate information. Although the interview format may take many forms, we focus on structured interviews in this chapter.

Functional Analysis Interview

The Functional Analysis Interview (FAI) developed by O'Neill and colleagues (1997) is a structured interview that contains 11 sections designed to identify quickly potential functions for maladaptive behavior. The FAI generally takes about 45–90 minutes to complete, depending on the amount of information gathered. The interview guides the interviewer through the following content areas: (1) a description of the behavior, (2) settings events, (3) antecedents and consequences for the maladaptive behavior, (4) how efficient maladaptive behavior is, (5) alternative behavior and communicative ability, (6) identification of reinforcers, and (7) history of previous interventions. The information gathered by the interviewer is then used to determine the operational definitions of target behaviors, settings in which the behaviors occur, antecedent and consequent conditions that both occasion and maintain the behavior, and other information that aids in selecting a treatment to decrease the likelihood of the target behavior and increase the likelihood of functionally equivalent, socially acceptable alternative responses.

Description of Behavior

In this section of the FAI, the interviewer is prompted to ask about all challenging behavior that is a concern and to rank the topographies in order of importance. This section also involves the development of precise descriptions for all topographies of maladaptive behavior. These operational definitions allow the behavior to be identified easily by an objective observer watching the individual of concern. Thus, independent raters should be able to agree on both occurrences and nonoccurrences of the target behaviors, even when conditions may appear to be ambiguous.

Ecological/Setting Events

In this section of the FAI, the interviewer is prompted to ask questions about events that may affect behavior but do not necessarily occur immediately prior to its occurrence. For instance, the interviewer may ask questions about medications, physical problems, sleep patterns, staffing patterns, and the student's daily schedule. Previous research has shown that too little sleep or allergy symptoms (Kennedy & Meyer, 1996), recurrent otitis media (O'Reilly, 1997), or stimulant medication (Kelley, Fisher, Lomas, & Sanders, 2006) may affect the likelihood of occurrence of target behaviors. Thus, information regarding environmental events that may set the occasion for problem behavior

is considered when determining the function of problem behavior.

Antecedents

In this section of the FAI, the interviewer is prompted to ask questions about the environment immediately prior to the occurrence of challenging behavior. The purpose of these questions is to determine the triggers for challenging behavior. The literature on establishing operations (Michael, 1993, 2000) suggests that identifying environmental events or stimulus conditions that precede the occurrence of a behavior provides information about the client's motivation to engage in the response. Thus, the interviewer may glean not only information about the conditions under which the response is likely to occur but also information for treatment development.

Consequences

In this section of the FAI, the interviewer is prompted to ask questions about the environment immediately after to the occurrence of challenging behavior. The purpose of these questions is to determine what consequence the challenging behavior produces. Typical consequences for problem behavior include positive reinforcement in the form of access to tangibles or attention, negative reinforcement in the form of escape from demands, automatic reinforcement in the form of sensory feedback, and perhaps punishment contingencies in the form of reprimands or time-out (see Iwata et al., 1982/1994, for a description of the consequence contingencies during functional analysis).

Efficiency of the Behavior

This FAI section refers to how efficiently both maladaptive and adaptive behaviors obtain reinforcement. For instance, if maladaptive behavior results in reinforcement that requires less effort, in quicker or more consistent reinforcement compared to adaptive behavior, people may continue their maladaptive behavior. Voluminous research suggests that individuals engage in a response associated with less effort, a richer schedule, a shorter delay, and higher-quality reinforcement than a response associated with more effort, a thinner schedule, a longer delay, and lower-quality reinforcement (Fisher & Mazur, 1997; Horner & Day, 1991; Mace, Neef, Shade, & Mauro, 1996; Neef & Lutz, 2001; Neef, Mace, & Shade, 1993; Neef, Shade, & Miller, 1994).

Functional Alternative Behavior

This section of the FAI involves questions about how individuals obtain things that they want using appropriate behavior, such as asking or signing for breaks or for tangible items. Probably the most widely cited example of a method for providing reinforcement for a functional alternative behavior is functional communication training (FCT; Carr & Durand, 1985), which involves determining the function of a target behavior, then providing reinforcement for an alternative, socially appropriate response. Thus, the alternative behavior is designed to replace the target response as a means of recruiting reinforcement.

Primary Mode of Communication

This section of the FAI solicits information about the way the learner communicates with others. In other words, it is designed to determine whether the client uses verbal language, sign language, and/or picture exchange to communicate with others. Thus, the interviewer may select a mode of communication that is most likely to come under the control of treatment contingencies to produce the most efficient and successful outcome.

Things to Do/Things to Avoid

This section of the FAI involves questions about things that "work well" and "do not work well" with the learner. This includes questions about the pace of instruction or how animated the instructor is during instruction.

Reinforcers

This section of the FAI is designed to identify effective reinforcers for the learner (e.g., objects, items, or activities). Identification of stimuli that are likely to function as reinforcers in treatment is an important compo-

nent of the assessment process (e.g., Fisher et al., 1992; Pace, Ivancic, Edwards, Iwata, & Page, 1985; Roane, Vollmer, Rihgdahl, & Marcus, 1998). Caregivers may provide information about items or activities that are most likely to function as reinforcers during treatment.

History of Undesirable Behavior

This section of the FAI involves asking questions about how long challenging behavior has occurred given that this may affect how long it may take to intervene effectively. In addition, this section addresses the intervention history for the maladaptive behavior. The history of what has worked and not worked in the past may provide useful information regarding behavioral function (e.g., if a time-out procedure resulted in increased maladaptive behavior, it may indicate that the target response is escape-maintained).

Summary Statements

The information gleaned from the different sections of the FAI is used to develop summary statements that explain the maintaining factors for the behavior of concern. Summary statements have three components: the situation (setting events, immediate antecedents), the behavior, and the function of the behavior (outcomes produced).

Rating Scales

The purpose of gathering information with rating scales is identical to that of the structured interviews: to identify the likely antecedents and consequences that influence the occurrence of problem behavior, so that a function-based treatment may be implemented. Rating scales differ from structured interviews, in that structured interviews are usually open-ended; that is, the interviewer typically reads a question, and the interviewee provides a narrative answer. In contrast, rating scales usually include a choice of several fixed answers. The Likert scale is probably most well known and most commonly used method for scoring rating scales. For example, a rating scale question may read, "My child engages in problem behavior at levels far above that which would be normally accepted in a school." The answers may include a range of answers: 1—*strongly disagree*, 2—*somewhat disagree*, 3—*neither agree nor disagree*, 4—*somewhat agree*, and 5—*strongly agree*. The scorer of the rating scale may add the answers to all of the questions in an attempt to draw conclusions about the function of the target behavior.

Rating scales are useful because, in contrast to structured interviews, they provide quantifiable information (Hosp, Howell, & Hosp, 2003). Specifically, the answers provided by a caregiver can be assigned numerical values, and those values can be added and subsequently compared to predetermined criteria. Ultimately, the quantification of the information provided by the caregivers may be more useful that qualitative information for several reasons. One, the results of the rating scales may be more readily tested for reliability and validity. Reliability may be assessed across time, between raters, and within the scale. Validity may be assessed by comparing the results of the rating scale to scales that purport to assess the same construct (*concurrent validity*), or a different construct (*discordant validity*). Two, the results can be easily compared across time, raters, or settings to assess changes in the occurrence of the behaviors across those dimensions. Finally, ratings may be free of some of the biases that may compromise the results of structured interviews because the quantifiable responses may be less open to interpretation than qualitative responses.

Problem Behavior Questionnaire

The Problem Behavior Questionnaire (PBQ; Lewis, Scott, & Sugai, 1994) is a 15-question rating scale developed for a variety of topographies of challenging behavior. Each question corresponds to an aspect of behavioral function (peer/adult escape or peer/adult attention). Responses for each question are in a 6-point Likert-scale format (*Never, 10% of the time, 25% of the time, 50% of the time, 75% of the time, 90% of the time, Always*). The scores for each question are then totaled and categorized to determine the function of challenging behavior. One limitation of the PBQ is that reliability and validity data have not been collected. Thus, the pyschometric soundness of this instrument, like many others, has not been assessed, and results should

be interpreted within the context of a more extensive assessment.

Functional Analysis Screening Tool

The Functional Analysis Screening Tool (FAST; Iwata & DeLeon, 1996), a commonly used rating scale, provides preliminary information regarding the environmental and physical factors that influence maladaptive behavior. The FAST is a 16-question informant rating scale that divides maintaining variables into social and nonsocial factors. Social factors include items about social positive reinforcement contingencies (attention, preferred items) and social negative reinforcement contingencies (escape from demands, etc.). Questions about nonsocial (or automatic) factors include both positive automatic reinforcement (sensory stimulation) and negative automatic reinforcement (pain attenuation). Questions from the scale are in yes–no format (e.g., "Does the person usually engage in the problem behavior more often when (s)he is ill?"). The total number of "yes" responses in each category (social positive, social negative, automatic positive, automatic negative) are calculated to determine possible behavioral function. The function with the highest number of "*yes*" responses is considered to be the maintaining variable. Reliability and validity analyses have not been conducted for the FAST.

Motivation Assessment Scale

The MAS (Durand & Crimmins, 1988) is a 16-item questionnaire that purports to identify the function of problem behavior based on information about the conditions occasioning (i.e., antecedents) aberrant behavior; that is, caregivers rate items on a Likert-type scale related to one of three potential maintaining variables: automatic reinforcement (*sensory*), positive reinforcement (*attention* or *tangible*), or negative reinforcement (*escape*). Durand and Crimmins reported that the results of the reliability assessment indicated that the MAS produced acceptable *interrater* (agreement between raters) and *test–retest* (agreement on separate occasions) reliability. Furthermore, validity assessments, conducted by comparing MAS results with direct observation, indicated that the MAS predicted situations in which individuals were likely and unlikely to engage in problem behavior.

However, studies by other researchers have produced divergent results relative to the reliability and utility of the MAS (Bihm, Kienlen, Ness, & Poindexter, 1991; Iwata, Vollmer, & Zarcone, 1990; Paclawskyj, Matson, Rush, Smalls, & Vollmer, 2001; Sigafoos, Kerr, & Roberts, 1994; Singh et al., 1993). Initially, the MAS was reported to show high levels of reliability (e.g., Durand & Crimmins, 1988). However, other studies that evaluated more conservative measures of reliability found that MAS reliability may not be as robust as previously reported (Zarcone, Rodgers, Iwata, Rourke, & Dorsey, 1991). In this study, the authors applied the three correlational analyses suggested by Durand and Crimmins (1988; i.e., Pearson product correlation for each individual's MAS raw and mean scores, and the Spearman rank-order correlations for each pair of raters) and more conservative reliability calculation methods (i.e., exact agreement) to data gleaned from 39 participants. The purpose of this study was to compare results for reliability when using different methods. Zarcone and colleagues (1991) found that the reliability of the MAS did not reach acceptable levels when the exact-agreement method was applied to the data. In another study, Sigafoos and colleagues (1994) found lower reliability of the MAS when applied to aggression (Durand & Crimmins [1988] applied the MAS to self-injurious behavior). The authors suggested that the topography of the problem behavior being evaluated may produce differential outcomes when assessing reliability. Finally, Duker and Sigafoos (1998) evaluated the reliability, internal consistency, and construct validity of the MAS across three topographies of problem behavior and two methods of calculation. Results suggested that the MAS had low levels of reliability and "ambiguous" construct validity. Overall, results of these studies suggest that the reliability of the MAS may not be as high as previously reported, and the MAS should not replace direct observation or experimental manipulation in determining the function of problem behavior and prescribing treatment.

The results of these studies highlight the importance of using multiple assessment methods when attempting to determine the

function of a target behavior prior to implementing treatment; that is, the preceding studies all used similar methods to evaluate the reliability of the same instrument, yet each yielded disparate information. The results of these and other studies suggest that behavior analysts should not rely solely on rating scales such as the MAS for identifying the operant function of problem behavior.

Questions about Behavioral Function

Questions about Behavioral Function (QABF; Matson & Vollmer, 1995) is a behavioral checklist whose purpose is to determine environmental correlates and potential functions of problem behavior for individuals diagnosed with mental retardation. The QABF differs from both previous checklists/rating scales and standard experimental analysis techniques (e.g., Iwata et al., 1982/1994) in that a broader range of potential variables may be assessed, for example, the standard functional analysis tests for positive reinforcement in the form of attention, negative reinforcement in the form of escape (usually academic or life skills demands), and automatic reinforcement (however, for exceptions see studies by Carr, Yarbrough, & Langdon, 1997; Van Camp et al., 2002). The QABF was designed to determine potential functions (e.g., tangible reinforcement, physical discomfort, and social avoidance) that are relatively underinvestigated.

Several studies have been conducted to determine the reliability and validity of the measures in the QABF. Paclawskyj and colleagues (2001) provided psychometric data for test–retest, interrater, and internal consistency reliability. Results of this study suggested that assessments were relatively stable over time, that the subscales were homogeneous, and that multiple raters produced similar ratings. A study by Matson, Bamburg, Cherry, and Paclawskyj (1999) assessed the validity of the QABF for predicting treatment success across several topographies of problem behavior. First, participants' putative function for problem behavior was assessed by the QABF. Results showed that for 84% of participants, a clear function was identified (a *clear function* was defined as subscales with a minimum score of four of five possible endorsements on a subscale, with no other subscales containing significant endorsements; see Matson & Vollmer, 1995, for more detail). Next, the authors assessed the extent to which the results of the QABF prescribed effective treatment. Only those individuals whose QABF results suggested a clear function participated in this experiment. Results suggested that treatments based on the results of the QABF were more effective for reducing problem behavior than those not based on the results of the QABF. Finally, Applegate, Matson, and Cherry (1999) found that the QABF produced social functions for aggression and was likely to show a nonsocial function for all other behaviors (e.g., self-injurious behavior; stereotypy).

Although the QABF has been studied more extensively than most indirect FBAs, additional research is warranted to determine whether it may be used as a replacement for more resource-intensive procedures (e.g., functional analysis; Iwata et al., 1982/1994). Much of the data gathered thus far suggest that the QABF may be useful for determining behavioral function and prescribing treatment (Matson et al., 1999). However, additional research is necessary to determine the conditions under which the QABF may produce outcomes similar to those generated by functional analysis methodology. Specifically, research on the concurrent validity of the QABF and functional analysis methodology is necessary to draw conclusions about the efficacy of the QABF for determining behavioral functional and prescribing treatment.

Summary

A number of authors have argued against using interviews and rating scales as the sole method of functional assessment because these procedures are prone to yield inaccurate or incomplete information (Fisher, Piazza, Bowman, & Amari, 1996; Green & Striefel, 1988; Lennox & Miltenberger, 1989; Umbreit, 1996). Combining interviews with direct observation or systematic functional analysis may prove to be useful, however, and has been recommended by most authors who promote indirect methods (e.g., Durand, 1990; Umbreit, 1996).

Ultimately, best practice is likely to include an assessment package that contains a structured interview, at least one rating scale, direct observation, and experimental manipulation of environmental variables. A combination of these assessment methods is likely to produce the most accurate information about the topography of behavior, the conditions under which the behavior is likely and unlikely to occur, the consequences that typically follow the response, and the environmental manipulations that will produce a desirable outcome.

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CHAPTER 12

Direct Observation

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This chapter focuses on methods of assessment involving the direct observation of behavior. These methods typically are referred to as descriptive methods, in that the assessments *describe* a series of naturally occurring events but do not demonstrate a functional relation between any of those events (i.e., there is no experimental manipulation). Like indirect assessment, the goal of the descriptive analysis[1] is to identify naturally occurring behavior–environment relations (McComas, Vollmer, & Kennedy, 2009). Unlike indirect methods, descriptive analysis involves the measurement of behavior and various environmental events through repeated direct observation.

Descriptive analysis methods have been used widely in the behavioral sciences for decades. In fact, direct observation of naturally occurring behavior is considered one of the defining features of ethology, a field that grew out of the biological tradition (Hinde, 1982; Tinbergen, 1951). This approach was introduced more recently to the young field of applied behavior analysis through a seminal paper by Bijou, Peterson, and Ault (1968), which highlighted the importance of descriptive studies of behavior, described an ideal interrelation between descriptive and experimental studies, and recommended specific descriptive analysis procedures to improve the objectivity and ease of interpretation of descriptive data (Mendres & Frank-Crawford, 2009).

Bijou and colleagues (1968) presented a case study of a young boy in a nursery school setting to illustrate and integrate the key components of a descriptive analysis. They described the classroom, the routine, the number of children and adults present, and precise operational definitions of child and adult behavior. Observations were conducted during 3-hour blocks across 28 days during one of several classroom activities (e.g., art, snack). An assessment of observer reliability was conducted, and data were presented graphically to depict levels of various forms of child and teacher behavior. In short, the researchers developed a model for descriptive analyses and also provided a case illustration of the method in application.

Bijou and colleagues (1968) noted that experimental studies are essential to an understanding of behavior, in that experimental

[1]The term *analysis* is sometimes reserved only for studies involving experimental manipulation. However, in the broader sense of the term, descriptive studies may be considered analyses in that they involve the examination of relations between events.

manipulation uncovers functional relations between behavior and environment. However, as Baer (1973) pointed out, an experimental demonstration that a given variable produces a particular behavior change demonstrates only that the relation is possible. It does not follow that those same circumstances influence behavior under naturally occurring conditions. For example, one might demonstrate language acquisition experimentally through the use of a shaping procedure. These results would indicate only that language *can be* shaped, but they do not provide direct evidence that language *is* shaped through, for example, typical parent–child interactions. The addition of descriptive data showing that parents provide some potentially reinforcing event following successive approximations to language would support the contention that shaping is responsible for language acquisition outside the laboratory. Thus, as Bijou and colleagues and Baer point out, descriptive analysis is a vital tool in understanding naturally occurring behavior–environment relations.

Choosing an Appropriate Set of Procedures

Researchers and clinicians may consider several factors in the selection process when considering the range of available options for data collection and analysis. Perhaps the most obvious factor to consider is the overall purpose of the descriptive analysis; that is, what is the clinician or researcher attempting to accomplish by conducting the analysis? Although descriptive analyses are conducted most commonly as a means of developing hypotheses regarding behavioral function, there may be other informative purposes as well. Briefly, such purposes may include (1) identifying common contingencies in naturalistic settings (e.g., Borrero, Woods, Borrero, Masler, & Lesser, 2010; McComas, Moore, et al., 2009; McKerchar & Thompson, 2004; Thompson & Iwata, 2001), (2) establishing a baseline by which to assess the efficacy of subsequent treatment evaluations (e.g., Rapp, Vollmer, St. Peter, Dozier, & Cotnoir, 2004), (3) studying basic behavioral processes (e.g., reinforcement, punishment, extinction) under naturally occurring circumstances (Addison & Lerman, 2009; Borrero, Vollmer, Borrero, & Bourret, 2005; Sloman et al., 2005), and (4) studying quantitative models of behavior such as the matching law (e.g., Borrero & Vollmer, 2002; Oliver, Hall, & Nixon, 1999) and behavioral momentum (e.g., Strand, Wahler, & Herring, 2000). Even though the focus of this chapter is on applications of descriptive analysis procedures to develop hypotheses regarding behavioral function, it is important to recognize that descriptive analysis is a highly flexible and widely used means of studying naturally occurring behavior, and it can be adapted easily for a variety of purposes.

A second consideration in the selection of descriptive analysis methods involves available resources. The most sophisticated methods of gathering and analyzing descriptive analysis data involve (1) direct observation by trained observers who are free from other responsibilities (e.g., patient care) during the observation period; (2) computers to collect, organize, and analyze data; and (3) the availability of a trained professional to interpret and use results to make treatment decisions. When such resources are not available, use of these procedures is a moot point, and such procedures likely will be withdrawn from consideration. In these cases, the only reasonable option may be to implement descriptive analysis procedures that are relatively easy and inexpensive to carryout.

Developing Hypotheses Regarding Behavioral Function

In practice, descriptive analysis often is used alone or in combination with indirect assessments to develop hypotheses regarding the function of behavior. In these cases, treatment is prescribed based on the results of the descriptive analysis, and no experimental analysis is conducted to verify that a functional relation exists between the events. Kern, Hilt, and Gresham (2004) reviewed literature involving the functional assessment of problem behavior in school settings with children with or at risk for emotional and behavioral disorders, and found that 16 of 20 studies reported using direct observation alone or in combination with indirect assessment to identify variables maintaining problem behavior.

VanDerHeyden, Witt, and Gatti (2001) used this strategy in an attempt to identify variables contributing to disruptive behavior displayed by preschool children during a large group activity (i.e., circle time). Observers recorded child compliance and disruptive behavior, as well as a number of potentially influential antecedents (e.g., removal of a tangible item, presentation of a demand) and consequences[2] (e.g., attention, escape). Attention was the most common event following problem behavior, and there was a higher probability of attention following disruptive behavior as compared with compliance. The experimenters then compared an intervention predicted to be effective based on the results of the descriptive analysis and an intervention that was contraindicated based on these data, and found that only the former was effective.

As noted, descriptive analyses are used widely to prescribe treatment. However, a limitation of this approach is that descriptive analyses may identify events correlated with, but not functionally related to, the target behavior (e.g., Camp, Iwata, Hammond, & Bloom, 2009; Hall, 2005; Mace & Lalli, 1991; Pence, Roscoe, Bourret, & Ahearn, 2009; Piazza et al., 2003; Thompson & Iwata, 2007) or may fail to identify sources of reinforcement that are delivered only intermittently or under circumscribed conditions not sampled during the descriptive analysis (Lerman & Iwata, 1993). When this occurs, the prescribed treatment may include irrelevant components and/or may lack essential features. This lack of correspondence between descriptive and experimental analyses raises some considerable concern about the practice of prescribing interventions based solely on the results of descriptive analyses.

It should be noted that correspondence between descriptive and experimental outcomes appears to improve when descriptive analysis conditions are structured to approximate experimental procedures more closely (e.g., Anderson & Long, 2002; Freeman, Anderson, & Scotti, 2000). However, some naturalistic features of the descriptive analysis are compromised by structuring interactions during the descriptive analysis. In fact, the systematic manipulation of antecedent conditions transforms a descriptive analysis into an experimental analysis (e.g., Carr & Durand, 1985). Thus, as with experimental analyses, structured descriptive analyses may to some extent sacrifice ecological validity in order to produce clearer outcomes; that is, when antecedent events are programmed specifically during "descriptive analysis," it is unclear whether these events represent *naturally occurring* phenomena.

Although in many cases prescribed interventions are based on some combination of indirect and descriptive analyses, many practitioners also conduct experimental analyses. In fact, surveys of those responsible for developing behavior programs for individuals with developmental disabilities have reported that over half of respondents use some form of experimental analysis with their clients (Desrochers, Hile, & Williams-Moseley, 1997; Ellingson, Miltenberger, & Long, 1999). These respondents also indicated that they used other methods of assessment, including both indirect and descriptive methods. Thus, it seems common for practitioners to combine descriptive and experimental assessment methods. This approach is consistent with the recommendations by Mace, Lalli, and Lalli (1991), who suggested conducting a descriptive analysis to uncover potentially influential, naturally occurring relations prior to experimental analysis, and structuring the experimental analysis to test only naturally occurring behavior–environment relations.

This approach is illustrated in a study by Arndorfer, Miltenberger, Woster, Rortvedt, and Gaffaney (1994), who developed hypotheses regarding the function of problem behavior based on results from indirect and descriptive analyses and then constructed an experimental analysis to test these hypotheses. Results of the experimental analyses did, in fact, confirm these hypotheses. The authors concluded that a descriptive analysis and interview may be sufficient for identifying functions of problem behavior. However, one limitation of this study is that the experimental analysis tested only the variable

[2]The term *consequence* is used for ease of communication to describe events that occur subsequent and in close temporal relation to behavior of interest. It should be noted that descriptive analysis does not allow for the determination of functional relations; thus, it may be more appropriate to refer to these events as *subsequent*.

that was hypothesized to maintain problem behavior. Thus, it was impossible for the experimental analysis to identify a behavioral function other than the one hypothesized to maintain behavior. One potential limitation of this approach is that maintaining variables may be overlooked because they are not apparent during descriptive analyses and, thus, are not included in an experimental analysis.

An additional limitation of this approach is that it can be quite time consuming to conduct thorough descriptive and experimental analyses; thus, treatment may be delayed substantially. As an alternative, Iwata (1994) has recommended exposing behavior to conditions that test for sources of reinforcement (i.e., attention, escape, automatic reinforcement) shown to maintain problem behavior in a large proportion of cases (Derby et al., 1992; Iwata et al., 1994; Kurtz et al., 2003) and modifying experimental conditions based on descriptive data (or other sources of information) only if the initial analysis is inconclusive. It should be noted that the approach recommended by Iwata does *not* involve exposing all individuals (or behavior) to the same, "standard" functional analysis. Rather, programming of minor adjustments to experimental analysis conditions (e.g., the presentation of noise in the escape condition; Iwata et al., 1994) is based on formal (e.g., caregiver interview) and informal (e.g., casual observation) information gathering that typically occurs when clinical contact is initiated. One might then conduct more extensive or detailed descriptive analyses to identify potential sources of behavioral control if the initial experimental analysis is inconclusive.

This general approach is described in a number of studies in which inconclusive experimental analyses were followed by some form of descriptive analysis that informed the development of a subsequent experimental analysis (e.g., Bowman, Fisher, Thompson, & Piazza, 1997; Fisher, Adelinis, Thompson, Worsdell, & Zarcone, 1998; Fisher, Kuhn, & Thompson, 1998; Richman & Hagopian, 1999). These studies hint at the utility of using descriptive analysis information clinically to modify experimental analyses; however, these studies often contain insufficient detail for others to replicate the process, and their design does not permit a demonstration that the descriptive analysis was *necessary* to produce a conclusive experimental analysis (for a notable exception, see Tiger, Hanley, & Bessette, 2006). Typically, these studies have reported (1) an inconclusive functional analysis, (2) the results of some form of descriptive analysis, and (3) a conclusive functional analysis whose modification was based on the results of the descriptive analysis. This essentially A-B design does not rule out alternative explanations for the conclusive experimental analysis results (e.g., additional exposure to experimental conditions). Therefore, additional research is needed to evaluate this approach.

It is important to consider that most contemporary descriptive analyses borrow heavily from the functional analytic method of behavioral assessment described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) when considering the relation between descriptive and experimental analyses aimed at identifying variables maintaining behavior. For example, Sasso and colleagues (1992) compared the results of an experimental analysis and those of a descriptive analysis that sampled activities "that would most resemble experimental analogues." Antecedent variables explicitly manipulated via functional analysis are measured frequently during descriptive analysis. For example, periods of low attention, instructional demands, and, more recently, restricted access to preferred tangibles represent starting points for gathering information on potentially evocative environmental events. Similarly, consequences manipulated via functional analysis also are measured frequently (e.g., attention, escape from instructional demands, provision of preferred tangibles). Thus, while the basic tenets of descriptive analysis research described by Bijou and colleagues (1968) remain guideposts in practice, current descriptive research has benefited significantly from the experimental procedures described by Iwata and colleagues.

Some researchers (e.g., Carr, 1994) have suggested that descriptive analysis is useful in identifying idiosyncratic maintaining variables that would not typically be tested using the Iwata and colleagues (1982/1994)

experimental analysis procedures. However, descriptive analyses designed to capture only those events typically presented in functional analyses do not detect idiosyncratic environmental events. Thus, in some cases, descriptive analyses should be expanded to include a wider range of events and more detail regarding the quality of those events in order to identify idiosyncratic influences on problem behavior (e.g., Richman & Hagopian, 1999). Measurement of such features, however, may be unnecessary when experimental analysis conditions designed to identify broad contingencies are sufficient for suggesting behavioral function and, therefore, a function-based intervention.

Variations in Measurement during Direct Observation

Generally, direct observation may involve *continuous recording*, or periodic sampling of behavior and other environmental events. Continuous methods involve collecting data on each instance of the target response, and, in some cases, environmental events occurring in close temporal proximity to the target response throughout the entire observation period. For example, Moss and colleagues (2005) collected data on the self-injurious behavior (SIB) of eight participants diagnosed with Cornelia de Lange syndrome, as well as potential evocative events contiguous with SIB, using continuous recording. *Sampling* methods involve collecting data at the end of prespecified intervals. Harding and colleagues (1999) used a time-sampling procedure to assess child behavior at the end of each 10-second interval, while allocating the remainder of the interval recording teacher behavior. One must consider the effort associated with each method, as well as the amount and quality of the resultant data, in determining which of the two methods (continuous recording or sampling) to select. Continuous methods of data collection are not only more labor intensive but also they provide the richest sample of behavioral data. Sampling procedures, on the other hand, require somewhat less effort (this, of course, depends on how frequently observations are conducted) but provide data that are less comprehensive than those gathered using continuous methods of data collection.

Continuous observation may be accomplished by way of *event recording* (i.e., the number of times a response occurs) or by recording the occurrence (or nonoccurrence) of behavior in relatively small intervals (e.g., 10–20 seconds). A study by Anderson and Long (2002) illustrates the use of both methods. Problem behavior was recorded each time it occurred (i.e., event recording), while potentially evocative environmental events (e.g., periods of low attention) were scored as either occurring or not occurring during 5-second intervals.

Partial-interval and whole-interval recording are options in recording the occurrence or nonoccurrence of events. *Partial-interval recording* involves scoring an event if it occurs during any portion of a prespecified interval; thus, partial-interval recording procedures may overestimate the occurrence of events (Gardenier, MacDonald, & Green, 2004). By contrast, *whole-interval recording* involves scoring an event if it occurs for the duration of the prespecified interval; thus, whole-interval recording procedures may underestimate the occurrence of events (e.g., Cooper, Heron, & Heward, 2007). Selection of the appropriate measurement procedure depend in part on whether the response is high or low frequency, and whether the response is targeted for increase or decrease.

Below, we describe a series of commonly implemented data collection and data analysis methods, progressing from methods that examine behavior–environment relations with relatively low resolution to those providing relatively greater resolution. Each method of data collection described in the following sections involves either continuous observation or periodic samples of behavior. In this section, we highlight methods of summarizing data and make specific recommendations regarding appropriate applications of each method.

The Scatterplot

The *scatterplot* is a form of descriptive analysis used to identify temporal patterns of a target behavior under naturally occurring conditions. Typically, this form of assessment involves continuous observation of

behavior, and recording only the target behavior and the time period during which the behavior occurred. Thus, the measurement involved in this form of assessment differs from other forms of descriptive analysis (described below) in that environmental events surrounding the target behavior are not recorded. The most distinctive feature of scatterplot assessment is the manner of data depiction. In most cases, a code indicating the frequency of the target behavior is recorded on a grid in which each cell indicates a time interval (e.g., a 30-minute interval) on a particular day (with days listed in columns). For example, an empty cell may indicate that the target behavior did not occur during the interval, a cell with a slash may indicate a low frequency of the target behavior, and a darkened cell may indicate a high frequency (Touchette, MacDonald, & Langer, 1985).

Data then are analyzed through visual inspection of the grid to identify periods of time associated with zero, low, and high frequencies of problem behavior. If a temporal pattern of behavior is identified, this information might then be used to modify features of the environment (e.g., staffing patterns, activities) that are correlated with the problematic time periods. Additional assessment may be required to isolate the environmental conditions associated with problem behavior further, if multiple variables are associated with the problematic time periods. For example, Arndorfer and colleagues (1994) used a parent-completed scatterplot to identify periods during which problem behavior was likely. Observers then recorded antecedents and consequences associated with problem behavior during periods identified through the scatterplot.

Touchette and colleagues (1985) illustrated the use of the scatterplot, presenting data on the temporal patterns of problem behavior displayed by three participants. The scatterplot showed that problem behavior was correlated reliably with particular periods of time for two of these participants, and this information led to environmental modifications aimed at reducing problem behavior. Scatterplot data were uninterpretable for the third participant; problem behavior was not correlated reliably with any particular period of time. Results of a study by Kahng and colleagues (1998) suggest that the third case may be more representative. These researchers examined scatterplots depicting the frequency of problem behavior displayed by 15 participants and found that none of the datasets showed a predictable temporal pattern upon visual inspection. However, when the same data were evaluated using statistical control charts (e.g., Pfadt & Wheeler, 1995), temporal patterns of behavior were identified for 12 participants, suggesting that the main limitation of the scatterplot may be related to data depiction and analysis rather than measurement. Nevertheless, the practical utility of the scatterplot is severely limited if the construction of statistic control charts is necessary for interpreting scatterplot data.

Scatterplot assessment is described infrequently in the published literature, although practitioners report the frequent use of this form of descriptive analysis (Desrochers et al., 1997; Ellingson et al., 1999), and existing data suggest that this method may be limited for the purpose of assessing correlates of problem behavior such as aggression or SIB (Kahng et al., 1998). In addition, results do not readily identify manipulable features of the environment that can be altered during intervention because the assessment provides information only about temporal patterns of the target behavior.

Despite these limitations, the scatterplot technique may be adopted widely due to the ease of implementation of this strategy. In addition, scatterplot data provide gross approximations of response frequency (i.e., instances of behavior) and response rate (i.e., instances of behavior per unit of time) that may provide a useful description of the target behavior (i.e., a baseline) even when a reliable temporal pattern of behavior is not identified. It may be valuable to explore further the use of this method given these potential advantages of the scatterplot. For example, the scatterplot may be more useful when applied to responses that are likely to be organized temporally. Ashbaugh and Peck (1998) used a scatterplot to evaluate parent-collected data on disturbed sleep exhibited by a typically developing 2-year-old girl. Data gathered 24 hours per day revealed many intervals of sleep during scheduled awake hours and many intervals awake during scheduled sleep hours. This pattern was modified subsequently with a combination of bedtime fading and response cost. In a more recent study, Maas, Didden, Bouts,

Smits, and Curfs (2009) used scatterplot data to assess signs of sleepiness and disruptive behavior for individuals diagnosed with Prader–Willi syndrome. Conceivably, similar methods of data collection could be applied to assess temporal patterns of enuresis and feeding among dependent populations (e.g., older adults, infants in child care settings). Results may be useful, for example, in designing interventions (e.g., appropriate timing of scheduled toilet visits) and developing staffing patterns (e.g., allocating more staff to feeding duties at particular times).

A-B-C Recording

Unlike the recording associated with the scatterplot, most descriptive analyses involve the recording of a number of environmental events (antecedents and consequences) surrounding the behavior of interest. This type of analysis is sometimes referred to as antecedent–behavior–consequence (A-B-C) recording because it is designed to capture the familiar three-term contingency (Skinner, 1953). The recorded events are typically those that are contiguous with the target behavior (e.g., Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001), but some attempts have been made to record more temporally distant events that may occasion or evoke the target behavior (e.g., Carr, Smith, Giacin, Whelan, & Pancari, 2003). This general method may involve either continuous observation and recording of events or recording of antecedent and consequent events only when the target behavior occurs. This section describes several specific sets of A-B-C recording and analysis procedures.

Narrative Recording

Narrative recording, a form of A-B-C recording, involves a written account of observed events (Thompson, Symons, & Felce, 2000). The procedure is relatively easy to implement and requires little in the way of equipment and training (observers need little more than a notepad and pen). In fact, 50% of practitioners report using this form of assessment with the majority of their cases (Ellingson et al., 1999). Historically, narrative recording procedures have involved a running description of events in the absence of any specific guidelines (e.g., event categories, operational definitions) for recording (Bijou, Peterson, Harris, Allen, & Johnston, 1969); however, some more recent examples of narrative recording impose more structure on observations. For example, the Detailed Behavior Report (DBR) described by Groden (1989), and more recently by Groden and Lantz (2001), prompts observers to provide a narrative description of events in specific antecedent (e.g., activity, social/interpersonal) and consequence (e.g., implementation of a behavior management program) categories.

A potential advantage of narrative recording over other descriptive analysis methods is the level of detail and amount of qualitative information that can be captured. Considering these strengths, narrative recording procedures may be useful in the development of operational definitions for problem behavior and potential replacement behavior (Borrero, Vollmer, & Borrero, 2004; Repp & Karsh, 1994; Wahler, Winkel, Peterson, & Morrison, 1965) and may assist with scheduling more structured observations by familiarizing the observer with scheduled activities and transition periods (Bijou et al., 1969). In addition, narrative recording procedures may augment behavioral assessment when more rigorous experimental evaluations of operant function are inconclusive. For example, narrative recording may be useful in determining qualitative features of naturally occurring antecedent (e.g., instruction delivery; Borrero et al., 2004) and consequent events (e.g., quality of attention; Richman & Hagopian, 1999) incorporated into experimental analyses or considered during treatment development.

As noted previously, it is unlikely that a descriptive analysis will detect unique features of the behavior or environment when the measurement system is developed a priori based on common behavior–environment relations. The flexible nature of narrative recording makes this method more appropriate than more structured recording methods for these applications. Similarly, narrative recording procedures may be quite useful for the evaluation and description of generative or novel behavior (e.g., verbal behavior; Hamo, Blum-Kulka, & Hacohen, 2004; Hart & Risley, 1995) that would be difficult to specify or define prior to observations.

However, as Bijou and colleagues (1968) point out, these potential strengths simulta-

neously present a number of barriers to the analysis of narrative data that severely limit the utility of this method. For example, narrative recording may involve a great deal of observer inference, such as when the DBR prompts observers to describe covert antecedents and affective states (Groden, 1989). This reliance on observer inference is likely to limit both interobserver agreement and one's ability to identify potentially influential and manipulable features of the environment. In addition, data obtained by way of narrative recording may lack many quantifiable features of behavior and environment, making it difficult to transform the data into behavioral units (e.g., individual responses, specific antecedents) for analysis. In some respects, the basic components of descriptive analysis described by Bijou and colleagues were a response to then-common methods of narrative recording that were lacking in quantifiable dimensions (e.g., Barker & Wright, 1955).

A-B-C Checklist

The objectivity associated with descriptive analysis is improved greatly when events to be recorded are identified and operationally defined prior to direct observation, as with an A-B-C checklist. Observers record the occurrence of problem behavior and indicate (with a check mark) which of several antecedents and consequences are associated with behavior with this form of measurement (Miltenberger, 2004). Here the term *checklist* refers only to the fact that observers choose from a menu of options when recording antecedents and consequences. This approach should not be confused with indirect forms of assessment (see Kelley, LaRue, Roane, & Gadaire, Chapter 11, this volume) that involve caregivers responding to questionnaires presented in checklist format.

Arndorfer and colleagues (1994) used this strategy to structure home observations of five children who displayed problem behavior. In this study, generated antecedent categories were based on information gathered during parent interviews, and consequence categories were structured based on the common functions of problem behavior (Iwata et al., 1982/1994). During the descriptive analyses, observers checked off the appropriate antecedent and consequence categories when problem behavior occurred. These researchers achieved a high level of interobserver agreement and were able to relate the results of the descriptive analysis to manipulable features of the environment by structuring measurement during direct observations.

Although there are few examples of this form of direct observation in the literature, 25% of practitioners report using this method with the majority of their cases (Ellingson et al., 1999). This method may be adopted readily because it can be implemented with relatively little training by individuals directly responsible for the client (e.g., teachers, direct care staff), and it has the potential to provide more objective information about manipulable features of the environment compared to the scatterplot or narrative recording methods. Thus, this method may be useful in gathering preliminary data on variables surrounding the target behavior and may be desirable when a trained observer is unavailable.

The A-B-C checklist remains limited in that it provides little information about quantifiable dimensions of behavior and relevant environmental events, although this analysis represents an improvement over narrative recording with respect to objectivity. Typically, A-B-C checklist data simply indicate that a target behavior occurred (with unknown frequency and duration), and that some events preceded and followed the behavior (without reference to the time interval between these events and behavior).

Frequency, Interval, and Time-Sample Recording

When the goal is to obtain more detailed information about quantifiable dimensions of naturally occurring events, it is most appropriate to record the frequency, duration, or occurrence of behavior and environmental events during continuous observation (e.g., Piazza et al., 2003; Vollmer et al., 2001) or time samples (Harding et al., 1999). This method of A-B-C recording is advantageous in that it allows for both objective measurement and the analysis of relations between events of quantified dimensions (Pence et al., 2009). As a result, this approach to descriptive analysis facilitates integration of descriptive and experimental methods and results (Bijou et al., 1968). Therefore, this method of descriptive analysis is used com-

monly in research involving the integration or comparison of assessment methods (e.g., Anderson & Long, 2002; Galiatsatos & Graff, 2003; Tang, Kennedy, Koppekin, & Caruso, 2002).

This approach may be more difficult to carry out compared to alternative descriptive analysis methods when resources are limited. The measurement of the frequency, duration, or occurrence of a target behavior and the surrounding environmental events can involve a rather elaborate coding system that requires specific training to develop and implement. In addition, trained observers who are free from other duties may be necessary to implement this more detailed form of descriptive analysis.

Although manual (i.e., paper-and-pencil) methods of data collection are appropriate for this type of analysis, measurement and data analysis may, in some cases, be facilitated by computerized data collection (for a list of programs and features, see Kahng & Iwata, 1998, 2000). For example, computerized systems may be more appropriate when multiple response measures negatively impact one's ability to obtain sufficient levels of interobserver agreement, when second-by-second changes in behavior or environmental context are essential to the purpose of the analysis, or when complex methods of data analysis are desirable. Disadvantages of computerized data collection systems may include cost (although inexpensive resources are available) and those problems associated with all computer systems (e.g., unexpected "crashes").

Methods of Data Analysis: Probability Analyses

Typical methods of data analysis provide gross descriptions of behavior and related environmental events for many of the descriptive analysis procedures described earlier. However, a number of more complex methods of data analysis provide more fine-grained descriptions. In the following section we focus on two methods that have been studied extensively both within and outside of applied behavior analysis: comparative probability analyses and lag sequential analysis. Both types of analyses *can be* conducted using hand data collection procedures; however, these analyses may be facilitated by computerized data collection and analysis programs.

Static Probability Analyses

Many researchers have analyzed descriptive analysis data by calculating conditional probabilities to determine whether relations exist between behavior and environmental events. *Conditional probabilities* evaluate the likelihood of one event (e.g., attention) *given that* another event occurred (e.g., aggression). Frequently, evaluations of conditional probabilities involve analyses of the target response (e.g., aggression) and a potential reinforcer (e.g., attention). In many cases, the conditional probabilities of various events (e.g., attention, escape, material presentation) are calculated and compared to determine the event(s) with the highest conditional probability given the target behavior. This event(s) then is considered the likely maintaining variable (e.g., Anderson & Long, 2002; Noell, VanDerHeyden, Gatti, & Whitmarsh, 2001).

One limitation of this approach is that the analysis may identify variables that occur with a high frequency following the target behavior, only because the events are presented with a high frequency, independent of responding. For example, it is likely that any observed target behavior will be followed by teacher attention, if teacher attention is available (independent of behavior) nearly continuously during an observation. In this case, the conditional probability of attention would be very high, although the target behavior does not actually increase the probability of attention. Vollmer and colleagues (2001) recommend comparing conditional probabilities to unconditional (or background) probabilities of the same event to determine whether the probability of an event (e.g., attention) actually changes as a result of the target behavior (i.e., to detect a possible contingency) to address this weakness (also see Herscovitch, Roscoe, Libby, Bourret, & Ahearn, 2009).

Dynamic Probability Analyses

Closely related to the concept of comparative probability analyses is the method of lag sequential analysis (Bakeman & Gottman, 1997). Typically, evaluations of comparative

probabilities produce one conditional probability value and one unconditional probability value. For example, observers may record data for 4 hours and report the probability of attention and the probability of attention given an instance of the target response for the entire 4-hour observation. This information provides a rather static depiction of what is likely a very dynamic exchange, even though it has certainly proven useful in evaluations of behavior–environment relations. Lag sequential analysis, on the other hand, can provide a more refined description of exchanges in the natural environment by depicting comparative probabilities both before and after an instance of the target response on a second-by-second basis.

The term *lag* illustrates that behavior–environment relations may be evaluated several seconds before or after the response occurs. For example, a lag +1 would indicate that the probability of a particular environmental event is calculated 1 second after the occurrence of the target response. A lag –1 would indicate that the probability of a particular environmental event is calculated 1 unit (e.g., 1 second) prior to the occurrence of the target response. Emerson, Thompson, Reeves, Henderson, and Robertson (1995) demonstrated the use of lag sequential analysis by evaluating both the probability of various environmental events given the occurrence of the problem behavior (i.e., the conditional probability) with the probability of the given environmental event without reference to the target response (i.e., the unconditional probability). Results for one participant showed that changes in the probability of instructional demands increased the probability of problem behavior and events that occurred before instances of problem behavior on a second-by-second basis.

Vollmer and colleagues (2001) also conducted comparative probability analyses and used a variation of the lag sequential analysis procedure described by Emerson and colleagues (1995). The researchers conducted a descriptive analysis of interactions between individuals referred for the assessment and treatment of severe problem behavior and their primary caregivers. Next, the researchers compared the probability of an environmental event to the probability of an environmental event given problem behavior in the context of various potential establishing operations (e.g., low attention). Probabilities were evaluated with lags of +5, +10, +15, and +20, using a variant of the lag sequential analysis procedures; that is, the investigators calculated the probability of an event within 5, 10, 15 and 20 seconds of a particular point in time (for the unconditional probability) or an instance of the target response (for the conditional probability). Even though the procedure does not provide the same level of analysis as the method described by Emerson et al., the method does provide four intervals for which probabilistic changes can be evaluated, and the method was reported to be useful in identifying *potential* contingencies between environmental events and target responses.

It is critically important to emphasize relative probabilities, while placing less emphasis on absolute probabilities with regard to both static and dynamic probability analyses. For example, one may conclude that a positive contingency between aggression and attention is unlikely if data show that the probability of attention given problem behavior is .2. However, if further data analysis reveals that the probability of attention is .1, then problem behavior, in this example, actually increases the probability of attention.

The data analysis techniques just described have been used primarily in evaluating descriptive analysis data for research (e.g., Anderson & Long, 2002; Borrero & Borrero, 2008; Doggett, Edwards, Moore, Tingstrom, & Wilczynski, 2001; Forman, Hall, & Oliver, 2002; Marion, Touchette, & Sandman, 2003; Moss et al., 2005; Noell et al., 2001; Woods, Borrero, Laud, & Borrero, 2010), perhaps because the complexity of the analyses may preclude the use of these methods by most practitioners. In addition, it is important to recognize that although these methods provide a more fine-grained analysis of naturally occurring behavior–environment relations than other descriptive analysis methods, the analysis is limited similarly in that results suggest correlations between two events (e.g., attention and aggression) but do not identify functional relations (e.g., St. Peter, Vollmer, Bourret, Borrero, Sloman, & Rapp, 2005).

Recommendations

The measurement and analysis of naturally occurring behavior–environment relations is necessary for a complete understanding of behavior. However, there is disagreement regarding the role of descriptive analysis in behavioral assessment and various strategies for quantifying those relations (e.g., Martens, DiGennaro, Reed, Szczech, & Rosenthal, 2008). It has been suggested that descriptive analysis is a critical feature of any behavioral assessment (e.g., Lalli & Goh, 1993). In fact, some researchers recommend descriptive methods to the exclusion of experimental analyses when such methods produce conclusive outcomes (Conroy, Fox, Crain, Jenkins, & Belcher, 1996). Yet results of several studies showing poor correspondence between descriptive and experimental analysis outcomes raise significant concerns regarding the value of the information gained through descriptive analyses (Hall, 2005; Lerman & Iwata, 1993; Mace & Lalli, 1991; Pence et al., 2009; Piazza et al., 2003; Thompson & Iwata, 2007).

There are inherent limitations to the information that can be gained through descriptive analyses because this method is limited to correlational (and not functional) descriptions of naturally occurring behavior–environment relations. Thus, the most complete understanding of these relations may be gained by combining descriptive and experimental methods. When this occurs, descriptive analysis data provide information regarding the environmental events that are related to behavior under naturally occurring conditions, and the experimental analysis identifies those events that are related functionally to the behavior of interest. Following the recommendations of Mace and colleagues (1991), one might develop functional analysis conditions based on the results of an initial descriptive analysis. Alternatively, as Iwata (1994) recommended, one might modify functional analysis conditions based on the results of a descriptive analysis only when an initial functional analysis is inconclusive.

The evaluation of matched and mismatched treatments (e.g., Repp, Felce, & Barton, 1988; VanDerHeyden et al., 2001) may help to identify the strengths and weaknesses of the method and suggest ways in which it may be improved when descriptive analyses are conducted in lieu of experimental analyses or in concert with indirect assessment methods. For example, a treatment designed to treat problem behavior reinforced by attention might be compared to one designed to treat problem behavior reinforced by escape if descriptive analysis suggests that attention frequently follows problem behavior (whereas other common consequences do not).

This chapter has described a number of descriptive analysis methods that vary with respect to the level of detail provided by the resultant data, and the level of expertise and amount of resources necessary to conduct the analysis. Of these methods, the scatterplot, narrative recording, and A-B-C checklist generally can be implemented with very little training by those directly responsible for the participant. Although there is little empirical evidence that these methods are valuable in the development of behavioral interventions or subsequent behavioral assessments, it seems reasonable to conduct one or more of these analyses during initial phases of information gathering and hypothesis development because these forms of assessment can be implemented with relatively low cost. In addition, the open-ended nature of narrative recording isolates this as the most appropriate method for identifying idiosyncratic variables influencing behavior or unexpected changes in the behavior under study (e.g., topography shifts, increases in intensity of a response). In clinical practice, it seems useful to include some form of narrative recording in any analysis (descriptive or experimental) to capture unexpected characteristics of behavior or its relation to the environment that could be incorporated into the measurement system of a more structured descriptive or experimental analysis later.

A more detailed descriptive analysis involves recording a target behavior and its surrounding events using frequency, interval, or time-sample recording. As noted, probability analyses of these data often are conducted to uncover relations between recorded events. This type of analysis represents the state of the art in describing naturally occurring behavior–environment relations; however, the costs associated

with this method may prohibit its use under many practical conditions. Thus, it may be most reasonable to expect that this type of descriptive analysis will be implemented by trained personnel who are dedicated specifically to behavioral assessment. It should be noted that although this method offers the most fine-grained analysis, the data remain correlational. In addition, many studies showing poor correspondence between descriptive and experimental analysis have used this more detailed form of descriptive analysis. Therefore, we would caution practitioners to weigh the costs and benefits of conducting these analyses.

Future Research

Despite the limitations of descriptive analysis, the apparent ubiquity of its implementation (Ellingson et al., 1999) and the importance of understanding conditions naturally surrounding behavior necessitate further refinements in descriptive analysis methods and data analysis techniques. Recent innovations in descriptive analysis methods have considerably improved the way in which naturally occurring response–environment relations can be evaluated. However, a number of questions remain. The extent to which outcomes of descriptive and experimental analyses comport has been limited (e.g., Hall, 2005) and should be considered troublesome to behavior analysts. Additional research is necessary to identify the nature of these discrepancies and to determine the best method of integrating these complimentary assessment methods.

The main focus of this chapter has been the use of descriptive analyses to generate hypotheses regarding naturally occurring reinforcers for problem behavior. However, there may be a number of other of uses for descriptive analysis in behavioral assessment. For example, descriptive analysis might be used to identify general practices that promote or interfere with desirable behavior (this practice may or may not identify reinforcers for the target behavior). For example, Austin, Carr, and Agnew (1999) suggested that descriptive analyses might reveal the form of instruction that produces the most accurate and efficient performance with organizations (see Ndoro, Hanley, Tiger, & Heal, 2006, for an application in the preschool).

Finally, the implementation of descriptive analysis procedures as a form of behavioral assessment may be underrepresented in the literature. Frequently, researchers conduct descriptive analyses as a means of augmenting experimental analyses, thus deemphasizing descriptive data. Formal presentation of descriptive data may help researchers and practitioners to identify the conditions under which descriptive data can be most beneficial.

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CHAPTER 13

Functional Analysis

History and Methods

Alison M. Betz and Wayne W. Fisher

Traditional methods of classifying behavior disorders (e.g., the *Diagnostic and Statistical Manual of Mental Disorders*; American Psychiatric Association, 2000) rely primarily on observed correlations among aberrant responses or symptoms. For example, a child who is easily distracted from attending to homework assignments, who blurts out answers before the question is completed, and often fidgets and squirms while seated might receive a diagnosis of attention-deficit/hyperactivity disorder (ADHD). This approach focuses on the structural characteristics of responses and also on the extent to which certain responses covary. A behavior analytic alternative to this structural approach to nosological classification of behavior is to categorize problem behavior according to environmental events of which the behavior is a function.

History and Conceptual Foundations of Functional Analyses

Skinner (1953) introduced the terms *functional relation* and *functional analysis* to the field of behavior analysis. Historically, the term *functional analysis* was used as a descriptive label for a branch of mathematics in which the basic tools of calculus have been used to study the spaces of functions, and was later adapted by Skinner. According to Skinner, the term *functional relation* refers to a relation in which a change in an independent variable produces an orderly and predictable change in a dependent variable. He was particularly interested in human behavior as a dependent variable and in the discovery of the environmental events that acted as independent variables of which human behavior was a function. Thus, Skinner introduced the term *functional analysis* to label the process through which one might go about identifying the independent variables that are functionally related to human behavior. He identified a variety of methods that might be included in a functional analysis of behavior, all of which fall into one of three categories of *functional behavioral assessments (FBAs)*.[1]

[1]In this chapter we use the general term *functional behavioral assessment* to refer to the broad range of assessment strategies that are employed to implicate the function of an aberrant response, including indirect measures of behavior (e.g., interviews, rating scales), direct observation measures, and controlled functional analyses, in which the environmental events that are hypothesized to reinforce problem behavior are directly manipulated using single-case designs. We restrict the term *functional analysis* strictly for this last type of functional behavioral assessment, in which potential functions of problem behavior are systematically evaluated using single-case designs.

The three major types of FBAs derived from Skinner's introduction of operant function were (1) *indirect assessments*, in which rating scales, interviews, or questionnaires are used to estimate the frequency or severity of the problem in different environmental contexts; (2) *direct assessments*, in which the problem behavior is directly observed and counted in various environmental situations; and (3) functional analyses (the focus of this chapter), in which environmental events hypothesized to influence problem behavior are systematically introduced and withdrawn under highly controlled conditions (while the behavior is directly observed and counted). An indirect assessment is the most time- and cost-efficient form of FBA. However, most indirect assessments suffer from poor interrater reliability (two observers often produce different ratings regarding the frequency of the behavior in different environmental contexts; e.g., Zarcone, Rodgers, Iwata, Rourke, & Dorsey, 1991). Direct assessments (or descriptive assessments) conducted by trained observers are more labor intensive and costly than indirect assessments, but they generally produce highly accurate estimates of the frequency of the problem behavior in different, and typically natural, environmental situations (Mace, 1994). The primary limitation is that direct assessments generally cannot establish the specific antecedents and consequences that influence the behavior in those situations. Studies that have compared the results from direct assessment with those from controlled functional analyses have generally shown negligible or, at best, moderate correspondence (Camp, Iwata, Hammond, & Bloom, 2009; Lerman & Iwata, 1993; Mace & Lalli, 1991; Sasso et al., 1999; St. Peter et al., 2005; Thompson & Iwata, 2007).

Functional analysis is perhaps the most costly and labor intensive form of FBA, but this approach also provides the most reliable, valid, and useful information. Functional analysis has emerged as the predominant method of prescribing effective behavioral treatments for persons with mental retardation who display severe destructive behavior (Repp, 1994). A number of investigations have directly compared behavioral interventions are and are not based on a functional analysis, and the results have consistently favored the functional analysis–based treatments (Kuhn, DeLeon, Fisher, & Wilke, 1999; Smith, Iwata, Vollmer, & Zarcone, 1992). In addition, results of a large-scale meta-analysis indicated that, across studies, behavioral treatments tended to be more effective than pharmacological interventions, and that behavioral treatments were more effective when based on a prior functional analysis (Didden, Duker, & Korzilius, 1997; Iwata, Pace, Dorsey, et al., 1994).

The systematic manipulation of environmental variables to determine effects on behavior began in the late 1960s with research on self-injurious behavior (SIB). During this time, several researchers examined single functions of SIB to determine environmental variables associated with high levels of self-injury. Lovaas, Freitag, Gold, and Kassorla (1965), for example, observed that the frequency of a child's SIB increased when the therapists provided attention in the form of sympathetic statements contingent on the occurrence of SIB. In a subsequent study, Lovaas and Simmons (1969) systematically exposed a child who engaged in SIB to conditions with differing levels of attention. These conditions included (1) attention deprivation, (2) continuous attention (i.e., noncontingent attention), and (3) attention contingent on the occurrence of SIB. These data suggested that for this child, not only was SIB maintained by attention, but it also could be decreased with the use of extinction (attention deprivation) and noncontingent reinforcement procedures.

Another series of studies by Carr and colleagues showed that SIB (Carr, Newsom, & Binkoff, 1976) and aggression (Carr, Newsom, & Binkoff, 1980) occurred more frequently under conditions in which demands were presented relative to conditions in which no demands were presented to an individual. These data suggested that unlike the studies by Lovaas, positive reinforcement was not the maintaining consequence for the problem behavior, but rather negative reinforcement in the form of escape from demands. Last, Berkson and Mason (1963, 1964) observed in a series of studies individuals in whom social contingencies were not maintaining problem behavior. They demonstrated that some individuals with mental retardation tended to engage in higher levels of stereotypical movement when environmentally deprived compared

to conditions in which they had access to leisure items.

The purpose of these studies was to demonstrate the effects of a single variable (i.e. attention, demands, environmental enrichment) on a single behavior (e.g., SIB). However, as a group, these studies provided potential hypotheses as to why the operant variables maintain problem behavior. Carr (1977) wrote a seminal review of the extant literature on potential mechanisms involved in SIB, in which he posed five hypotheses regarding the motivation behind SIB. In the review, Carr suggested that SIB (1) is a learned operant maintained by socially positive reinforcement; (2) is a learned operant maintained by the termination of an aversive stimulus or condition (negative reinforcement); (3) is a means of providing sensory stimulation; (4) is a product of aberrant physiological processes; and (5) is an attempt to establish ego boundaries or to reduce guilt. After reviewing the literature that accounted for the five hypotheses to explain why individuals engage in SIB, Carr suggested that SIB may be multiply maintained, and that future research should investigate potential relationships, between the different motivations and sources of SIB. He also suggested that future researchers should attempt to determine whether there are sequential relationships between motivational factors. For example, automatic stimulation may possibly function as the motivation for SIB, but social contingencies then take over. In his conclusion, Carr suggested that further studies to determine the maintaining variables of SIB could help to form a basis for assessing the validity of the various hypotheses pertaining to the motivation of SIB.

Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) published a landmark study based in part on Carr's review of motivational variables in the occurrence of SIB. The purpose of the article was to describe and test an operant methodology to assess functional relations between environmental variables and SIB. This functional analysis method for evaluating SIB consisted of a control condition (instructional play) and three test conditions (social disapproval, academic demand, aloneness) designed to measure the prevailing behavioral hypotheses regarding SIB as articulated by Carr (1977). These three hypotheses were that SIB was maintained by (1) positive reinforcement in the form of contingent attention, (2) negative reinforcement (escape from or avoidance of nonpreferred activities), and/or (3) automatic reinforcement (e.g., the sensory stimulation automatically produced by the response).

After repeatedly exposing nine participants to the four conditions (social disapproval, academic demand, aloneness, and instructional play), Iwata and colleagues (1982/1994) reported that data showed both between- and within-subject variability. However, for six of the nine participants, higher levels of SIB were consistently associated with specific stimulus conditions. The authors concluded that the within-subject variability was a function of the social and physical environment. They also suggested that treatments based on functional analysis data would be more effective than those based solely on the structural characteristics of SIB.

Operant Components of Functional Analysis Conditions

Iwata, Pace, Cowdery, and Miltenberger (1994) described three operant mechanisms related to the function of problem behavior that should be incorporated into a functional analysis. The first mechanism of a functional analysis condition is its discriminative stimulus; that is, each functional analysis condition has one or more unique antecedent stimuli that signal the consequence that is given in each condition. For example, in the attention condition only, the therapist sits in the room reading a magazine or working. Therefore, only in the attention condition does the presence of the magazine or work signal that when the client engages in the target behavior, contingent attention is delivered. For another example, demand materials (i.e. desk, paper and pencil, work stimuli) are only present in the contingent escape condition.

Second, a motivating operation (MO; Laraway, Snycerski, Michael, & Poling, 2003) should be present during each functional analysis condition. An MO is an environmental variable that alters (1) the reinforcing effectiveness of a stimulus, event, or condition; and (2) the current frequency of all behavior that has been reinforced by that

stimulus, event, or condition. For example, deprivation of food may be an MO because it increases both the reinforcing effectiveness of food itself and the current frequency of behaviors that have, in the past, been reinforced with food (eating a sandwich, buying lunch, etc.). In functional analysis sessions, the MO is contrived by withholding the potential maintaining variable and is only presented contingent on the occurrence of the target problem behavior. For example, while testing the effects of contingent attention, attention is withheld from the client throughout the session and is only provided when the target behavior occurs. In a contingent escape session, demands are continuously presented (and escape from demands or breaks) are withheld until the client engages in the target behavior. The third mechanism of a functional analysis condition is its reinforcing consequence. A specific consequence is delivered following the target behavior on a dense schedule of reinforcement (i.e., fixed-ratio [FR 1] schedule). It is important to deliver the corresponding consequence following the target behavior on such a dense schedule of reinforcement, so that the contingency is strong and salient, potentially leading to a clearer function of the problem behavior (Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001). Furthermore, FR 1 schedules of reinforcement tend to produce lower levels of behavior than do intermittent schedules. This is beneficial during functional analyses of potentially dangerous behaviors and minimizes the risk associated with severe self-injurious or aggressive behavior. Later in this chapter we provide a description of each condition commonly included in a functional analysis, as described by Iwata and colleagues (1982/1994) according to these operant mechanisms (discriminative stimulus, MO, and corresponding consequence). First, however, we describe other important factors to consider while conducting a functional analysis.

Conducting Functional Analyses

Managing Potential Risks during a Functional Analysis

In order to assess the effects of the different environmental variables on problem behaviors such as SIB and aggression, participants are allowed to engage in the target behavior, often in the absence of protective equipment (e.g., a padded helmet) or mechanical restraints. Allowing the individual to emit dangerous behavior has the potential of placing that individual (in the case of SIB) or the therapists conducting the analysis (in the case of aggression) at risk of physical harm. Therefore, it is important that behavior analysts (1) assess the potential risks associated with conducting a functional analysis with each individual, and (2) include appropriate safety measures to ensure that risks associated with the assessment are minimal and that benefits clearly outweigh the risks (Weeden, Mahoney, & Poling, 2010).

Iwata and colleagues (1982/1994) applied several criteria to ensure the safety of each participant. First, each participant received a medical examination, as well as other diagnostic consultations to assess the current physical status of the individual and to rule out organic factors of SIB (i.e., genetic or nongentic disorders in which SIB is a symptom, such as Lesch–Nyhan syndrome). Second, the participants' physician recommended criteria for terminating observation sessions due to physical risks. Physicians and nurses also intermittently observed sessions to assess participants' SIB as it occurred and to modify the criteria if needed. Third, if a participant's physical condition or level of responding met the criterion for termination, he or she was removed from the session room, SIB was interrupted by implementation of brief physical or mechanical restraints, and nurses examined the individual and either approved continuation or recommended postponing the sessions. Fourth, following a set of four observation sessions, participants were routinely examined by a nurse, who noted any changes in physical status as a result of SIB. The authors noted that in light of these procedures, the degree of risk to which subjects were exposed was no greater or less than that found in their natural environment.

The level of medical oversight to ensure patient safety was possible during this and other early studies on the function of SIB because these studies were conducted in an inpatient setting (Iwata et al., 1982/1994). Other behavior analysts working in outpatient settings have used objective criteria for managing the risks associated with a func-

tional analysis of SIB. First, the primary caregiver(s) should be interviewed to ascertain a history of how often and under what conditions the individual's aberrant behavior has resulted in physical harm to self, others, or the environment. This information is then used to ensure that the no one is exposed to more risk during the functional analysis than has occurred in the natural environment. Second, SIB or aggression directed toward vulnerable organs (e.g., eye gouging) should always be blocked or prevented via protective equipment (e.g., arm splints). Third, the potentially harmful effects of severe headbanging (e.g., detached retinas, concussions, brain damage) should be mitigated by conducting the sessions in a well-padded treatment room or having the individual wear a padded helmet. Fourth, sessions should be terminated if SIB results in reddening of the skin or frank bleeding, and further occurrences of SIB should be blocked with protective equipment, until the tissue has fully healed or the individual has been examined by a nurse or physician and is cleared to continue the functional analysis.

Selecting and Defining the Target Responses for the Functional Analysis

Prevalence studies indicate that individuals with one topography of problem behavior (e.g., property destruction) are also likely to display one or more additional forms (e.g., aggression, SIB) (Sigafoos, Elkins, Kerr, & Attwood, 1994). Given this high rate of cooccurrence, the behavior analyst is often faced with the difficult decision of whether to include all topographies of problem behavior or to focus only on the most troublesome response topography. Including all topographies is generally more efficient, but only when the functional analysis produces clear results. However, clear functional analysis results are probably less likely when multiple response topographies are included in the analysis and several of those topographies have separate operant functions (Derby et al., 1994, 2000). Graphing each topography individually may sometimes reveal separate operant functions that were not evident when the topographies were combined and graphed as a single dependent measure (Derby et al., 1994, 2000). Nevertheless, Hanley, Iwata, and McCord (2003) wisely recommend minimizing the number of topographies in the defined contingency class of a functional analysis because inconclusive results may be more likely when multiple topographies with separate operant functions are assessed.

Determining the Duration of Each Session

Wallace and Iwata (1999) collected 46 functional analyses of SIB for which session duration was 15 minutes and the analysis was completed using a multielement design. They created and interpreted 138 graphs, 46 using only the data from the first 5 minutes of each session, 46 using only the data from the first 10 minutes of each session, and 46 using the data from the full 15 minutes of each session. They then compared the results obtained from the abbreviated session times (5 and 10 minutes) with the lengthier session duration (15 minutes). Results obtained with the briefest (5-minute) sessions were the same as the full (15-minute) sessions for all but three of the cases (93.5% concordance), and results obtained with the 10-minute observations were identical to those of the 15-minute sessions (100% concordance). Based primarily on these unequivocal results, our current practice is to conduct 5-minute sessions and to extend session duration only after repeated exposure to each condition (e.g., at least four exposures to each condition) have yielded unclear functional analysis results.

Selecting the Initial and Subsequent Experimental Designs

The vast majority of functional analyses published in the literature have employed multielement designs (81.2%; Hanley et al., 2003), and these analyses have generally produced clear results. The multielement design is often selected as the initial experimental design for a functional analysis because it is more efficient than a reversal design. Multielement designs are also less susceptible to variables external to the experimental preparation (e.g., sleep deprivation, illness) because the experimental conditions are rapidly alternated and equally exposed to the external variables. The primary drawback of the multielement design is that when the levels of problem behavior are undifferentiated across conditions, it is not always clear whether the results are due to multiple-treatment interference (i.e., car-

ryover effects) or whether such findings implicate automatic reinforcement as the consequence responsible for maintenance of the target response.

When a multielement functional analysis produces high and undifferentiated results across conditions, one way to differentiate automatically reinforced responding from multiple-treatment interference is to conduct a series of extended or consecutive alone sessions (Vollmer, Marcus, Rihgdahl, & Roane, 1995). If the response persists in this single condition, multiple-treatment interference can be ruled out (because there is just one condition), and automatic reinforcement is the likely function of problem behavior because social consequences are not available in the alone condition. Finally, if the target response does not persist during the extended alone condition, automatic reinforcement can be ruled out and multiple-treatment interference is the more likely explanation for the undifferentiated results. When this occurs, a reasonable next step would be to conduct a series of pairwise comparisons in which the control condition (play) is alternated with one test condition (e.g., demand) in each phase (e.g., Iwata, Duncan, Zarcone, Lerman, & Shore, 1994).

Analyzing the Behavioral Effects of Contingent Attention

Problem behavior, specifically aggression and SIB, often produces immediate attention from others in the form of altered facial expressions, reprimands, soothing statements, or physical contact. Even if unintentional, these reactions can serve as positive reinforcement for problem behavior in many individuals. Problem behavior that is maintained by social positive reinforcement often occurs under conditions in which attention is given infrequently (i.e., large classroom, when parents are preparing meals). Therefore, it is important to construct a condition that is similar to those that may occur in the natural environment.

In the contingent attention condition of a functional analysis, the reinforcing consequence is social positive reinforcement in the form of attention from the therapist. In order to conduct an accurate test of the reinforcing effects of contingent attention on problem behavior, it is important (for purposes of ecological validity) that the form of attention delivered during the functional analysis is highly similar to or identical to what is delivered in the natural environment. In addition, several studies have demonstrated that qualitatively different forms of attention may vary greatly in terms of their reinforcing effects on problem behavior (e.g., Fisher, Ninness, Piazza, & Owens-DeSchryver, 1996; Piazza et al., 1999). One way to ensure continuity between the putative reinforcer delivered in the natural environment and the one in the functional analysis is to conduct a descriptive assessment prior to initiating the functional analysis (e.g., Lalli & Casey, 1996). A less costly or time-consuming alternative is to conduct informal observations of the client and primary caregiver (e.g., Fisher et al., 1996). Our current practice is to observe the primary caregiver conduct one demand, one attention, and one tangible condition (each lasting 5 minutes), so that the consequences we deliver during the functional analysis are highly similar to those provided by the primary caregiver.

Another important variable to consider when constructing the attention condition of a functional analysis involves determining what materials will be available to the individual during the session. For children, toys are typically freely available during the attention condition of a functional analysis, and for adults, leisure materials are generally available. However, several studies have shown that response-independent availability of highly preferred tangible items (e.g., toys) can reduce attention-reinforced problem behavior to near-zero levels (e.g., Fisher, O'Connor, Kurtz, DeLeon, & Gotjen, 2000). Therefore, it is important to select relatively low-preference toys or leisure materials for the attention condition; otherwise, the functional analysis may produce a false-negative result and fail to identify an attention function that is responsible for the maintenance of the target behavior in the natural environment.

Prior to the start of an attention condition, it is common for the therapist to interact with the individual for 1 to 2 minutes. Following this interaction, the therapist diverts his or her attention toward a magazine or work material (the discriminative stimulus), while the individual is left to play with relatively low-preference toys or leisure materials. Contingent only on the target behavior, the therapist provides attention similar in form

to that given in the natural environment (i.e. reprimands, physical contact, soothing statements). Attention is not provided for any behavior other than the target behavior. Depriving the individual of attention at any time other than immediately after the occurrence of the target behavior is designed to function as a MO for responses that have been reinforced by attention in the past.

Contingent Escape

Negative reinforcement involves an increase in responding due to the response-contingent removal, reduction, prevention, or postponement of an aversive stimulus (Iwata, 1987). Some problem behaviors are learned as a result of negative reinforcement due to their effectiveness in terminating or postponing (avoiding) aversive stimuli or events. For example, an individual with autism may learn to display aggressive or self-injurious behaviors when asked to complete nonpreferred tasks because caregivers stop prompting the individual when the problem behavior is exhibited.

To test the effects of negative reinforcement in a functional analysis, it is important for the escape contingency to be associated with a salient and clear discriminative stimulus. This is generally accomplished by presenting the tasks and task materials only in the contingent-escape condition. Another important feature of the test condition for escape is to present demands that are likely to act as an MO for behaviors that have produced escape in the past. Typically, demands selected for the escape condition have been correlated with the target behavior in the past, based on caregiver report and/or informal observations (Fisher, Adelinis, Thompson, Worsdell, & Zarcone, 1998; McComas, Hoch, Paone, & El-Roy, 2000). For some individuals, difficult demands may be more likely to evoke problem behavior, whereas for others, easy (e.g., boring) demands may acts as a MO. Some individuals may be more likely to display problem behavior when the demands involve movement from one location to another (McCord, Thompson, & Iwata, 2001). Thus, it is important to interview the primary caregiver carefully regarding the types of demands that are most likely to evoke problem behavior, and to use those tasks in the test condition for negative reinforcement.

During the demand condition, therapist and participant are typically seated at a table, and academic tasks are presented to the participant in a least-to-most prompting strategy (successive spoken, modeled, and physical prompts; Horner & Keilitz, 1975). The participant is given 5 seconds to respond after each successive prompt, and the sequence continues until the participant displays problem behavior or correctly completes the task. Problem behavior results in immediate cessation of the task for 20–30 seconds (i.e., escape), and compliance with either the spoken or modeled prompt results in brief praise; otherwise, successive prompts and demands continue unabated.

Tangible Condition

Although this condition was not originally assessed in the seminal study by Iwata and colleagues (1982/1994), it has been repeatedly shown in the literature that contingent access to preferred stimuli or events often maintains aberrant behavior. For example, a child may aggress toward a peer to gain access to a toy, or an individual may engage in a tantrum at the store until his mother gives him the candy bar he wants. The child is likely to repeat the tantrum in the future because it produced the candy bar in the past. This parent may also repeat the act of contingently delivering the candy bar because doing so provides temporary (but immediate) relief from the problem behavior (i.e., the parent's response may be maintained by negative reinforcement in the form of escape from the child's tantrum).

Prior to initiating the tangible condition, it is important to select one or more tangible items that are likely to evoke problem behavior when removed. We typically use the highest-preference item identified by a systematic preference assessment (e.g., Fisher et al., 1992) and/or ask the primary caregiver what items evoke problem behavior when taken away from the individual.

The individual is given approximately 2 minutes of access to a highly preferred item or activity prior to each tangible session. At the start of the tangible session, the therapist takes the high-preference item from the individual and interacts with it (which serves as the discriminative stimulus because it is the only condition in which this occurs). Allowing the child brief access to the item prior

to the session, then depriving access to the item during the sessions should act as a MO and potentially evoke problem behavior if it has been reinforced by access to the tangible item in the past. Contingent on the target behavior, the individual is given the item for a brief period of time (e.g., 20 seconds). Once this time elapses, the therapist removes the item once again. Throughout the session, all other behavior is ignored (i.e., extinction).

Alone or Ignore Condition

Some responses do not depend on reinforcers that are delivered or mediated by other individuals in the environment. Rather, these responses are reinforced by the stimulation that is automatically produced by the response. For example, turning on a stereo may be automatically reinforced by the audio sensation that comes from listening to music (i.e., automatic positive reinforcement). Scratching one's nose may be automatically reinforced because it relieves or reduces an itchy sensation (i.e., automatic negative reinforcement).

When testing for the potential effects of automatic reinforcement during a functional analysis, the participant is generally placed in a room alone, if it is possible for the individual to emit the target response while alone. For example, an alone condition is generally used to test for automatic reinforcement if the target response is SIB (e.g., Iwata et al., 1982/1994). Although it may be ideal to test the effects of automatic reinforcement for some behaviors (i.e., SIB) in the absence of any external or social stimuli, it is important to assess the potential risks of the behavior. For example, if the individual's SIB is so severe that there is a potential risk for injury, it may be best to put someone in the room to block instances of SIB. There are some behaviors, however, for which testing a possible automatic function during an alone condition is not feasible. If, for example, the target response is one that requires the presence of another individual (e.g., aggression toward others is only possible in the presence of another individual), then an ignore condition is used to test the potential effects of automatic reinforcement. During an ignore condition, another person (i.e., therapist, parent) is in the room with the individual but does not provide any social consequences for the target behavior.

Another variation of an alone condition is to place the individual in what is called a "baited" environment (i.e., one that contains materials with which the individual can emit the target behavior). Piazza and colleagues (1998) described a procedure for "baiting" a room to assess the occurrence of pica. The room is "baited" with materials with which the individual can safely engage in pica. For example, if the individual has a history of eating peeling paint off walls, safe edible materials that look remarkably similar to peeling paint can then be used to bait the room for the functional analysis condition (Finney, Russo, & Cataldo, 1982). This preparation permits the measurement of the target behavior without exposing the child to unnecessary health risks.

When conducting an alone or ignore condition to test for automatic reinforcement, it is important that the environment be fairly austere (no toys, leisure materials, furniture, or windows to look out). An austere environment is more likely (than a more enriched environment) to act as an MO and evoke problem behavior maintained by automatic reinforcement because the individual does not have alternative sources of stimulation (i.e., self-stimulatory behavior is most likely to occur in a situation in which the individual has nothing else to do).

It should be acknowledged that high levels of problem behavior in an alone or ignore condition relative to the control condition is not proof positive that the behavior is maintained by automatic reinforcement. In order to prove or demonstrate functional control of responding via automatic reinforcement, once must systematically present and withdraw the reinforcing consequence, which often is not possible when that consequence is an automatic product of the target response. However, in cases where it has been possible systematically to manipulate the putative automatic reinforcer (e.g., Rincover, 1978) or its MO (e.g., Piazza, Adelinis, Hanley, Goh, & Delia, 2000), the results have consistently supported the automatic reinforcement hypothesis. For example, Rincover (1978) systematically eliminated the auditory stimulation (the hypothesized automatic reinforcer) produced by a participant's stereotypical flipping and spinning of objects on a table by covering the table with a carpet. Adding the carpet removed the auditory stimulation and reduced the target response, and removing

the carpet reintroduced the auditory stimulation and increased the target response.

Toy Play (Control) Condition

The toy play condition (or leisure condition for adults) acts as a control condition of a functional analysis. This condition is an analogue of an enriched environment. This condition is unique, in that the therapist plays with the child (i.e., the discriminative stimulus), and the MO for each of the test conditions is absent; that is, attention and preferred tangible items are readily available on dense schedules of reinforcement (thus eliminating the MOs associated with positive and automatic reinforcement), and no demands are presented (thus eliminating the MO associated with negative reinforcement). Consequently, low level of problem behavior should be observed during this condition.

Interpreting Functional Analysis Data

During a functional analysis, the individual is exposed multiple times to each of the test and control conditions, which are generally repeated in accordance with a multielement design (i.e., each condition repeated 5–10 times in a randomized order, with each session lasting between 5 and 15 minutes). The results of the analysis are graphed, and visual inspection identifies the function(s) of the target behavior. When determining the function of a behavior through visual inspection of a graph, it is important to look at the conditions under which high levels of behavior occurred. If the levels of the target behavior(s) are consistently higher when compared to the control condition, it suggests that the environmental variables present in that condition may be maintaining the client's problem behavior. Figure 13.1 shows an example of a functional analysis showing that the patient's (Mike) problem behavior is maintained by social attention. As can be seen, the rates of destructive behavior are clearly and consistently higher in the attention condition than in any other (including the control condition). This suggests that attention contingent on destructive behavior is the primary variable maintaining Mike's problem behavior.

When a target response is maintained by automatic reinforcement, the levels of responding are often highest in the alone or ignore condition. However, in some cases, an automatic reinforcement function can produce relatively high and stable levels of responding across all or most of the conditions of a functional analysis. An example of this pattern of responding is that of Hank, shown in Figure 13.2.

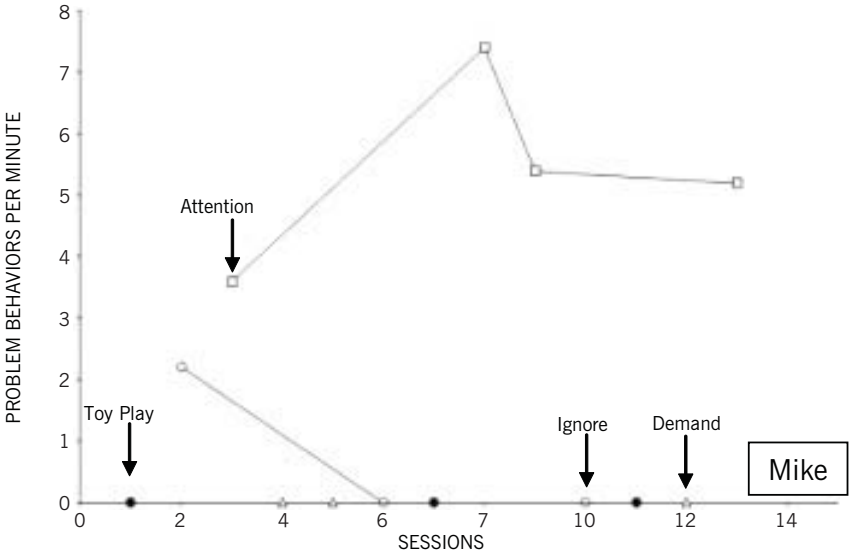


FIGURE 13.1. An example of a functional analysis in which contingent attention is the consequence responsible for maintenance of problem behavior for Mike.

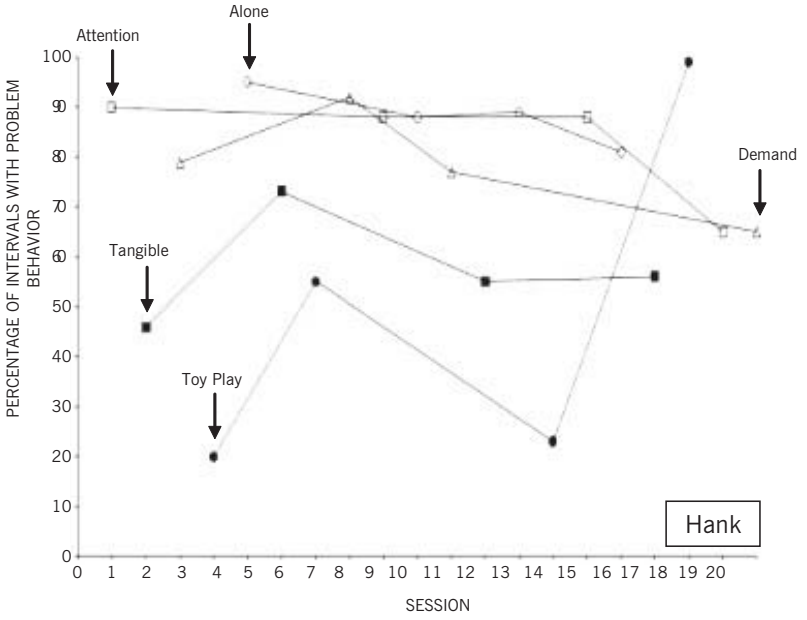


FIGURE 13.2. An example of a functional analysis that implicates automatic reinforcement as the consequence responsible for maintenance of Hank's problem behavior.

Often an individual's problem behavior has two or more functions (e.g., reinforcement by attention and escape from nonpreferred demands). Target responses that show elevated levels of responding in more than one test condition of a functional analysis are generally referred to as *multiply maintained responses*. In other words, the target behavior serves more than one function. Figure 13.3 shows an example (Willie) of multiply maintained problem behavior. In this example, the rates of responding were highest in the tangible condition; however, higher levels of responding were also observed in

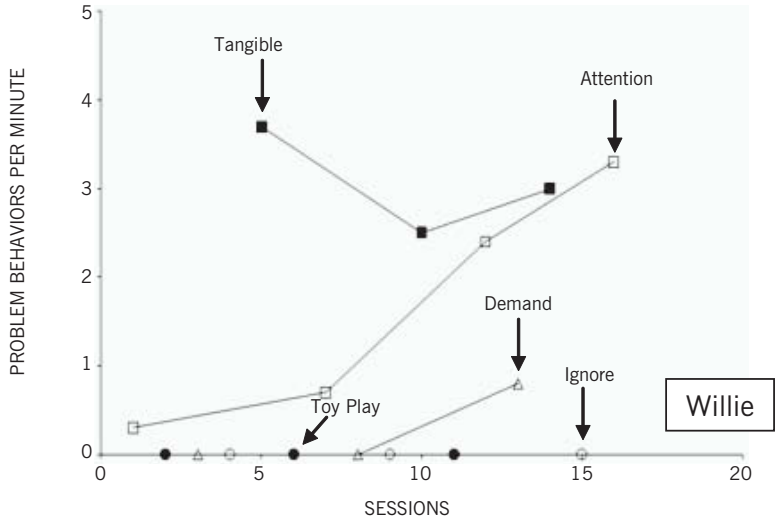


FIGURE 13.3. An example of a functional analysis that implicates two sources of reinforcement for Willie's problem behavior.

the attention condition relative to the control condition. This pattern of responding indicates that Willie's problem behavior was reinforced by both access to preferred tangible items and attention.

If the levels of problem behavior are variable across all conditions, without any of the test conditions showing clearly higher levels than the control condition, responding is considered to be undifferentiated, and the results of the functional analysis are considered inconclusive. An example of a functional analysis that produced undifferentiated and inconclusive results is that of Lynn, shown in Figure 13.4. As is evident, there are no clear patterns of responding, and Lynn's rate of behavior is low and variable across all conditions.

There are several reasons why a functional analysis may result in undifferentiated results. First, the client's behavior may not be coming under the control of the discriminative stimuli associated with each condition. As mentioned earlier, this problem may be solved by adding in very salient and distinct discriminative stimuli that correspond to each session. For example, a therapist wears a red shirt only while conducting contingent attention sessions during the functional analysis. A second reason for undifferentiated results in a functional analysis is that the standard conditions are not capturing the appropriate MO. If this is the case, altering one or several of the MOs present during functional analysis conditions may result in clearer results. Finally, a functional analysis may result in undifferentiated data because the consequences maintaining the aberrant behavior are not present in any of the conditions in a standard functional analysis. Therefore, altering the reinforcing consequences presented in the standard conditions of a functional analysis, or including additional conditions, may be necessary to produce differentiated results.

Functional analysis data are generally analyzed with the use of informal visual inspection procedures in which the data path for each test condition is compared with the data path for the control condition. This method of data analysis is reasonable when the results of the functional analysis are relatively clear, as in the examples shown earlier. However, when the results of a functional analysis are somewhat more ambiguous than these examples, it can be helpful to apply more structured criteria for interpreting the functional analysis results.

Hagopian and colleagues (1997) developed and evaluated a set of structured criteria for visually inspecting and interpreting functional analysis data. In this study, the

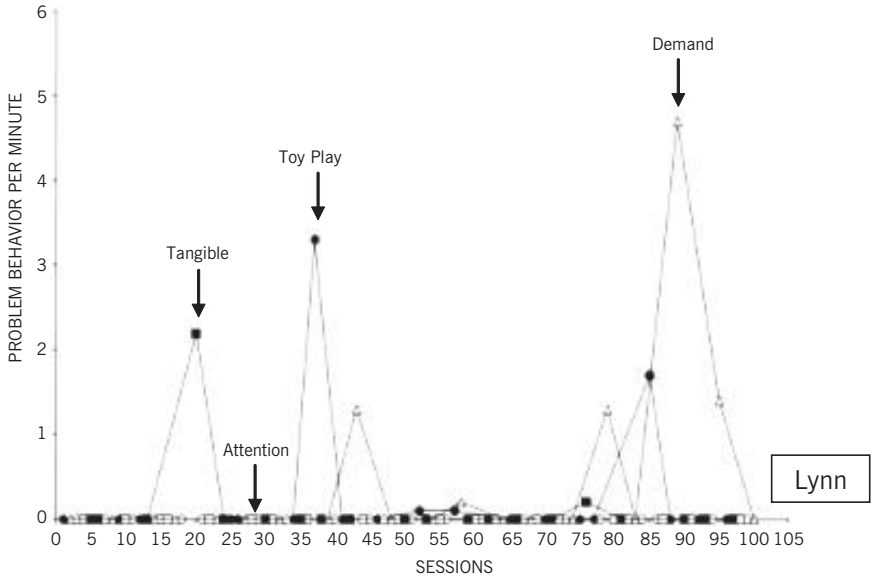


FIGURE 13.4. An example of Lynn's functional analysis, showing undifferentiated, inconclusive results.

investigators demonstrated that these structured criteria improved both the reliability and the validity of interpretations made by graduate students (when visual interpretations of an expert panel were used as the criterion variable). One major component of these structured criteria involved drawing criterion lines on each functional analysis graph that systematically specified the typical range and variance for the levels of responding in the control condition (toy play). The upper criterion line (UCL) was positioned about one standard deviation above the mean for the toy play condition, and the lower criterion line (LCL) was placed about one standard deviation below the mean. The visual inspector then counted the number of data points for each condition that fell above the UCL and below the LCL, then subtracted the latter number from the former ($X_{UCL} - X_{LCL}$). If the difference between these two number was greater than or equal to one-half of the total number of data points for that condition (e.g., $X_{UCL} - X_{LCL} = > 5$, with 10 data points per condition), then that test condition was determined to be differentiated from the control condition (e.g., higher levels in the attention condition than in the control condition) and a function was identified (e.g., aberrant behavior reinforced by contingent attention). Other components of the structured criteria included specific rules for (1) automatic reinforcement functions, (2) overall trends in the data, (3) magnitude of effect, (4) low-level responding, and (5) multiply controlled responding. In the Hagopian and colleagues study, training graduate students to use these structured criteria improved their accuracy for interpreting functional analysis graphs from a mean of 54% correct responding in baseline to a mean of 90% correct following training.

Extensions and Alterations of Functional Analysis Methods

Iwata and colleagues (1982/1994) originally developed the functional analysis method for individuals with mental retardation who exhibited severe SIB. Over the past quarter of a century these basic procedures have been adapted and used with a variety of disorders and target behaviors, including but not limited to ADHD (Northup et al., 1997), autism (Fisher, Piazza, Alterson, & Kuhn, 1999), nonhuman animals (Dorey, Rosales-Ruiz, Smith, & Lovelace, 2009), breath holding (Kern, Mauk, Marder, & Mace, 1995), disruptive behavior (Asmus et al., 1999), elopement (Lang et al., 2010; Piazza et al., 1997), ingestion of drugs (Chapman, Fisher, Piazza, & Kurtz, 1993), noncompliance (Wilder, Harris, Reagan, & Rasey, 2007), pica (Piazza et al., 1998), psychotic speech (Fisher, Piazza, & Page, 1989), feeding problems (Piazza et al., 2003), and tantrums (Repp & Karsh, 1994). In addition, functional analysis methods have been modified by various investigators for purposes such as increasing (1) its efficiency (e.g., Derby et al., 1992), (2) its accuracy (e.g., Vollmer et al., 1995), (3) its generality to natural environments (e.g., Mace & Lalli, 1991), (4) its applicability to different populations (e.g., Cooper et al., 1992), and (5) its use for identifying idiosyncratic or complex antecedent–behavior–consequence (A-B-C) relations (e.g., Fisher, Lindauer, Alterson, & Thompson, 1998). Although a comprehensive discussion of the various ways in which functional analysis methods have been adapted or altered for such purposes is beyond the scope of this chapter, we attempt to describe some of the most influential refinements of functional analysis methods.

Brief and Extended Functional Analyses

We previously discussed research showing that brief (5-minute) sessions generally produce results that are equivalent to more lengthy (15-minute) sessions (Wallace & Iwata, 1999), which can greatly reduce the overall length of a functional analysis. Brief sessions were first introduced by Wacker and colleagues (Cooper, Wacker, Sasso, Reimers, & Donn, 1990), who showed that in a sizable proportion of cases, controlled functional analyses can be completed during a 90-minute outpatient visit (Derby et al., 1992). With this brief functional analysis model, each test condition is typically conducted once during the first phase of the analysis. Replications are then conducted for the test condition with the highest levels of problem behavior. For example, if problem behavior is highest in the attention condition, then differential attention is provided for appropriate behavior in the next session

and for problem behavior in the final session. If the levels of appropriate and problem behavior increase when contingent attention is delivered and decrease when extinction is in place, then an attention function is confirmed.

There are also situations in which it may become necessary to increase the duration of functional analysis sessions or the overall length of the assessment. For example, Kahng, Abt, and Schonbachler (2001) conducted a functional analysis of low-rate, high-intensity aggression using 10-minute sessions, but the participant never displayed aggression in any of the sessions. They then extended the length of the sessions, so that the participant was exposed to one condition per day (e.g., attention), with each exposure lasting for most of the work day (9:00 A.M. to 4:00 P.M.). These extended exposures suggested that aggression was reinforced by contingent attention, and the treatment analysis validated this conclusion.

Another reason for extending the functional analyses is when a sufficient amount of responding is observed during the assessment but the levels of the target response are undifferentiated across conditions. Undifferentiated results may occur because the participant fails to discriminate the conditions in effect or because there are interactions or carryover effects (e.g., a behavioral burst starts in the demand condition and continues into the subsequent attention condition). When this occurs, it may be beneficial to conduct an extended analysis of the problem behavior. Vollmer and colleagues (1995) suggested that one way to test whether undifferentiated responding is a product of one of the preceding factors is to observe the client repeatedly in an alone or an ignore condition. They suggested that if the behavior is a product of social contingencies only, it should extinguish, and if the behavior is not maintained by social consequences, it will persist at levels similar to those observed in the standard functional analysis. Figure 13.5 shows an example of an extended analysis in which an extended-alone condition was conducted because the standard functional analysis produced undifferentiated data. In this case, the behavior remained at high rates, implying an automatic function.

If the problem behavior does not persist during the extended alone or ignore condition, then the behavior may be responsive to social reinforcement that may have not been observed in the standard functional analysis because of rapid alternation between conditions, or failure to discriminate between con-

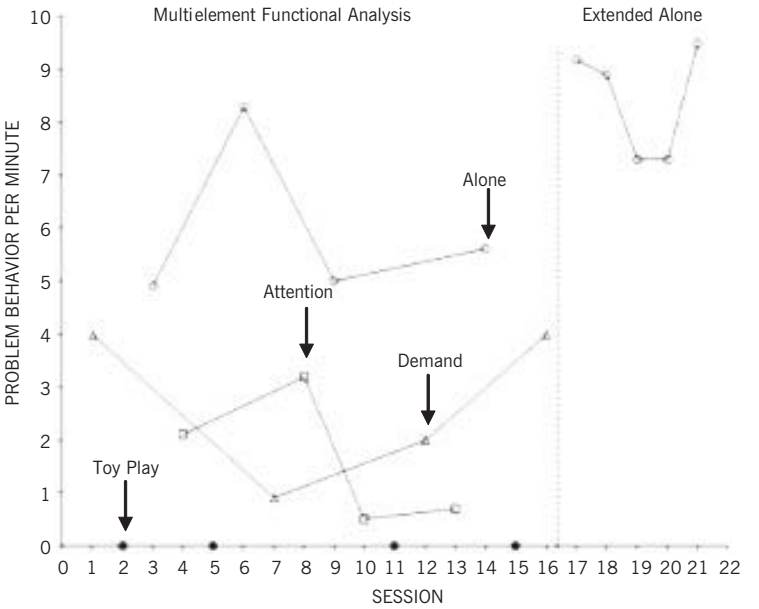


FIGURE 13.5. Example of a functional analysis with an extended alone condition.

ditions. One way to determine whether this is the case with undifferentiated outcomes is to re-present the social reinforcement conditions tested in the standard functional analysis (i.e. contingent attention, contingent escape, and tangible) in a reversal design, which is less prone to carryover effects (Iwata et al., 1982/1994). Figure 13.6 shows an example of an extended functional analysis in which behaviors did not persist during an extended ignore condition. Therefore, a reversal between a contingent escape condition and an ignore condition was implemented, and an increase in the rate of responding was observed during the contingent escape conditions, suggesting that problem behavior was maintained by escape from demands.

Analyzing within-session (minute-by-minute) response patterns is another strategy in analyzing undifferentiated results (Vollmer & Smith, 1996). Examining data minute-by-minute may assist in determining whether there are any carryover effects from previous sessions. For example, Vollmer, Iwata, Zarcone, Smith, and Mazaleski (1993) analyzed within-session data for a participant who showed high rates of SIB in the alone and play conditions. After further analyses, the authors concluded that extinction bursts occurred in the beginning of these sessions, when they immediately followed contingent attention sessions. Thus, analyzing within-session data may allow researchers and clinicians to identify maintaining variables better for those functional analyses that appear undifferentiated.

Furthermore, Roane, Lerman, Kelley, and Van Camp (1999) suggested analyzing within-session functional analysis data to determine the effects of momentary changes in the establishing operation (e.g., EO is present or absent) on problem behavior. Roane and colleagues examined within-session data for five individuals who participated in a functional analysis. They then analyzed each session by coding whether the problem behavior occurred when the EO for each condition was present or absent. The results demonstrated that analyzing within-session data of a functional analysis in terms of EO

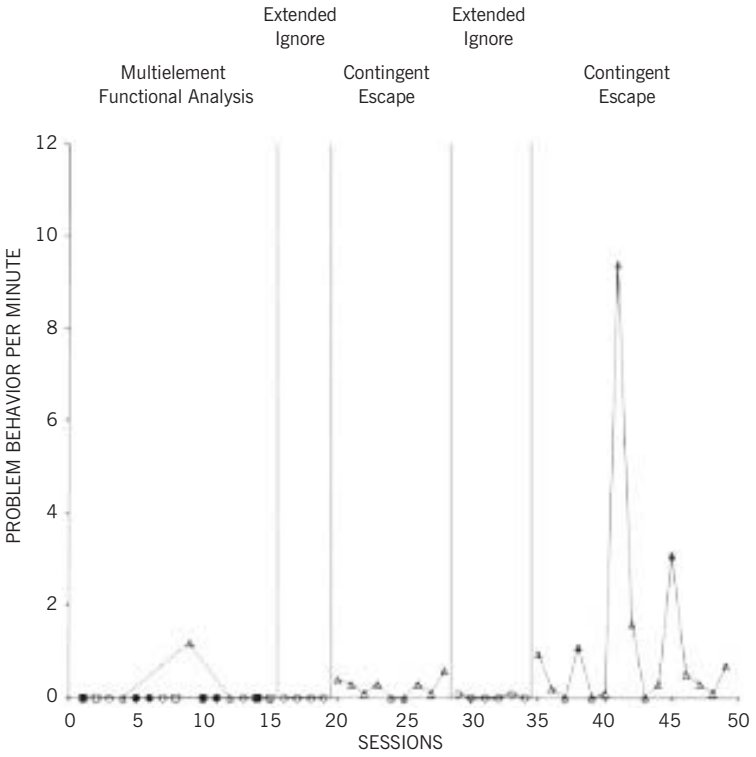


FIGURE 13.6. Example of an extended analysis with a reversal design.

assisted in determining the functions of otherwise undifferentiated functional analyses, thus suggesting that when one is analyzing functional analysis data, it may be beneficial to determine effects of these momentary changes in EOs on the problem behavior.

Idiosyncratic Conditions

In most cases, one or more variables that are manipulated in the test conditions of a functional analysis described earlier (i.e. contingent attention, contingent escape, tangible, alone) are functionally related to problem behavior. However, in some cases, idiosyncratic variables that are not specifically tested in the standard functional analysis are associated with aberrant behavior. For example, Van Camp and colleagues (2000) investigated idiosyncratic environment–behavior relations more precisely after identifying particular stimuli that evoked problem behavior in a standard functional analysis for two children with disabilities. After conducting a standard functional analysis, the authors hypothesized that hand biting (for one participant) occurred at higher rates in the presence of a particular toy (a Bumble Ball®). Therefore, three conditions were implemented to test this hypothesis: (1) a contingent removal condition, in which the participant received continuous access to the ball and the therapist removed the ball contingent on had biting; (2) a contingent access condition, in which the participant received access to the ball for a brief period only after occurrences of hand biting; and (3) a no-interaction condition, which was identical to the no-interaction (or ignore) condition in the standard functional analysis. Results of the functional analysis, including the idiosyncratic conditions, suggested that handing biting was occasioned by the presence of the ball, but the behavior was maintained in the absence of social interactions.

Generating and Testing Hypotheses about Idiosyncratic Functions

Fisher and colleagues used a set of informal descriptive assessments to generate hypotheses about idiosyncratic operant functions for problem behavior, then developed specific test and control conditions to test those hypotheses (Bowman, Fisher, Thompson, & Piazza, 1997; Fisher, Adelinis, et al., 1998; Fisher, Lindauer, et al., 1998; Thompson, Fisher, Piazza, & Kuhn, 1998). For example, in the Bowman and colleagues (1997) study, the authors' informal observations indicated that parents of the participants frequently complied with (or gave in to) almost all of the children's spoken requests or mands, even ones that seemed unreasonable (e.g., requesting that the adult hop on one foot in a circle while playing a card game). Destructive behavior was observed primarily when the children's mands were not reinforced by the parents. These observations led to the hypothesis that a precurrent relation had developed between spoken mands and destructive behavior. A *precurrent relation* is one in which the precurrent response (e.g., destructive behavior) increases the probability of reinforcement of the current response (e.g., spoken mands); that is, the participant's mands specified a variety of preferred reinforcers (e.g., requesting a drink when one's throat is dry; requesting to leave a noisy place), and parents were more likely to deliver the requested reinforcer because their children had a history of displaying destructive behavior when they did not fulfill such requests.

To test this hypothesis, Bowman and colleagues (1997) developed a test condition in which the therapist complied with all child mands for a minute or two prior to the session, then began responding in a manner that deviated from the child's mands at the start of the session, and resumed compliance with child's mands for 30 seconds following each occurrence of problem behavior. In the control condition, the therapist complied with all child mands, independent of the occurrence or nonoccurrence of problem behavior. During this specific functional analysis, called the *mand analysis*, problem behavior occurred at high and consistent rates in the test condition and at near-zero rates in the control condition. A treatment based on this mand analysis reduced problem behavior to near-zero levels in both cases.

Over time, Fisher and colleagues have made their informal process somewhat more formal, in that they typically adhere to the following steps. First, the parents, teachers, and other significant caregivers are interviewed to determine (1) the child's typical daily routine; (2) when, during that routine, problem behavior is most likely to occur;

and (3) what activities are most associated with problem behavior. Next, the caregivers are asked to collect descriptive A-B-C data (Sulzer-Azaroff & Mayer, 1977). If specific situations are identified in which problem behavior appears to be more probable, either through the interviews or the A-B-C data, trained therapists then conduct direct observations under those higher-probability conditions (e.g., observation during mealtime if that is when problem behavior is more probable). The purpose of these direct observations is to try and pinpoint specific antecedents that evoke or occasion problem behavior, and potential consequences that reinforce it. Finally, in brief (1- to 2-minute) probe sessions, the identified antecedents and consequences are re-presented several times to determine whether problem behavior reliably reoccurs when these environmental events are re-created (i.e., "re-create the scene"; see Van Houten, & Rolider, 1988 for another application of "re-creating the scene"). If problem behavior reliably occurs when the scene is re-created, specific hypotheses based on these probes and corresponding test and control conditions are developed to test those hypotheses (e.g., Bowman et al., 1997).

Ecological Influences

The majority of functional analyses reported in the literature were conducted in highly controlled environments. One advantage of this method is that each hypothesized function of the target behavior can be isolated and rigorously tested. One potential limitation of this approach is that variables evaluated in the controlled clinical laboratory may differ from the ones that influence the target response in the natural environment, and the ecological validity of the analysis may suffer. As a result, a number of researchers have attempted to improve the ecological validity of functional analysis procedures by conducting the assessment in the natural environment (e.g., Sigafoos & Saggers, 1995) or by incorporating parents, peers, or caregivers from the natural environment into the assessment (e.g., Broussard & Northup, 1995; Rihgdahl & Sellers, 2000; Umbreit, 1996). The extent to which the experimental rigor of a controlled functional analyses is achieved via a trade-off that sacrifices the ecological validity of the assessment remains unknown (see Hanley et al., 2003, for a more detailed discussion of this issue). This issue is likely to be resolved only through large-scale studies that directly compare the results of more naturalistic and highly controlled functional analyses (Hanley et al., 2003).

Advantages and Limitations of Functional Analysis

As stated previously, a primary advantage of functional analysis is that it produces clear experimental data that demonstrate the variables maintaining the occurrence of problem behavior. Consequently, it is the method most often used in the assessment and treatment of problem behavior (Arndorfer & Miltenberger, 1993). Another primary advantage is that functional analysis allows for the development of function-based interventions, which repeatedly have been demonstrated to be most effective in the treatment of severe behavior disorders. Furthermore, implementing function-based interventions from a functional analysis has decreased the use of punishment as part of treatment of problem behavior (Iwata, Pace, Dorsey, et al., 1994).

Although there are many advantages to identifying and understanding environmental influences on problem behavior via functional analysis, there are also some potential limitations that warrant discussion. First, a functional analysis exposes the individual to conditions in which problem behavior is reinforced on a dense (usually FR 1) schedule, which temporarily may result in an overall increase in the target response. Second, exposing the individual to a variety of potential reinforcers following problem behavior may result in the participant learning a new function that had not previously operated in the natural environment. With either of these limitations, introducing a function-based treatment (e.g., functional communication training with extinction; see Vollmer & Athens, Chapter 19, this volume) should markedly reduce the target behavior. Nevertheless, it is important for the behavior analyst to recognize and address appropriately these potential limitations if and when they arise.

In summary, when one considers the strengths and limitation of the functional analysis method originally developed for SIB by Iwata and colleagues (1982/1994) and subsequently adapted, altered, and refined for a wide variety of disorders and target responses, this methodology arguably represents the most important advancement in applied behavior analysis in the last quarter-century. Functional analysis provides direct prescriptive links between assessment and treatment, and treatments developed on the basis of a functional analysis are more effective than those developed without a prior functional analysis (Didden et al., 1997; Iwata, Pace, Dorsey, et al., 1994). Functional analysis has led to the development of a number of novel and innovative interventions, especially for problem behavior maintained by negative reinforcement (Iwata, Pace, Cowdery, et al., 1994), and for problem behavior reinforced by idiosyncratic functions (Bowman et al., 1997). Finally, functional analysis provides a highly controlled method for conducting large-scale epidemiological investigations to study environmental influences on problem behavior, a method that includes an experimentally controlled analysis of each participant in the study (Iwata, Pace, Dorsey, et al., 1994).

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PART V

INTERVENTIONS FOR INCREASING DESIRABLE BEHAVIOR

CHAPTER 14

Differential Reinforcement Procedures

Gregory P. Hanley and Jeffrey H. Tiger

The term *reinforcement* describes the process in which a behavior is strengthened as a result of its occurrence being followed by some improvement in the environment. By *strengthened*, we mean that the behavior is more likely to occur in the future when the person experiences similar environmental conditions. The process of reinforcement is fundamental to the manner in which people interact with and learn from their environment. Children repeat phrases that made their parents laugh, teenagers wear the same clothes that made their friends take notice, and adults swing a golf club with particular form when doing so has resulted in long and accurate drives.

Much of early human learning can be described by infants moving through their environment and experiencing natural reinforcement (and punishment) contingencies (Bijou, 1996; Schlinger, 1995). Infants may experience reinforcers for grasping their food only when they apply the appropriate amount of strength to their grip. Grasping too hard will squash their food or cause it to slip from their hands. Grasping too softly will not capture the food. Such gradual and natural reinforcement processes may at least partially account for learning to chew, babble, stand, and walk.

Although natural contingencies may account for a large amount of human learning, alone they bring about behavior change in a very slow and inefficient manner, particularly when reinforcers for engaging in important behavior are delayed or intermittent, or when a chain of behavior is necessary to produced reinforcement. Imagine trying to learn to drive a manual transmission car based solely upon the natural consequences of that behavior. Two distinguishing capacities of people are the abilities to relay personal learning histories to other people through verbal behavior (e.g., speech and writing), and to arrange contingencies to develop and refine important behaviors in others. Thus, we are capable of increasing the speed at which important behavior develops and eventually comes into contact with natural reinforcement contingencies. In this regard, *differential reinforcement* (DR) is applicable as a *procedural* term used to describe the act of increasing the occurrence of a desirable behavior in others by systematically arranging for improvements to follow such behavior.

By arranging for reinforcers to occur more following one behavior relative to one or several others, DR has two effects: It strengthens the favored behavior and weakens other

behavior that is functionally similar. Given this latter effect, a large proportion of published studies relying on DR aim primarily at reducing an existing problem behavior (see Vollmer & Iwata, 1992, and Vollmer & Athens, Chapter 19, this volume) and, by many accounts, have revolutionized the educational and care practices for all young children, especially children with disabilities and individuals with severe problem behaviors (Risley, 2005). However, the accelerative effects of DR are also valuable for designing any teaching and habilitative environment, and our chapter focuses primarily on the use of DR to develop and refine new behavior, and to maintain this behavior in a variety of settings.

The general procedure of DR is deceptively simple—arrange some environmental improvement (i.e., some reinforcers) to favor behavior, or features of behavior, one would like to see more often and withhold or minimize these same reinforcers for behaviors or features of behaviors one would like to see less often. Socially important behavior change, however, is often not that simple. A comprehensive technology for increasing desirable behavior through DR has been developed and applied since the inception of applied behavior analysis in the early 1960s. We review those technological developments in this chapter. Specifically, we provide descriptions and examples of features of behaviors that may be strengthened through DR, and highlight considerations for practitioners designing interventions based on DR. In addition, we highlight the diverse array of applications with DR at their core.

Features of Behavior That May Be Targeted through DR

The following section defines characteristics of behavior that are sensitive to DR and provides an illustrative example of how each of these characteristics has been modified by DR.

Topography

As noted earlier, common examples of DR involve reinforcement of one topography of behavior in lieu of another existent and problematic form of behavior (this is often referred to as differential reinforcement of an alternative behavior, or DRA). Pinkston, Reese, LeBlanc, and Baer (1973) provided such an example of DR of one desirable response topography (appropriate peer interactions) in lieu of another existent topography (aggression). Under baseline conditions, teachers typically responded to instances of peer aggression with admonishment (e.g., "You can't do that here!") and paid little attention to appropriate social interaction; this resulted in relatively higher rates of aggression. Teachers were then taught to no longer attend to the child who aggressed but rather to provide attention when the children engaged in desirable peer interactions. This simple manipulation resulted in increased appropriate peer interactions and decreased occurrences of aggression.

Rate

Rate refers to the number of responses emitted within a certain period of time. Some responses must occur repeatedly within a time period to be considered useful or functional skills (e.g., typing speed, answering math facts). Differential reinforcement of high-rate *behavior*, or DRH, procedures are one means of producing such acceleration. This procedure involves providing reinforcement only if a minimum number of responses are emitted prior to the end of a specified time interval. A procedure used by Ingham and Andrews (1973) in the treatment of stuttering can be conceptualized as a DRH schedule. In this study, participants were initially treated for stuttering with auditory feedback (i.e., a tone was emitted when they stuttered). This treatment resulted in stutter-free speech but, according to the authors, the speech was slow and unnatural. A token-based reinforcement program requiring progressively higher rates of spoken words per minute was then implemented. This DRH component maintained stutter-free speech, while increasing the rate and naturalness of the speech.

In other cases, certain behaviors are socially acceptable only when they occur at moderate to low rates. For instance, the desirability of requesting assistance from others, an important behavior often taught to

persons with developmental disabilities, is often predicated on the rate of that behavior, with excessively high rates being a negative outcome of such teaching programs. Differential reinforcement of low-rate behavior, or DRL, procedures involve providing reinforcement for a response only when it occurs below a certain threshold. This useful schedule for maintaining a response at a particular moderate or low rate has often been used as an initial treatment for reduction of problem behavior. For instance, Deitz and colleagues (1978) described the use of what they termed an *interval DRL procedure* with a 7-year-old with learning disabilities. Each 30-minute session was divided into fifteen 2-minute intervals. The experimenters provided a sticker that could be exchanged for extra recess time at the conclusion of each 2-minute interval in which 0 or 1 incidents of disruptive behavior occurred. Because DRL schedules generally result in maintenance of the response, but at low levels, it seems most appropriate for maintaining desirable responses, but at low rates.

Duration

Duration refers to the amount of time a particular response occupies. The number of certain behaviors, such as completing homework, playing, or reading, is usually less informative than the amount of time a person is engaged in the behavior. Miller and Kelley (1994) described the use of DR of sustained engagement in homework for 4 school-age children. Parents and children arrived at a stated goal regarding the amount of time allocated to homework, and parents then provided access to preferred activities when children met or exceeded the duration of the stated goals.

Intensity

Intensity refers to the physical force or magnitude of the target response. For instance, the volume at which speech is emitted is integral to a conversational partner's ability to respond. Speech that is emitted too softly may not be heard, while speech that is emitted to loudly may be aversive to a listener. Fleece and colleagues (1981) demonstrated the use of DR of greater intensities to increase the voice volume of two preschool children with developmental delays. In this study, a sound-sensitive apparatus placed in front of the participant was calibrated such that any vocalizations exceeding a minimum threshold would produce a series of red- and green-colored lights in the shape of a Christmas tree (a presumed reinforcer). As children successfully activated the device, the experimenters then increased the minimum threshold, which resulted in a corresponding increase in children's speech volume up to, but not exceeding, the conversational intensity of their peers.

Latency

Latency refers to the amount of time that passes between the occurrence of some event and the completion of behavior. For example, the time that expires between an alarm clock sounding and a person actually getting out of bed can be described as the latency to awaken. Fjellstedt and Sulzer-Azaroff (1973) described one DR application of short response latencies with a young boy who was slow to comply with instructions. DR was arranged in which compliance with instructions resulted in access to a token reinforcer, but only if it occurred within a specified amount of time from the time the instruction was issued. This contingency, which emphasized responding within a particular latency, decreased the time required for this boy to comply with instructions across activities.

Interresponse Time

Interresponse time (IRT) refers to the amount to time that expires between two instances of a response. DR of short IRTs results in fast responding (i.e., short pausing between like responses) and DR of longer interresponse times results in slow responding (i.e., greater pausing between like responses). Lennox, Miltenberger, and Donnelly (1987) reduced the rapid eating of three adults with profound mental retardation by differentially reinforcing long IRTs. Following an initial baseline to ascertain the initial IRTs between bites of food, the experimenters set a target IRT interval of 15 seconds; that is, they blocked any attempts

to place food in the mouth prior to 15 seconds and allowed food to be consumed only at the termination of the 15-second interval. When this contingency was combined with a prompt to engage in an incompatible response during the 15-second interval, IRTs for bites of food taken increased for each participant.

Considerations in Arranging DR Procedures

After determining the target response and dimension of that response to strengthen through DR, the practitioner then confronts several decisions regarding how to implement DR. The likelihood of DR's effectiveness depends on several parameters of the response–reinforcer relation, including the effort involved in the target response and the immediacy, schedule, amount, type, and quality of reinforcement. Each of these elements is discussed in turn.

Response Effort

The effort associated with emitting a response is likely to affect the speed at which the response is acquired, with lower effort responses acquired more quickly than higher effort responses, and simpler responses acquired more quickly than complex responses. Horner, Sprague, O'Brien, and Heathfield (1990) showed the importance of response effort when teaching alternative communicative responses to two participants engaged in socially mediated problem behavior. When participants were initially required to type a full sentence on an augmentative communication device to acquire the reinforcer, acquisition was slow and incomplete, and problem behavior persisted. The less effortful alternative, in which pressing a single key generated the same sentence, was more quickly acquired and maintained, and resulted in a sustained decrease in problem behavior. When speed of acquisition is critical, decreasing response effort is an important tactic to consider. Higher effort or more complex responses may still be taught by arranging DR of successively higher effort of more complex response forms following acquisition of the simpler response form (see Hernandez, Hanley, Ingvarsson, & Tiger, 2007, for an example of this strategy).

Immediacy of Reinforcers

Reinforcer immediacy refers to the time expired between an instance of behavior and the delivery of reinforcement (also referred to as *reinforcer contiguity*; Vollmer & Hackenberg, 2001). Responses may still be acquired when considerable time expires between the response and a reinforcing event (i.e., acquisition under delayed reinforcement conditions); the acquisition process is, however, usually substantially longer, even with only brief delays (Gleeson & Lattal, 1987). Considering the well-documented contingency-weakening effects of delayed reinforcement (Fisher, Thompson, Hagopian, Bowman, & Krug, 2000; Hanley, Iwata, & Thompson, 2009) and the fact that even a single immediate reinforcement of a response is likely to result in the strengthening of that response (Skinner, 1948), ensuring the immediate delivery of reinforcement following a targeted behavior is critical to the rapid development and maintenance of a response through DR (Hanley, Iwata, & Thompson, 2001).

Schedule of Reinforcers

Reinforcement schedules are descriptions of the number of responses and amount of passed time required to produce reinforcement. There are a number of different sets of rules for delivering reinforcers (these sets of rules are also called schedules) and many schedules have specific names due to their frequent usage in the early development of behavior analysis. The most common schedule of reinforcement is one in which each response produces a reinforcer. This is referred to as a continuous reinforcement (or CRF) schedule, and these schedules are most commonly used to strengthen a target response in applied behavior analysis. Applied behavior analysts also implement intermittent schedules of reinforcement, in which only some responses produce reinforcers. When an intermittent schedule is arranged for a single response, the speed and patterning of that response are likely to vary depending on the specific type of schedule used, the values of that schedule, the amount of time a particular schedule is experienced, and the order in which people experience multiple schedule values. In this section we briefly review simple intermittent reinforcement schedules,

which were first described by Ferster and Skinner (1957).

Ratio-Based Schedules

Ratio-based schedules are those in which reinforcers are delivered following a certain number of responses. The response requirements may be fixed, variable, or progressive. In a fixed-ratio (FR) schedule, the number of responses required to produce reinforcement remains constant. For instance, during an FR 5 schedule, every fifth response produces a reinforcer, and during a FR 10 schedule, every 10th response produces a reinforcer. FR schedules may generate a pause-and-run pattern in which responding occurs at a consistent and very high rate up to the point when the reinforcer is delivered; a pause is then observed for a period of time before high-rate responding resumes (Ferster & Skinner, 1957; Orlando & Bijou, 1960). The duration of the pause is related to several factors, such as size of the ratio and magnitude of the reinforcer (see Schlinger, Derenne, & Baron, 2008, for a review of these factors). Pay for a specific number of materials made (e.g., piecework) is one common example of an FR schedule (Schroeder, 1972).

Variable-ratio (VR) schedules are similar to FR schedules in that the number of responses emitted results in a reinforcer; however, as opposed to being fixed, that number of responses varies around a mean number in VR schedules. For instance during a VR 5 schedule, a mean of five responses is required for a reinforcer; thus, any particular reinforcer may be delivered after one, three, five, seven, or nine responses. VR schedules tend to produce very high response rates, but without the postreinforcement pause (responding tends to be more consistent; Ferster & Skinner, 1957; Schlinger et al., 2008). The contingencies operating on slot machines approximate VR schedules of reinforcement (Crossman, 1983).

Progressive-ratio (PR) schedules are unique relative to other ratio-based schedules, in that the number of responses required to produce reinforcement increases across reinforcer deliveries. These schedules progress either by the addition of a fixed number of responses following each reinforcer delivery (arithmetic increases) or by multiplying each progressive schedule value by a constant (geometric increases). For instance, during a geometric PR 2 schedule, the number of responses required to produce reinforcement doubles each time a reinforcer is delivered. PR schedules may be used to generate rapid responding at high schedule values. PR schedules may also be implemented to determine the strength of a reinforcer because this schedule can identify schedule values at which responding ceases to occur. For instance, Roane, Lerman, and Vorndran (2001) used PR schedules to isolate the relative value of two leisure items for two persons with developmental disabilities. Results of an initial preference assessment showed that two items were equally preferred. PR schedules were then arranged to determine the schedule values at which participants stopped responding when the two different leisure items were used as consequences for responding. Because distinct differences in schedule values were identified for each item, PR schedules proved to be a sensitive means of detecting differences in reinforcer strength for each participant.

Interval-Based Schedules

Interval-based schedules are those in which reinforcers are delivered for the first response occurring after a specified amount of time. Interval-based schedules may be either fixed or variable. In a fixed-interval (FI) schedule, the amount of time that must elapse prior to a response resulting in a reinforcer is constant. For instance, during an FI 60-second schedule, the first response after 60 seconds will produce a reinforcer, and, during an FI 120-second schedule, the first response after 120 seconds will produce a reinforcer. FI schedules may also generate high rates of responding, especially with low-effort responses and relatively small schedule values (e.g., Hanley, Iwata, & Thompson, 2001). With continued experience at higher FI values, these schedules tend to produce a scalloped behavior pattern in which very little responding occurs early in the interval, but it gradually accelerates to high rates as the interval comes close to the end (Ferster & Skinner, 1957; Weiner, 1969). Critchfield, Haley, Sabo, Colbert, and Macropoulis (2003) posed that the delivery of reinforcers for bill passing of the U.S. Congress approximate an FI schedule of reinforcement

because the reinforcers (e.g., ability to brag to constituents and run for reelection at the end of the congressional session) are only available at the close of the congressional term. These authors examined 50 years of bill-passing and found that these patterns did indeed conform to those commonly produced by FI schedules.

When implementing a variable-interval (VI) schedule, the time that must elapse prior to a response producing reinforcement varies around a defined mean. For instance, during a VI 60-second schedule, reinforcement may be available for the first response after 10, 30, 80, or 90 seconds. VI schedules tend to produce fairly steady response rates (i.e., very little pausing; Orlando & Bijou, 1960).

Amount (Magnitude) of Reinforcers

Reinforcer magnitude refers to the amount or duration of a reinforcer, which is often determined by practical or social constraints (e.g., a teacher has only 5 minutes available for free play, or only a certain number of edibles is considered acceptable); however, this factor may influence the efficacy of DR procedures. For instance, Trosclair-Lasserre, Lerman, Call, Addison, and Kodak (2008) showed that with three children diagnosed with autism larger amounts of reinforcers (attention and toys) maintained responding at higher schedule values than did smaller amounts of reinforcers. Like most functional relations, there are relevant boundary conditions. For instance, delivering copious amounts of reinforcement would likely result in satiation to the reinforcer and limit the effectiveness of the DR procedure. Therefore, selection of an appropriate amount of reinforcement should be based on practicality, social acceptability, and effectiveness.

Type of Reinforcers

Positive versus Negative Reinforcers

In most reported applications, DR involves the use of positive reinforcers in which *delivery* of some item or event is contingent on a response, resulting in an increased future probability of that response. Commonly used positive reinforcers include vocal and physical attention, edible items, or leisure activities. In some, but fewer, applications, negative reinforcement has been arranged in DRA procedures in which removal or postponement of an event is contingent on a response, resulting in an increased future probability of that response (Iwata, 1987). Negative reinforcement applications can commonly be found when the target response to be strengthened is compliance. Piazza and colleagues (1997) and Lalli and colleagues (1999), strengthened compliance via differential reinforcement, with a break from instructions.

The advantages of incorporating negative DR in teaching programs have also been demonstrated. Rodgers and Iwata (1991) compared the efficacy of three conditions in teaching a match-to-sample discrimination to seven adults with disabilities. All conditions involved positive DR of correct responding with praise and either food or tokens. In two conditions that also involved the use of negative reinforcers, correct responses resulted in omission of error-correction trials in which learners were prompted to repeat the correct response or to repeat an irrelevant response. Five of the seven participants acquired more discriminations in the error-correction conditions, highlighting the impact of the negative reinforcement contingency.

Social and Nonsocial (Automatic) Reinforcers

Social reinforcers are events delivered by another person (e.g., a teacher saying "Nice work!" or a mother giving a child a cookie). By contrast, nonsocial or *automatic reinforcers* refer to those events that occur as a direct result of the behavior (e.g., obtaining a cookie from a vending machine; Vaughan & Michael, 1982). Since a DR procedure is typically arranged by a concerned caregiver or teacher, almost all descriptions of DR involve the use of social reinforcers. Nevertheless, it is possible, and it may also be useful, to program nonsocial or automatic reinforcers following the occurrence of target behaviors. For example, in the treatment of severe self-injurious behavior, Linscheid, Iwata, Ricketts, Williams, and Griffin (1990) described a device that could automatically detect the occurrence of self-injurious headbanging and automatically activate electronic devices. One unused function of the de-

vice involved a DR of other behavior (DRO) function that allowed delivery of a preferred event (e.g., music from a radio, visual stimulation from a television) by the automated device upon the cessation of headbanging for specified periods of time.

Automatic *negative* DR may also be arranged, For instance, Azrin, Ruben, O'Brien, Ayllon, and Roll (1968) engineered a device to automatically detect adults' "slouching." Upon the occurrence of adult slouching position, a quiet tone was emitted, followed in 3 seconds by a loud tone (i.e., one likely to be heard by coworkers). Persons wearing the device could avoid the second tone by correcting their posture during the 3-second warning, or avoid both tones by sitting and standing erect continuously.

Several authors have arranged for persons with developmental disabilities to access their own stereotypical behavior contingent on the emission of target responses (Charlop-Christy, & Haymes, 1996; Charlop, Kurtz, & Casey, 1990; Wolery, Kirk, & Gast, 1985). They have shown that these arrangements can increase some target responses, such as academic discriminations and play skills. By conducting a functional analysis (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) prior to arranging a contingency between stereotypical behavior and desirable target responses, Hanley, Iwata, Thompson, and Lindberg (2000) showed that the stereotypical behavior of their clients persisted in the absence of social consequences, thus appearing to be maintained by automatic reinforcement. By providing access to these behaviors contingent on play with leisure materials, these authors essentially arranged automatic reinforcers (those produced directly by engaging in stereotypy) to strengthen target responses. This procedure seems to blur the distinction between socially mediated and automatic reinforcers; nevertheless, the use of automatic reinforcers to strengthen desirable behaviors may be especially important when more typical social events do not routinely function as effective reinforcers (e.g., persons with severe developmental disabilities; Reid, Phillips, & Green, 1991).

The use of automatic reinforcers may be desirable for several additional reasons. First, the delivery of social reinforcers commonly requires continuous monitoring and documentation of behavior by a staff member or caregiver. Procedures like those described by Linscheid and colleagues (1990) and Azrin and colleagues (1968) require neither, which may increase their utility. Second, the automated delivery of reinforcers is likely to be implemented with greater precision and immediacy than can be accomplished by human beings, assuming the proper programming and continued functioning of the device. Third, skills may be more readily acquired when the consequence of responding results directly from the behavior rather than when delivered by person contingent on the behavior, possibly because the consequence can be delivered with less delay (Thompson & Iwata, 2000).

Quality of Reinforcer

Reinforcer quality typically refers to an individual's subjective value of a particular reinforcing stimulus. It must be assumed that effective DR procedures rely on reinforcers of sufficient quality. Every individual is born with differential sensitivity to particular events as reinforcers and a unique conditioning history that may add or detract value from stimuli as reinforcers. As a result, the reinforcement quality of similar events varies across and within individuals over time. To accommodate these differences while attempting to design effective DR procedures, researchers have developed a number of preference assessments to identify high-quality events on an individualized basis. In the following section we review some of these procedures and discuss some of the issues that arise when attempting to program the use of high-quality reinforcers across time.

Identifying High-Quality Reinforcers

One relatively simple means of identifying reinforcers is to ask the individual receiving the behavioral programming, or someone else who knows the individual, what items or events he or she regularly consumes, engages in, or simply prefers. Although this indirect method of identifying reinforcers is intuitive and relatively easy, several studies have shown that exclusive reliance on vocal verbal reports does not result in the identifi-

cation of preferred events or reinforcers (e.g., Green et al., 1988; Northup, George, Jones, Broussard, & Vollmer, 1996). Research has shown, however, that these reports are a helpful first step in identifying reinforcers. For instance, Fisher, Piazza, Bowman, and Amari (1996) developed a standardized interview tool (the Reinforcer Assessment Interview for Individuals with Severe Disabilities, or RAISD) to help caregivers identify preferred social and nonsocial reinforcers. This interview involves both a nomination procedure, in which caregivers are provided examples of reinforcers affecting different sensory modalities and asked to nominate items or activities in which their child engages, and a ranking procedure, in which they are asked to rank-order the nominated activities from most to least preferred. Fisher and colleagues found that those items nominated by caregivers using the RAISD were more effective than items selected from a list of commonly used reinforcers in maintaining appropriate behavior. These results emphasize the importance of allowing caregiver opinions to inform more direct assessments to identify reinforcing events. Subsequent research has shown that caregiver opinion alone may identify reinforcing events, but that combining both caregiver reports and direct assessments (i.e., allowing the former to inform the latter), identifies the most potent reinforcing events (see Cote, Thompson, Hanley, & McKerchar, 2007).

There are multiple direct preference assessment formats; however, they all involve presentation of a potentially reinforcing item or event and measurement of an individual's approach toward, engagement with, or selection of that item or event. These different measures are considered preference indices, and all have been shown to be predictive of the reinforcing efficacy of an item. Because there are distinct advantages and disadvantages of the various direct assessment methods, we briefly describe several of the formats (see Ivancic, 2000, for a review).

Single-Stimulus Formats

As the name implies, single-stimulus preference assessment formats involve presenting one item at a time to an individual and measuring his or her approach toward or interaction with that item. Items with higher approach/interaction levels are considered to be more preferred than those with lower approach levels, and Pace, Ivancic, Edwards, Iwata, and Page (1985) showed that more highly preferred stimuli are indeed more potent reinforcers. Single-stimulus presentation formats relying on approach measures are limited in that they often do not yield preference hierarchies because individuals often approach all items; therefore, determinations of relative preference are not usually obtainable. This presumably has led several researchers to use duration-based interaction measures in their single-item preference assessments (e.g. DeLeon, Iwata, Conners, & Wallace, 1999; Piazza, Fisher, Hanley, Hilker, & Derby, 1996). By allowing the individual more time to interact with the items and measuring the total amount of interaction time with the items, as opposed to measuring only whether the item was approached, more variability is obtained in the measures, and preference hierarchies are more easily attainable. Because some events are only reinforcing when engagement is for a particular amount of time (e.g., puzzles, movies, music), another putative advantage of these duration-based procedures is that they may more accurately capture the reinforcing value of these types of events. The limitation of allowing greater access time with the assessment items is that these assessments are more time-consuming than approach-based assessments.

Paired-Item Formats

A more direct method for obtaining preference hierarchies while still measuring approach responses was described by Fisher and colleagues (1992), who introduced the paired-item format. This assessment format involves pairing each item with every other item and measuring the participant's selection of one of the two items, while allowing consumption of that one item on each trial. At the completion of the assessment, the percentage of times each item was selected is calculated. Preference hierarchies are usually achieved with this format because each item is placed in direct competition with every other item. The main limitation is that the time required to complete the assessment grows exponentially as more items are added.

Multiple-Stimulus Formats

Multiple-stimulus preference assessments involve the simultaneous presentation of multiple items. An early description of this format was provided by Windsor, Piché, and Locke (1994), who arranged for participants to select their most preferred item from an array on each trial. After being consumed, the item was replaced in the array for the next trial. An advantage is that this procedure allows assessment of preference for multiple items simultaneously. But because selected items are returned to the array, this assessment is not likely to not yield a preference hierarchy. It may therefore be most useful when attempting to identify the single most preferred item.

DeLeon and Iwata (1996) described an alternative multiple-stimulus assessment format in which the selected stimulus was not replaced in trials subsequent to its selection, such that the array of stimuli progressively dwindled following each selection. They referred to this procedure as a multiple-stimulus without replacement (MSWO) assessment. Preference hierarchies are likely with the MSWO procedures based on the order in which items were selected (i.e., those selected sooner are considered more preferred than those selected in the later trials). This assessment format was shown to result in outcomes comparable to those of the paired-item format (Fisher et al., 1992) while requiring less time to complete. Because selection percentages can lead to misleading conclusions regarding the value of each item (that item selected first is assigned 100%; that selected second is assigned 50%; that selected third is assigned 33%, etc.), users of this format are encouraged to assign ranks to the items following the order in which the items were selected (see, e.g., Solberg, Hanley, Layer, & Ingvarsson, 2007).

Perhaps the quickest assessment is the free-operant assessment described by Roane, Vollmer, Rihgdahl, and Marcus (1998). This assessment is capable of identifying preferred items and activities via duration-based recording of interaction while all items are simultaneously available. The efficiency advantage is offset by the fact that exclusive interaction with one or a few items is often observed; therefore, information regarding the value of all items included in the assessment is usually not provided. Nevertheless, the free-operant procedure is a quick means of identifying an individual's most preferred item or event. Because of the absence of trials or other procedural interferences, this assessment can also be used to identify preferences for naturally occurring activities that are simultaneously available. For instance, Hanley, Cammilleri, Tiger, and Ingvarsson (2007) described the use of a free-operant type of assessment that simultaneously captured the preferences of an entire classroom of preschoolers for typically available classroom activities.

If the relative value of multiple activities is a goal, and assessment efficiency is not paramount, a response restriction assessment (Hanley, Iwata, Lindberg, & Conners, 2003) may be useful. Response restriction procedures capitalize on the advantages of (1) extended access to assessment items and activities (like that realized in the duration assessments described by DeLeon et al., 1999; Roane et al., 1998) and (2) the hierarchy that results from restricting access to previously selected items and activities (like that evident in DeLeon & Iwata, 1996), and have been shown to be a reliable means for detecting preference hierarchies among activities (Hanley, Iwata, Lindberg, et al., 2003; Hanley, Iwata, Roscoe, Thompson, & Lindberg, 2003).

Strategies to Increase or Maintain the Effectiveness of Reinforcers

Motivating Operations

The effectiveness of a reinforcing stimulus is sensitive to the motivational conditions at the time the reinforcer is being delivered. There are two broad categories of motivating operations (Laraway, Snycerski, Michael, & Poling, 2003), those that temporarily increase the value of a reinforcer (called establishing operations; EOs) and those that temporarily diminish the value of a reinforcer (called abolishing operations; AOs). The most common EO is deprivation, and the most common AO is satiation. For example, being deprived of water on a hot day establishes water as a reinforcer and evokes behavior that historically has been reinforced with water; whereas having just consumed a liter of water abolishes water as a reinforcer and

abates behavior that has historically been reinforced with water. These conditions may fluctuate across time, or they may be controlled and capitalized upon by the applied behavior analyst. For instance, Goh, Iwata, and DeLeon (2000) showed that establishing the value of a reinforcer is critical in the development of novel mands. DRA was initially implemented while a dense schedule of noncontingent reinforcement (NCR) was available; that is, the reinforcer was freely available from an NCR schedule, but the participants could earn more reinforcers due to the DRA schedule in effect. No participants acquired the novel response under these conditions presumably because the relevant establishing operation was absent. When the NCR schedule was progressively leaned, all participants acquired the novel responses, presumably because the relevant establishing operation was programmed.

A serious challenge in arranging reinforcement contingencies is that each delivery of a reinforcer serves as an abolishing operation for that reinforcer and its related responses (e.g., the EO for responses related to water is weakened with each sip of water). A therapist has several options to minimize or delay the onset of satiation. One common practice is to deliver a small amount of the reinforcer during each delivery. With a similar rationale, the reinforcer(s) to be used during training is often restricted to the teaching conditions in which it is programmed. Roane, Call, and Falcomata (2005) demonstrated the impact of out-of-session reinforcer availability on the value of reinforcers with two adolescents diagnosed with mental retardation. The adolescents gained access to preferred leisure items via a PR schedule under two experimental conditions. In the first condition, termed an *open economy*, the same reinforcer delivered for responding on the PR schedule was also available for a period of time following each session. Access to the reinforcer was restricted outside of sessions, such that it could only be obtained during session times in the second condition (termed a *closed economy*). Responding on the PR schedule persisted longer during the closed economy sessions than the open economy sessions, indicating that reinforcers used during DR programs are likely to be more effective when withheld outside of teaching sessions.

However, if an item cannot legally or ethically be withheld, it may be possible to conduct training around naturally occurring schedules to maximize the effectiveness of reinforcers. For example, when using food as a reinforcer, it may be possible to schedule sessions just prior to regularly scheduled meals (e.g., North & Iwata, 2005; Vollmer & Iwata, 1991).

Reinforcer Variation

If multiple reinforcing items or events can be identified, varying the type of reinforcers delivered may delay satiation and prolong the effectiveness of DR (Bowman, Piazza, Fisher, Hagopian, & Kogan, 1997; Egel, 1981; Koehler, Iwata, Roscoe, Rolider, & O'Steeen, 2005). For instance, Bowman and colleagues (1997) showed that five of seven participants preferred the varied delivery of three lesser preferred items to the constant delivery of their most preferred item, and Egel (1981) showed that varying reinforcers resulted in more stable levels of correct responding and on-task behavior with several children diagnosed with autism.

Reinforcer Choice

Providing a choice of reinforcing items may be a simple yet highly effective means of improving the efficacy of DR procedures (Dunlap et al., 1994; Dyer, Dunlap, & Winterling, 1990; Fisher, Thompson, Piazza, Crosland, & Gotjen, 1997; Thompson, Fisher, & Contrucci, 1998; Tiger, Hanley, & Hernandez, 2006). Providing choices may operate in a manner similar to reinforcer variation, in that it minimizes satiation effects secondary to the repeated delivery of the same item. Providing the opportunity to choose among several reinforcers also allows provision of the reinforcer with the greatest momentary value in the DR procedure.

There is also evidence supporting the notion that the opportunity to choose adds value to DR beyond obtaining the most momentarily preferred reinforcers. For example, Tiger and Hanley (2006) showed that six of seven preschoolers preferred to engage in academic seatwork when their correct responding resulted in an opportunity to select a single edible from an array

of identical edibles rather than work on the same academic materials when their correct responding resulted in a teacher providing the same amount and type of edible from the same type of array. There was no other value in this arrangement (i.e., the children did not receive more or better reinforcers in the choice condition) other than the act of choosing. Tiger and Hanley also showed that children were willing to engage in 12 to 16 times more academic work to be able to choose from among reinforcers. These data make it clear that programming opportunities to choose from among an array of reinforcers is an important tactic for enhancing the efficacy of DR procedures.

Token Reinforcement Systems

Arranging conditioned reinforcers that can later be traded in for preferred items, known as *backup reinforcers*, is another strategy to decrease satiation. Token economies, for example, involve providing arbitrary items (e.g., tickets, tokens, stickers, or points) following the occurrence of target behaviors. Later these tokens can be exchanged for preferred items (for reviews of the literature on token economies, see Kazdin, 1982; Kazdin & Bootzin, 1972). Using these systems of conditioned reinforcement, teachers or therapist have the opportunity to deliver multiple reinforcers contingent on desirable behavior, without adversely affecting the value of the primary or backup reinforcers.

Complementary Procedures to Develop New Behaviors

This section describes procedures to complement DR in the development of new behavior.

Prompting

Prompting is typically paired with DR to develop new behavior. The general sequence involves prompting a response to occur, providing reinforcement for the prompted response, and gradually eliminating the prompt over time. Prompts can be provided in many forms (e.g., vocal, visual, or physical response prompts; within-stimulus prompts, extrastimulus prompts), and the form chosen is usually dependent on the modality of the target response and the capabilities of the individual. For example, a motor response can be prompted by vocally instructing the response, modeling the response, or physically guiding the response to occur. When working with infants, Thompson, McKerchar, and Dancho (2004) opted to use delayed physical prompts and DR (e.g., spoonfuls of food) to teach three infants to emit the manual signs "Please" and "More" when food was established as a reinforcer. This delayed physical prompting, and DR strategy resulted in the acquisition of manual signs for all three infants.

By contrast, nonmotor target responses, such as vocalizations, cannot be physically prompted; therefore, alternative prompting procedures must be paired with DR. Bourret, Vollmer, and Rapp (2004) opted to use vocal and modeled responses to teach vocalizations to two children with autism. This procedure involved an initial instruction to emit the target utterance (e.g., "say tunes"); successful utterances were reinforced with access to music. If the individual did not emit the target utterance, progressively simpler models were provided (e.g., changing "say tune" to say "tuh"). As the participants successfully imitated the smaller phonemes, imitating a larger segment was then necessary to obtain reinforcement.

After a response is acquired through prompting, it is often exclusively or partially controlled by that prompt, and this prompt dependency needs to be eroded to promote independent responding. Various tactics for fading and eventually eliminating prompts are paired with DR to achieve independent or apparently spontaneous responding (see Halle, 1987, for a discussion of spontaneity). Thompson and colleagues (2004) and Bourret and colleagues (2004) eliminated prompts by increasing the delay between the presentation of the evocative event (e.g., toy within reach) and the prompts, such that reinforcement was more immediate for independent responses. Other tactics include withholding reinforcement entirely for prompted responses (i.e., only independent responses would be reinforced; Touchette & Howard, 1984) or decreasing the physical intensity of the prompts (see Wolery & Gast, 1984).

Shaping and Percentile Schedules

Certain responses, such as the complex motor movements involved in serving a tennis ball or initiating sleep, are difficult or impossible to prompt. Prompting may also not be useful when high rates or extended durations of particular responses are desired. Under these conditions, shaping is a recommended tool. In short, shaping involves DR of successive approximations of a behavior. To initiate a shaping procedure, one must (1) identify a behavior the individual currently emits that is an approximation of the target behavior, (2) provide suitable reinforcement for that behavior, and (3) require closer approximations to the terminal behavior (more complex forms, different rates or durations of behavior) for reinforcer delivery. Shaping has been used to develop a variety of complex behaviors, including eye contact in children with autism (e.g., McConnell, 1967), vocal speech in mute adults diagnosed as psychotic (Sherman, 1965), and limb use in patients who have suffered a stroke (Taub et al., 1994). While shaping is one of the oldest and most celebrated tools of the applied behavior analyst, there are few formalized rules of shaping. It is generally considered more an art than a well-crafted teaching technology.

In response, Galbicka (1994) described a formalized shaping system using percentile schedules, and researchers have recently published studies in which percentile schedules are the cornerstones of their behavior change procedures (Athens, Vollmer, & St. Peter Pipkin, 2007; Lamb, Kirby, Morral, Galbicka, & Iguchi, 2004; Lamb, Morral, Kirby, Iguchi, & Galbicka, 2004). To systematize the shaping process, percentile schedules involve rules for when to deliver reinforcers, and these momentary rules adjust based on recent (local) rates, durations, or types of responding. In order to arrange percentile schedules to develop a complex form of behavior, all responses emitted are rank-ordered from the simplest to the most complex. A running stream of the temporal order and form of the responses is kept, with a particular focus on the most recent responses. A reinforcer is delivered for a particular response if the response exceeds the formal qualities of the most recent subset of responses.

Percentile schedules may also be used to shape higher rates or durations of responding. For example, Athens and colleagues (2007) increased the engagement of four students with learning or developmental disabilities in academic tasks via percentile schedules. With each participant, the duration of each bout of task engagement was measured during a baseline period. During the percentile schedule phase, a bout of engagement resulted in a token exchangeable for food if the bout duration exceeded the median duration of the previous 5, 10, or 20 bouts, depending on the experimental condition. In this regard, the criterion for reinforcement was constantly shifting given the individual's recent duration of responding. The percentile schedule resulted in increased levels of engagement for all participants, and the authors determined that the best effects were obtained in conditions in which more of the participant's previous behavior was taken into account when determining the momentary criterion for reinforcement (e.g., higher levels of engagement were observed when the previous 20 bouts were considered in the reinforcement criterion, as opposed to only the last five bouts).

Response Chaining and Task Analysis

Commonly taught behaviors are often not single, unitary responses; instead, they are characterized by a series of topographically distinct behaviors that must be completed in sequence. Behavior analysts often refer to these series of behaviors as *response chains*, and to each component behavior as a link in the chain. Much as it would be ineffective to wait for a single particular response, it is also unlikely to observe a chain of responses in correct sequence to reinforce differentially. Therefore, behavior analysts typically use prompting and DR or shaping to establish individual members of the response chain, then differentially reinforce sequences of behaviors until a whole functional unit of behavior (an entire response chain) is produced. Two general procedures, called *forward chaining* and *backward chaining*, are often used to teach response chains. Forward chaining involves teaching the response chain in the same order in which it will ultimately occur; that is, the emission of the first behavior in the chain is differ-

entially reinforced, then the first and second behaviors are reinforced, and so forth. By contrast, backward chaining involves DR of the last behavior in the chain, and behaviors of the chain are then added to the DR contingency in reverse order.

Teaching response chains requires that each individual component of the response chain be identified. This process is called *task analysis*. The importance of task analysis to DR of chained responses was evident in a study by Neef, Parish, Hannigan, Page, and Iwata (1989), who taught self-catheterization skills to two young girls with spina bifida. Each step of self-catheterization was identified (preparation of materials, mirror placement and adjustment, catheter insertion and removal, and cleanup) and then partitioned into six- to 11-component steps; each step was then taught to each participant via prompting and DR, until the two girls could independently self-catheterize (see Noell, Call, & Ardoin, Chapter 15, this volume, for additional detail on task analysis and chaining procedures).

Arranging Extinction and Punishment of Competing Behaviors

When training a novel response, it is usually necessary to address other, competing behavior while implementing DR. Risley (1968) reported on the initially unsuccessful attempt to teach a girl diagnosed with autism to make eye contact. She would regularly leave the teaching situation and climb dangerously on furniture. Therefore, Risley implemented a punishment procedure that reduced climbing and simultaneously facilitated the learning of other, habilitative skills.

Given the advances in behavioral assessment over the past 40 years, it is often possible to identify the sources of reinforcement for these competing behaviors and reduce them without the use of punishment. For example, Shirley, Iwata, Kahng, Mazaleski, and Lerman (1997) evaluated DR of a communicative response when implemented with and without extinction for self-injurious behavior (SIB); that is, researchers identified the reinforcer for SIB by conducting a functional analysis (Iwata et al., 1982/1994), and a new response that was trained resulted in access to the same reinforcer. Under one training condition, SIB and the novel response resulted in delivery of reinforcement. Only the novel response resulted in reinforcement in a second condition. The novel response was acquired only when SIB was placed on extinction in this second condition. In a study with preschool children at risk for language delays, Hernandez and colleagues (2007) showed that extinction need not be comprehensive to facilitate acquisition and maintenance of newly acquired responses (in this case, framed mands; e.g., "May I have the dolls, please"). When extinction was arranged for undesirable behavior (e.g., grabbing items) and simple responses (e.g., "Dolls") in two contexts, acquisition and maintenance of framed mands occurred in three other contexts in which all mand forms were reinforced.

In some cases, however, extinction procedures are ineffective for reducing competing behaviors and allowing for new responses to be acquired or maintained; in these cases, punishment procedures may be necessary for DR to be effective. For instance, Hagopian, Fisher, Sullivan, Acquisto, and LeBlanc (1998) evaluated DR in the treatment of self-injury with 21 individuals admitted for the treatment of severe problem behavior. Initially DR was implemented without extinction for problem behavior, and the intervention was generally ineffective across all participants. When extinction was implemented, less than half of the participants responded well to treatment, but all participants met effective treatment standards after both a punishment and an extinction component were programmed to follow the competing behavior of self-injury.

Response Maintenance and Schedule Thinning

When establishing a new response, it is generally agreed that reinforcers should be delivered immediately, and following each target response. It is likely that delayed or intermittent reinforcement will hinder acquisition of most responses (e.g., Bennet & Cavanaugh, 1998). While necessary in the development of a skill, it is often challenging for caregivers and teachers to provide reinforcers immediately and following each response over time. Thus, DR procedures are likely to be implemented with imperfect integrity over

time. Therefore, it is advisable to implement some means of thinning the schedule of DR following acquisition of the new response.

One technique is to deliver reinforcement intermittently (i.e., progressively require more responding prior to delivering a reinforcer). For example, Van Houten and Nau (1980) increased the attending behaviors of elementary school-age students by arranging FR- and VR-like schedules of reinforcement for these behaviors. Under the fixed schedule, every eight observed intervals with attending behavior resulted in reinforcement. Under the VR schedule, following a 5-minute observation of continuous attending behavior, children could reach into a grab bag with a one-eighth probability of payoff. Procedures such as these may allow caregivers to miss a few instances of an important response without inadvertently weakening the response.

A second technique for making DR more practical is to include delays to reinforcement. This allows caregivers and teachers extra time to provide the reinforcer. However, delays to reinforcement often result in extinction of newly acquired responses (Fisher et al., 2000; Hanley et al., 2001) . The successful introduction of delays may be best accomplished by beginning with initially brief delays to reinforcement and gradually increasing the delay (Schweitzer & Sulzer-Azaroff, 1988), providing a signal when the delay has begun (Vollmer, Borrero, Lalli, & Daniel, 1999), and providing alternative activities during the delay period (Fisher et al., 2000).

A third technique, which involves teaching individuals when their responses will and will not be reinforced (i.e., gaining stimulus control over the behavior), is another means of making DR more practical to implement over time (Hanley et al., 2001; Tiger & Hanley, 2004). The procedure involves programming two distinct periods: one characterized by continuous availability of reinforcement, and the other by the complete absence of reinforcement. Both periods are correlated with different and distinctive cues that signal the availability or unavailability of reinforcement for responding (because the two schedules alternate and are associated with distinct cues, the procedure is often referred to as a *multiple schedule*). Hanley and colleagues (2001) showed that this multiple-schedule procedure maintains newly acquired social manding despite reinforcement being available only one-fifth of the time. This procedure does not weaken the contingency between responding and reinforcement as may occur with reinforcement delay and does not result in an excessive amount of behavior as may occur with intermittent schedules of reinforcement (Hanley et al., 2001). Instead, newly acquired behavior eventually occurs when and only when the person responsible for delivering the reinforcement signals that it is available. In addition, Tiger and Hanley (2006) showed that children preferred conditions in which reinforcement and extinction periods are signaled relative to conditions in which the signals are absent or not obvious, and Luczynksi and Hanley (2009) showed that children preferred multiple schedules to briefly signaled delays.

Exemplary Applications of DR

Behavioral Skills Training

Behavioral skills training (BST) is a comprehensive package most often used to teach self-protection skills. The package contains (1) instructions and education regarding the situations and target behaviors; (2) modeling of the target behavior in the situation by the interventionist or by a trained peer; (3) practice of the skill under role-playing conditions; (4) DR for correct responding, usually in the form of praise and more practice opportunities following errors, and, when necessary; (5) additional DR under seemingly real-life conditions. BST has been implemented to teach adults with mental retardation to avoid sexual abuse (Lumley, Miltenberger, Long, Rapp, & Roberts, 1998), to teach children to avoid strangers (Johnson et al., 2005) and gun play (Himle, Miltenberger et al., 2004; Miltenberger et al., 2004), and to teach children fire safety skills (Bannerman, Sheldon, & Sherman, 1991; Jones, Kazdin, & Haney, 1981) and to avoid common household injuries (Mori & Peterson, 1986). BST is generally considered the premier intervention for teaching safety skills to young children (Davis & Gidycz, 2000). BST, with DR at its core, has also been applied on classwide bases to teach important social skills to preschool children to minimize their existing

problem behavior and prevent the development of more severe behavior problems during later school years (e.g., Hanley, Heal, Ingvarsson, & Tiger, 2007).

Self-Management

DR procedures often require a great deal of supervision in that each instance of a response needs to be observed, documented, and potentially reinforced. As noted earlier, this may be prohibitive to the integral implementation of these procedures. Self-management techniques attempt to teach the target of an intervention to serve as his or her own intervention administrator. This involves observing and/or recording behavior, comparing this behavior to a preset criterion, and, when appropriate, recruiting reinforcement. (Note that self-management is distinct from self-reinforcement, with the latter being conceptually impossible; see Catania, 1975, for a discussion.) Bornstein and Quevillon (1976) provided an early demonstration of a self-management technique when they taught three preschool-age boys to ask themselves questions about task completion and target performance, to compare their performance to that of a standard, and to recruit praise from others. These performances taught in brief "pull-out" conditions readily appeared in the preschool classroom and were maintained when there was not an adult observing for accurate use of the self-management system. Self-management procedures have most often been used to limit disruptive behavior and increase attending classroom behavior (e.g., Craft, Alber, & Heward, 1998; Freeman & Dexter-Mazza, 2004; Mithaug & Mithaug, 2003; Ninness, Fuerst, Rutherford, & Glenn, 1991) but they have also been used to teach mathematics completion (Wood, Frank, & Wacker, 1998), transition skills (Connell, Carta, & Baer, 1993), and social skills (Sainato, Goldstein, & Strain, 1992).

DR of Diverse Responding

DR is typically implemented to increase the occurrence of a target behavior, but it may also be used to increase the diversity of behavior. The earliest demonstration of this type of arrangement involved preschoolers' block structures in a study by Goetz and Baer (1973). Each time a preschooler created a block structure that he or she had not already built that day, the experimenter provided descriptive praise (e.g., "Wow, a tower; that is new"). This contingency resulted in a sharp increase in the frequency of both new forms built within sessions and forms never before seen in the assessment. Since the initial Goetz and Baer study, similar procedures have been used to increase diverse verbal responses to questions (Lee, McComas, & Jawor, 2002), activity selections during free-play periods (Cammilleri & Hanley, 2005), and martial arts performances (Harding, Wacker, Berg, Rick, & Lee, 2004). Diverse patterns of behavior were achieved in these studies when these authors provided reinforcement only for responses that differed from some previous number of responses (this schedule is similar to a lag schedule; see Page & Neuringer, 1985). For example, Cammilleri and Hanley (2005) delivered reinforcement in the form of extra teacher attention when students selected a free-play activity that was different from their previous 11 selections. This lag DR contingency resulted in children, who historically only accessed a single activity during free play, accessing at least 10 different activities during free-play periods. By increasing the diversity of activity selections, these children also engaged in and completed more academic units while the lag DR contingency was in place.

Medical Compliance

Compliance with recommendations from medical professionals is often low due to the aversive nature of the immediate consequences for following the recommendation (as in chemotherapy) or the effortful nature of the requested behavior change (as in exercise). Behavior analysts have relied on the efficacy of DR procedures to assist patients in achieving the long-term reinforcers associated with heeding medical recommendations. For instance, Renne and Creer (1976), in an early example, increased asthmatic children's compliance with inhalation therapy routines by prompting and providing corrective feedback on the occurrence of eye fixation, facial posturing, and diaphragmatic breathing. Behavior analysts have also been involved in the treatment of enuresis and encopresis, preventive dentistry (Iwata &

Becksfort, 1981), reduction in overmonitoring of blood glucose levels of diabetics (Allen & Evans, 2001), self-catheterization (McComas, Lalli, & Benavides, 1999; Neef et al., 1989), preparation for functional magnetic resonance imaging (fMRI; Slifer, Koontz, & Cataldo, 2002), respiratory treatment for cystic fibrosis (Hagopian & Thompson, 1999), and increasing physical activity (VanWormer, 2004). All of the interventions involve multiple components, but the fundamental shared feature of these interventions is the reliance on DR of behaviors consistent with the medical prescription (e.g., lying still in an fMRI for successively longer periods or successful completion of a greater number of steps toward self-catheterization).

Group Contingencies

When the behavior of large groups of individuals is the target of intervention, the practical limitations of applying individualized DR to each member of the group may be prohibitive. Under these conditions, various dependent or interdependent group contingencies may be applicable. With a dependent group contingency, the consequences for the group are dependent on the behavior of only one or some members of the group (e.g., when an entire classroom earns extra recess time if a particular child scores well on an exam; Litow & Pumroy, 1975). Dependent contingencies can be arranged to motivate students to come to the aid of another student (e.g., help in preparing for an exam; Speltz, Shimamura, & McReynolds, 1982) or assist another in behaving more appropriately by not occasioning or rewarding misbehavior. Poorly designed group contingencies may, however, lead to unwelcome peer pressure, and most children do not prefer to have "their reinforcers" be contingent on someone else's behavior (e.g., Speltz et al., 1982). An alternative that allows the behavior of all members of the group to affect the probability of reinforcement is described as an *interdependent group contingency* (Litow & Pumroy, 1975). An example is requiring that all students exceed a particular minimum score on an exam (or engage in fewer than a particular number of classroom disruptions) in order to earn the reinforcer. Interdependent group contingencies sometimes also involve competition between two or more groups, with only the highest scoring group receiving the reinforcer (the "good behavior" game for students in classrooms: Barrish, Saunders, & Wolf, 1969; or the "good productivity" game for staff in hospitals: Lutzker, & White-Blackburn, 1979).

Lottery Contingencies

Even when intervening in the behavior of groups, individualized contingencies can be arranged in a time- and cost-effective manner. For instance, in a lottery-type contingency, the individualized performance of each individual is reinforced periodically with entry into a raffle, wherein a single individual receives the reinforcer. For example, Petry and colleagues (1998) used a lottery-type reinforcement procedure to decrease inappropriate verbal behavior in a heroin treatment center. Desirable verbal behavior resulted in the delivery of stickers to the clinics patients. At the end of each week, all sticker recipients were entered in the lottery, and one person's name was drawn to receive $25. This procedure resulted in increased complimenting and pleasantries, and decreased profanity and discussion of evading the police.

Conclusion

Due to the abundance of research on the topic, DR is one of the most advanced tactics by which behavior analysts improve the behavior of others. A mature understanding of DR involves knowledge of (1) the range and complexity of behavior that may be affected by DR, (2) the parameters that may be considered to turn on or increase the effectiveness of DR, and (3) the types of tactics DR may complement to bring about important and lasting changes to important behavioral repertoires. This sort of understanding, combined with supervised and dedicated practice implementing DR, is critical to the development of an effective applied behavior analyst.

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CHAPTER 15

Building Complex Repertoires from Discrete Behaviors by Establishing Stimulus Control, Behavioral Chains, and Strategic Behavior

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Behavior analytic approaches to establishing new behaviors can be characterized broadly as emphasizing an elemental or bottom-up approach. These approaches typically have focused on sequentially establishing discrete measurable behaviors, then elaborating upon those behaviors through procedures such as chaining or shaping. This simple-to-complex sequential approach can be contrasted readily with alternative approaches to teaching new behaviors that emphasize discovery learning, top-down conceptual instruction, executive control, and Gestalt-based approaches (e.g., Haywood, 2004; Keyes & Bryan, 2001; Martens & Daly, 1999). Although these alternatives do not inherently conflict with a behavior analytic approach to teaching, they have developed out of traditions that have emphasized cognitive constructs over measurable behaviors. As a result, cognitive constructivist approaches to teaching are commonly perceived as conflicting or competing with behavior analytic approaches. It is worth noting that cognitive constructivist and behavior analytic approaches to teaching have much in common. Both approaches seek to help individuals develop complex behavioral repertoires that include flexible and generalized responding to diverse stimuli. However, substantive differences exist in their emphases at conceptual, procedural, and practical levels.

The systematic elemental approach that generally has characterized behavior analytic teaching has been praised by some for simplifying complex behavior sufficiently that it can be taught to individuals whose developmental challenges have severely limited their acquisition of new or complex behavior (Luiselli & Hurley, 2005). By contrast, behavioral and behavior analytic approaches to establishing complex behavior have been severely criticized for failing to capture the symbolic meaning or underlying structure of complex behaviors, and for fostering dependence on instructors (Hickey, Moore, & Pellegrino, 2001; Kroesbergen, Van Luit, & Maas, 2004). For example, despite their success, stimulus equivalence approaches to teaching mathematics operations using procedures such as constant time delay prompts have been criticized by some mathematics educators as being mechanistic, reductionistic, and running the risk that students will not understand the concepts the operations represent (Koscinski & Hoy, 1993). From a behavior analytic perspective, this *understanding* may be conceptualized as a diverse, flexible, and generalized repertoire of behaviors that are part of a family of

new responses. This flexibility and diversity of behavior may be both a critical element of perceived competence and extremely difficult to establish.

Complexity: Flexible Diverse Behavior

Behavioral complexity is a concept that is difficult to define in clear objective terms because it emerges relative to both other behaviors and to the degree of proficiency an individual has attained in that skills domain. For example, means of communicating with friends might be ordered from less complex to more complex. Talking to a friend in the room is less complex than calling the friend on the phone, which in turn is less complex than writing a letter to the friend. In this case, the order of complexity is based on the number of steps required to complete the task and the additional skills required to complete these steps. Formerly complex behaviors may become simple operants as the individual develops greater skills within a domain. For example, decoding a single word can be a complex process that includes morphological discrimination, stimulus control based on the complex arrangement of stimuli, and phonological blending skills for beginning readers (Snow, Burns, & Griffin, 1998). Later in the process of becoming literate, such as during fluency building, reading that same word can become a simple behavior in which the word is perceived as a single stimulus corresponding to a single vocalization (Snow et al., 1998). Thus, a common goal of teaching is to permit the individual to master simple behaviors such that they become the elements of more complex behaviors.

Establishing flexible generalized responding that is adaptive and demonstrates mastery typically requires dealing with complex person–environment interactions. Complexity can emerge in any part of the three-part antecedent–behavior–consequence (A-B-C) chain. For example, completing a behavior might be described as more complex when the antecedent that is intended to occasion the behavior is ambiguous (e.g., Harding, Wacker, Cooper, Millard, & Jensen-Kovalan, 1994). Similarly, requiring a delay between the onset of the discriminative stimulus and the target behavior or presenting a complex multidimensional discriminative stimulus would likely increase task difficulty. Establishing behaviors that are controlled by stimuli whose functional properties change based on the context in which they occur can introduce considerable complexity to establishing appropriate stimulus control for new behaviors. Complex stimuli whose functional properties change across contexts are a common part of social contexts and academic activities, such as reading and vocational activities.

The first and most intuitive source of complexity in establishing new behaviors is the behaviors themselves. Although no generally accepted definition of behavioral complexity exists within behavior analysis, we suggest that five critical aspects of establishing flexible behavioral repertoires are sufficient for capturing some of the critical dimensions of establishing new behaviors. The five dimensions include subordinate and superordinate skills, sequencing behavior, promoting variability in responding, ambiguity in natural criteria, and establishing self-management skills. One of the more intuitively obvious sources of complexity in the establishment of new behavior is the reality that many skills a behavior analyst or other teacher may wish to establish are in reality composed of a number of subordinate skills. For example, fluent reading decoding skills are precursors to text search and reading comprehension skills (Shapiro, 1996). Virtually all behaviors that behavior analysts seek to establish have prerequisite subordinate skills. Even a simple motor response within a discrete trial teaching procedure requires that the student sit and orient toward the teacher in order to be taught.

One of the considerable challenges in teaching arises from identifying not only the behaviors that are prerequisites for the target response, but also the level of skill proficiency needed to set the occasion for teaching the target skill. It may be obvious that prior to teaching a student to balance a checkbook, the student first must be able to complete addition and subtraction operations correctly. However, defining which types of operations have to be taught first, and to what level of accuracy and fluency prior to beginning instruction in the target skill, may pose a considerable challenge (see Kelley, Reitman, & Noell, 2002, for a dis-

cussion of accuracy and fluency criteria in subordinate skills).

A second source of complexity in establishing new behaviors naturally emerges when target behaviors include multiple steps. Multiple-step behaviors are commonly described as behavioral chains within applied behavior analysis. A *behavioral chain* is a series of behaviors that occur sequentially and produce a consistent end state when they are ordered correctly. Within an established chain, each behavior produces the conditioned reinforcer that serves as the discriminative stimulus for the next behavior in the chain. The behavior analytic literature regarding the establishment of behavioral chains is relatively well developed and is discussed in some detail below.

A third source of complexity in establishing new behaviors emerges when competence requires variable behavior. At some level this can be described as necessity for the emergence of adequate response generalization, and it is a common feature needed for individuals to exhibit competence. For example, answering common questions requires the emergence of generalized responding demonstrated within behavior analytic teaching procedures (Secan, Egel, & Tilley, 1989). Similarly, responding to variations of antecedent stimuli within a class of stimuli can require variation in responding. Sprague and Horner (1984) provide an example of systematically introducing variation in the antecedent stimuli to occasion response generalization under the rubric of general case programming. The requirement that responding be variable within some accepted bounds to remain in contact with reinforcement is a common feature of social, vocational, and academic behaviors. For example, a student who writes the same excellent, creative entry into her language arts journal each day is unlikely to continue to be reinforced by her teacher. It is also worth noting that the issues of response generalization and behavioral flexibility are very challenging for some students. Students who require many trials with very carefully controlled antecedent stimuli to learn to emit a single member of a response class may in turn have a difficult time learning to respond to the natural variation in antecedent stimuli with a competent variety of responses. This difficulty with learning to respond in a naturally varied manner is one of the central features of some developmental disabilities (Travis & Sigman, 1998).

A fourth source of complexity in behaviors emerges when the behavior to be established has such varied forms that identification of a correct or criterion form is difficult. These types of behaviors are quite common in natural human contexts. For example, students writing an essay or responding to a social question about what they did over the weekend may have an essentially infinite number of correct responses. The diversity of "correct responses" in writing has led to the emergence of an entire literature relevant to the evaluation of writing samples (e.g., Gansle, Noell, VanDerHeyden, Naquin, & Slider, 2002). In these contexts, responding in the natural context that will make contact with reinforcement is often dependent on multiple dimensions of the behavior that are complementary. For example, a teacher who may be willing to overlook some grammatical errors in an exceptionally creative and engaging essay may expect greater technical precision from a less creative essay. Responses for which the criteria for correct responding are ambiguous and include multiple complementary dimensions of behavior often coincide with contexts in which variation in responding is also expected.

A fifth source of complexity emerges when behavior requires substantial planning, monitoring of the plan, and revision of the plan as it is implemented. This planning, monitoring, and revision process has been described as *executive control* (Pennington & Ozonoff, 1996) outside of applied behavior analysis and as *self-management* within some behavioral traditions (Gureasko-Moore, DuPaul, & White, 2006). Executive control or self-management in this context refers to the organization and evaluation of behaviors that are commonly necessary to complete complex behaviors. Although the term *executive control* typically is assumed to describe unobservable internal processes, planning and plan monitoring are not necessarily unobservable behaviors. Within behavioral traditions, these planning, monitoring, and revising behaviors have commonly been described as *strategies*, and the establishment of these behaviors has been described as *strategy instruction* (Pressley & Woloshyn, 1995). *Strategy use* can be

described as an overarching organizational behavior that the guides the selection, ordering, and evaluation of the task-directed behaviors completed as part of a behavioral chain that is adapted to the specific antecedent stimuli present (Alexander, Graham, & Harris, 1998). Strategy instruction may also be a form of generalization programming, in which the individual is specifically taught to generalize (Pressley & Woloshyn, 1995). In this case, strategic behavior provides a general problem-solving model within some domain. Strategic behavior is remarkably common in everyday life. It is evident in diverse tasks, such as reading, grocery shopping, and driving, as well as low-frequency but high-importance behaviors such as applying to graduate school. Strategy instruction is discussed in some detail later in this chapter.

A final source of complexity in establishing new behavior arises from the consequences of behavior. Among the salient challenges are consequences that are delayed and consequences that occur on thin schedules. Additionally, consequences that are multidimensional stimuli serving multiple functions simultaneously can present challenges to teaching new behaviors. In some naturally occurring contexts, existing consequences are sufficiently delayed, are on such thin schedules, and are so ambiguous in presentation that they are insufficient to teach new behavior or maintain existing behaviors. An extensive literature available within behavior analysis examines how the efficacy of consequences is affected by delay, quality, magnitude, and the schedule of presentation. Due to the breadth of that literature and space limitations, the procedural impact of variations in consequences per se is not an extensive focus of this chapter.

Although applied behavior analysis approaches to teaching commonly have relied upon elementally focused, tightly controlled procedures that may initially produce inflexible responding, these procedures should be conceptualized as a beginning rather than an endpoint. This tightly controlled elemental approach arose in part from efforts to improve the lives of individuals who were not benefiting from "traditional" instruction to a substantive degree (Luiselli & Hurley, 2005). The striking success of instruction derived from applied behavior analysis principles has in turn led to its successful application to typically developing individuals and to individuals whose development is almost typical, but who struggle with some behaviors (Daly, Persampieri, McCurdy, & Gortmaker, 2005; Koscinski & Hoy, 1993). The demonstration that individuals who previously may have been regarded as "unteachable" can learn, or that individuals whose learning previously was described as disabled can learn far more or far faster than previously thought possible has been the primary focus of the behavior establishment research within applied behavior analysis. Moving from initial discrete, teachable behavior to the more elaborate flexible repertoires is a fundamental goal of teaching that has been well represented within the applied behavior analysis literature. The balance of this chapter focuses on critical issues in the establishment of new behavior and the elaboration upon those behaviors such that more flexible adaptive repertoires are developed. In the following sections we discuss selected issues in the assessment of behaviors and individuals prior to teaching, then a number of specific procedures that might be used to establish new behavior. The procedures are presented as they might arise in practice as one moves from establishing an initial response in a domain to elaborating upon that behavior, to creating a more complex repertoire. As a result, those sections progress from shaping/prompting to chaining, to strategy instruction, and finally to generalization.

Assessing Behaviors and Individuals

Although it can be complex and effortful to achieve in practice, establishing new behavior can be conceptualized as being quite simple. Three questions naturally emerge. First, what is the student expected to do? Second, what does the student know how to do? Third, based on the answer to the second question, what procedures can lead to the student meeting the expectations identified in the first question? Although these questions are conceptually simple and have been answered by teachers, parents, and employers for centuries, considerable complexity arises in the details. For example, most individuals do not need to learn one

new behavior, but many new behaviors. These behaviors are likely to overlap in both function and topography. Initial work often is needed to prioritize the behaviors to be taught. Space limitations preclude an extensive consideration of prioritizing strategies within this chapter. Generally, those behaviors that have the broadest possible adaptive importance and those that are prerequisites of more advanced and broadly important skills should be targeted first. Behaviors that make very broad contributions to an individual's adaptive success previously have been described as *keystone behaviors* (Barnett, Bauer, Ehrhardt, Lentz, & Stollar, 1996). Obvious examples include spoken language in social contexts and reading in educational and/or vocational contexts.

Commonly, planning instruction begins by identifying the endpoint or competent performance by the student such that instruction in this domain will no longer be needed. The endpoint might be reading text and correctly answering comprehension questions, or it might be exhibiting age-appropriate oral language skills. For some individuals, the immediate endpoint may simply be an intermediate stage in preparing the student to learn additional material. For example, teaching a child with autism to articulate targeted words in response to appropriate antecedent stimuli is less likely to be an endpoint than to be a stage in the process of building oral language skills.

Once the immediate endpoint of instruction has been identified, the next stage in the process is often to break that performance down to identify its critical components. This process can result in either a task analysis or the identification of *relevant approximations*, which are behaviors topographically similar to the target response that potentially can be shaped through differential reinforcement to result in the target response (Isaacs, Thomas, & Goldiamond, 1960). For example, it may initially be necessary to bring making sounds under stimulus control through differential reinforcement prior to shaping vocalizing words (Isaacs et al., 1960). Similarly, a student who already reads grade-level words may do so with insufficient fluency to be competent. In this case, reading slowly may be an approximation of reading fluently that can then be used as a basis for establishing fluent reading by differential reinforcement (Noell et al., 1998).

In many instances, teaching consists of training children in a number of steps or skills that can then be combined to form the competent endpoint behavior. Identifying the steps or subordinate behaviors to be taught commonly is accomplished through a *task analysis*, which is the process of breaking down a complex behavior into a series of discrete, measurable, and teachable components. For example, completing multiplication problems often requires students to read the numbers, read the operation sign, identify the correct answer, and write the correct answer. A number of strategies for completing task analyses have been identified by various authors (Cooper, Heron, & Heward, 1987; Miltenburger, 2001). Three methods appear to be the predominant approaches recommended. First, the performance of competent individuals can be watched, and the steps they use to complete the task recorded. A second approach is to consult an expert. An expert may be an individual with specialized content expertise, or it may be a specialized resource that is published. Kohr, Parrish, Neef, Driessen, and Hallinan (1988) blended the first two approaches in developing a task analysis for teaching parents to communicate with professionals regarding their disabled children. The task analysis was derived from observation of parents, and review of published resources, and of recorded samples by an expert panel. A third commonly recommended approach to a task analysis is for one simply to complete the target behavior and record the steps necessary to complete the task.

Once the component steps of the target task have been identified, the next common step is to assess the student's skills on the target task. Typically this is begun by completing the task as a whole and recording those steps the student can complete independently as a means of identifying those steps that will need to be taught. Conceptually this is a simple process; in practice, however, at least two issues can add complexity to the assessment of skills prior to teaching. The first is the establishment of standards. For example, how clearly must words be articulated, or with what accuracy must numbers be read? For many domains within which behavior analysts work, obvious or broadly

accepted standards are not readily available. In many instances, reasoned standards can be developed rationally (e.g., students need to read all numbers correctly) or by examining the behavior of competent peers. It is important to note that adequate standards commonly need to include both accuracy and fluency dimensions of behavior, and it may be necessary to capture quality as well. Kelley and colleagues (2002) provide a more extensive discussion of the development of accuracy and fluency standards for specific skills.

Once the critical steps and subordinate skills have been identified, the next step in a behavior analytic approach commonly is to assess the student's behavior and compare it to relevant standards for accuracy and fluency. This stage is likely to identify critical behaviors contributing to the end goal that require additional instruction. For example, it may become apparent that the student's reading fluency is too low for him to her to answer comprehension questions accurately. Examination of reading performance may in turn suggest that the student has sufficient fundamental skills and simply needs fluency building, that some critical sight words are missing, and/or that phonics decoding skills are insufficient to cope with novel words (Shapiro, 1996). Each of these outcomes suggests a different initial focus for instruction.

One of the central features of applied behavior analysis is the recognition that the environment influences behavior. This fact is as important to the assessment of behavior as it is to the treatment of behavior. It is perfectly possible for the initial assessment to suggest that a student needs additional instruction with a particular skill, when in fact the environmental supports in the assessment context are simply insufficient to evoke competent responding. For example, the presence of reinforcement for competing responses, distractions, or the absence of contingencies for competent responding can potentially result in a downwardly biased estimate of student skills (Noell, Freeland, Witt, & Gansle, 2001). Prior research has demonstrated that repeated assessments suggesting an absence of skills in an environment that is optimized for desirable responding (e.g., providing rewards for improved responding) can result in substantially different assessment results and foci for instruction. Assessment of behavior under varied conditions in a manner that tests consequences should be an element of any preteaching assessment of behavior within an applied behavior analysis approach.

At the conclusion of the initial assessment stage of teaching, clear initial targets should be identified. Additionally, the importance of commonly occurring consequences, such as accuracy feedback, or praise versus additional programmed consequences, such as material rewards, should be clarified. The next stage in the process is to identify an instructional procedure that is appropriate for establishing or refining the target behavior. The remainder of this chapter describes specific procedures within an applied behavior analysis framework for teaching and developing more complex behavior. It is also worth noting that in reality the assessment–treatment/teaching process within applied behavior analysis is recursive and continuous; that is, once treatment begins, ongoing assessment data are available to guide decisions that in turn lead to changes in the instructional plan.

Shaping

Shaping is a particularly important instructional approach for students who have a low probability of exhibiting the target behavior even with prompting, but for whom some related prerequisite behavior can be identified as a basis from which to begin instruction. *Shaping* involves increasing the probability of a response through the gradual transformation of some property of responding. This transformation occurs because of the differential reinforcement of successive approximations of a targeted operant class. The process of shaping, which modifies the topography of a response, also has been referred to as *shaping across topographies* and has been demonstrated in a number of classic studies (Horner, 1971; Isaacs et al., 1960; Skinner, 1938). For example, Isaacs and colleagues (1960) shaped the eye movements of an individual diagnosed with comatose schizophrenia into lip movements, then speech sounds, and eventually recognizable words. Shaping may also be used to modify the rate, magnitude, or some other property

of the target operant, which is referred to as *shaping within topography*. This type of shaping has also been used across a number of studies, such as increasing the arm extension of an athlete during a critical step in pole vaulting (Rea & Williams, 2002) and the duration of individuals' breath holding prior to measuring exhaled carbon monoxide levels during smoking cessation treatment (Scott, Scott, & Goldwater, 1997).

When shaping begins, a distribution of behavior typically exists relevant to the response dimension to be altered. Shaping is the attempt to use extinction and reinforcement continually to shift this distribution such that the proportion of responses containing the desired response property increases (Galbicka, 1994). Continued differential reinforcement of responses above a criterion value results in *differentiation*: a shifting of the distribution of behavior, such that an increasing proportion falls at or nearer to the target behavior. Several factors impact the probability of using shaping successfully to produce a new behavior, including properties of the initial response and the manner in which the criterion for reinforcement is established. The initial behavior selected for reinforcement must occur at a sufficient level to permit initial reinforcement. It must also approximate the target behavior in some way, so that a response dimension can be differentially reinforced. Finally, variability of the initial response must allow for differential reinforcement of those responses that exceed an established criterion with respect to a desired response property. However, an increase in variability is a predictable side effect of both reinforcement (Skinner, 1938) and extinction (Lerman & Iwata, 1996), so initial responses that seem relatively invariant may still be amenable to shaping.

Determining which responses to reinforce and which responses to extinguish can be a challenging aspect of shaping. If the criterion for reinforcement is set too low, then a large proportion of the responses will result in reinforcement, causing differentiation and shaping to proceed slowly. By contrast, if the criterion is set too high, too large a proportion of the response distribution will result in extinction, and the behavior may extinguish altogether. Galbicka (1994) proposed a method for empirically determining the criterion for reinforcement when shaping using percentile schedules. All responses that exceed a preestablished rank-ordered response from a sample of the previous responses (e.g., the third highest from the last 10) result in reinforcement. The advantage of the percentile schedule is that as previous responding varies, the distribution of responses used to establish the criterion for reinforcement is constantly updated. However, the optimal rank order and number of responses to sample when establishing a percentile schedule are not known.

Prompting

When a response is not in a student's repertoire or is not under appropriate stimulus control, prompting may be necessary to evoke the response so it can be reinforced. *Prompts* are antecedent stimuli that increase the probability of a desired response. By increasing the number of opportunities to provide differential reinforcement in the presence of the stimulus that is supposed to, but does not yet, control the behavior, prompting can help this criterion stimulus become a discriminative one (Alberto & Troutman, 1986; Cooper et al., 1987; Demchak, 1990; Miltenberger, 2001). Prompts have been broadly divided into the categories of stimulus and response prompts (Schoen, 1986; Wolery & Gast, 1984). *Stimulus prompts* are those in which some property of the criterion stimulus is altered, or other stimuli are added to or removed from the criterion stimulus (Etzel & LeBlanc, 1979). By contrast, *response prompts* involve the addition of some behavior on the part of an instructor to evoke the desired learner behavior. Prompts have been used to teach a wide range of behaviors, including communicative (Matson, Sevin, Fridley, & Love, 1990; Williams, Donley, & Keller, 2000), academic (Stevens, Blackhurst, & Slaton, 1991), leisure (DiCarlo, Reid, & Stricklin, 2003; Schleien, Wehman, & Kiernan, 1981), social (Krantz & McClannahan, 1993), self-help (Pierce & Schreibman, 1994; Taylor, Hughes, Richard, Hoch, & Coello, 2004), and vocational (Wacker & Berg, 1983) skills.

Response prompts have been described as existing along a continuum of intrusiveness, or the amount of assistance required to evoke the desired behavior (Cooper et al.,

1987; Miltenberger, 2001). Verbal prompts are often considered the least intrusive, whereas physically guiding the student to perform the desired behavior is considered one of the more intrusive types of response prompt. Moderately intrusive response prompts include using gestures or modeling the desired behavior. Most types of prompts can also be delivered at different levels of intrusiveness, such as providing a partial verbal prompt (e.g., the first sound) instead of giving the complete instruction or physically guiding the student to perform just the first portion of the behavior instead of the whole response.

One type of prompt that can be especially effective for teaching complex behaviors is *modeling*: a type of prompt in which the antecedent stimulus is topographically identical to the target behavior being instructed (Bandura, Ross, & Ross, 1963). Whether *in vivo* or symbolic (e.g., video display, pictures), a number of factors can influence the effectiveness of modeling. For example, modeling is more likely to be successful if the learner observes the model's behavior result in reinforcement (Bandura et al., 1963). Also, similarity between the model and the learner, or between discriminative stimuli present during modeling and those present when the learner is to perform the behavior, can impact acquisition. Two potential limitations of modeling are that the learner must have generalized imitation skills and be able to attend to the model during instruction.

Prompt Fading

If a prompt is successful, then the behavior begins to occur in the presence of the prompt and the criterion stimulus, such that differential reinforcement can be delivered. However, if the prompt continues to be delivered in the same manner, then it may overshadow the criterion stimulus, such that the criterion stimulus never takes on discriminative properties in the absence of the prompt. Such "prompt dependence" can be problematic if the prompt does not occur in the natural environment. Thus, stimulus control must be transferred from the prompt to the criterion stimulus. *Prompt fading* is a method of gradually removing a prompt, so that the behavior eventually comes under control of the criterion stimulus in the absence of prompts.

Fading Stimulus Prompts

There are two primary methods of fading stimulus prompts: stimulus shaping and stimulus fading. In *stimulus shaping*, the property of the criterion stimulus that is critical to the intended discrimination is altered or exaggerated, so that the learner can initially make the discrimination. For example, when teaching a sous-chef to make subtle discriminations of saltiness, initial training may occur with very distinct differences in the salt content of two samples of the same dish. Once the student is reliably making the discrimination, the altered property of the stimulus is gradually diminished until the stimulus is representative of the criterion stimulus (Etzel & LeBlanc, 1979). Thus, when using stimulus shaping, the difference in the amount of salt in the two samples may become smaller until the sous-chef can detect even subtle differences.

Stimulus fading also involves manipulation of the criterion stimulus, but some property other than the dimension critical for the discrimination is altered (Etzel & LeBlanc, 1979). For example, position prompts or the size of a target letter could be altered when teaching receptive letter identification. In this case, neither position nor size is the dimension critical for discriminating the target letter from other letters. Rather, the form of the letter is the critical property. During stimulus fading, the size or position of the target letter is brought closer to the position or size of the alternative letter, until a discrimination is made solely on the basis of letter form.

A review of studies comparing instructional strategies found that both stimulus shaping and stimulus fading are successful instructional approaches (Ault, Wolery, Doyle, & Gast, 1989). However, stimulus shaping appears to be more effective than stimulus fading, perhaps because stimulus fading requires the student to shift the discrimination from an irrelevant stimulus dimension to the relevant dimension. Making such a shift may be difficult for some learners, especially those who selectively attend to certain dimensions of stimuli, such as some individuals with autism (Wolery & Gast, 1984).

Fading Response Prompts

Four main fading procedures have been studied for transferring stimulus control from a response prompt to a criterion stimulus: least to most, most to least, graduated guidance, and time (prompt) delay. *Least-to-most prompting* (also referred to as *system of least prompts*) is versatile, in that it is readily adaptable to teaching both response chains, such as a series of motor responses (e.g., folding laundry), and discrete responses (e.g., object labeling). To transfer stimulus control from a prompt to a criterion stimulus using least-to-most prompting, the learner is first provided with the opportunity to emit the correct response with only the criterion stimulus present. Increasingly intrusive prompts are subsequently presented as needed until the target response occurs. For example, teaching a student to identify sight words correctly using least-to-most prompting would begin with delivery of the criterion stimulus (i.e., a flash card). If the student does not make the target response within some set time interval (e.g., 5 seconds) a more intrusive prompt would be delivered (e.g., providing the first syllable). If the student still did not make the target response following this latency period, an even more intrusive prompt would be delivered (e.g., a full verbal model). Wolery and Gast (1984) suggest that the criterion stimulus should be presented at each prompt level when using least-to-most, and that a constant response interval should follow each prompt. Consideration should also be given to the extent to which each successive level of prompt increases the probability of the target response. If two responses have an equal probability of evoking the target response, there is no reason to include an additional level of prompting, and only the less intrusive of the two prompts should be included in the prompt hierarchy.

An advantage of least-to-most fading is that the learner is provided with the opportunity to emit the correct response in the absence of prompts on every trial. It has also been suggested that least-to-most fading may be easier to implement than other fading strategies because as the individual learns to emit the target behavior independently, more intrusive prompts are no longer necessary (Billingsley & Romer, 1983). This "self-fading" may simplify and accelerate teaching.

To use graduated guidance, a controlling prompt must first be identified. Wolery and colleagues (1992) define a *controlling prompt* as a prompt that consistently results in the student exhibiting the target behavior. Controlling prompts can be identified via least-to-most prompting and often include relatively intrusive prompts, such as physical guidance. During graduated guidance, a controlling prompt is gradually eliminated by the instructor presenting only as much of the prompt as is necessary to evoke the target behavior. For example, during toilet training, Foxx and Azrin (1973) gradually lessened the amount of pressure used during physical guidance as learners began to sit independently. Although it is usually described as a method of fading physical guidance, graduated guidance can also be used to transfer stimulus control of other types of controlling prompts (Schoen, 1986). For example, an instructor might begin to provide a verbal model of the target response but discontinue the prompt as soon as the learner begins to speak.

A main advantage of graduated guidance is that because only as much guidance is provided as necessary, the learner is allowed to be as independent as possible on each trial. However, disadvantages include the fact that fading is not systematically planned. Rather, fading relies on a series of subjective judgments about the level of prompting required (Wolery & Gast, 1984). These judgments regarding when to increase or decrease the level of the prompting must be made rapidly, based on the learner's responses, and can result in problematic treatment plan implementation. Additionally, the judgments are exceedingly difficult to evaluate due to the absence of research defining the correct spacing of transitions in the hierarchy.

As with graduated guidance, most-to-least fading begins with delivery of a controlling prompt. However, most-to-least prompt fading differs from graduated guidance in that the amount of assistance necessary for the individual to complete the task correctly varies across a series of trials instead of within a single trial. For example, when teaching a learner to operate a lever device, instruction might begin with a series of physically guided responses. If the learner

meets a predetermined mastery criterion for that level of prompt (e.g., five consecutive trials in which the response occurs with physical guidance), a less intrusive prompt (e.g., modeling lever pulling) would be utilized on subsequent trials. If the learner does not pull the lever following a model prompt on any given trial, the instructor would revert to physical guidance to ensure that the trial ended with the learner exhibiting the target behavior. If the mastery criterion is met with the model prompt, an even less intrusive prompt (e.g., a verbal prompt) would be used on subsequent trials. If at any level of prompting the learner meets a predetermined failure criterion (e.g., five consecutive trials in which that level of prompting is insufficient to evoke the response), subsequent trials would begin with the previous, more intrusive prompt until the mastery criterion has once again been met. It should be noted that if the first level of prompting is in fact a controlling prompt, then mastery criteria should always be reached because the response should always occur following this most intrusive prompt.

It has been suggested that both graduated guidance and most-to-least fading are best suited for teaching chained motor responses or for lower-functioning individuals (Wolery & Gast, 1984). This assertion may reflect the observation that these individuals may require a large number of response–reinforcer pairings prior to achieving independence. These two prompting procedures provide the most opportunities for such pairings during early training because less time is spent on less intrusive prompts that are unlikely to result in the target response.

In contrast to least-to-most, graduated guidance, or most-to-least fading, in which the intensity or type of prompt is systematically increased or decreased, prompt-delay fading alters the latency of the prompt following the criterion stimulus. There are two types of prompt-delay fading: constant and progressive (Snell & Gast, 1981). Both types of prompt-delay fading begin with a series of 0-second delay trials in which the criterion stimulus and prompt occur simultaneously. The number of 0-second delay trials may vary depending on the difficulty of the task and the functioning level of the student, with more 0-second delay trials for difficult tasks or low-functioning students. In progressive prompt delay, the amount of time between the presentation of the criterion stimulus and the prompt gradually increases (Heckaman, Alber, Hooper, & Heward, 1998). The increase in latency may occur after each trial, a specified number of trials, or each instructional session. With constant prompt delay, following the 0-second delay trials, the prompt is delayed for a specified number of seconds after the presentation of the criterion stimulus, with this latency remaining fixed throughout the remainder of instruction (Snell & Gast, 1981).

Some advantages of prompt delay include the low error rate, and the ease and small amount of time required to design and conduct instructional programs. It has been noted that constant prompt delay is especially simple to conduct, and that ease of implementation may result in higher treatment integrity (Wolery et al., 1992). For example, a recent study demonstrated that parents could reliably implement constant prompt delay to teach their children purchasing skills (DiPipi-Hoy & Jitendra, 2004).

A review of studies that compared different prompt fading techniques found that when teaching discrete responses, constant prompt delay appears to be at least as efficient (as measured by number of trials, sessions, errors, and minutes of instructional time to criterion) as progressive prompt delay and more efficient than least-to-most prompting (Wolery et al., 1992). However, a similar review of studies using constant prompt delay to teach chained responses showed conflicting results, in part because fewer of the studies directly compared different prompt fading strategies (Schuster et al., 1998). Those studies that did make direct comparisons showed conflicting results, with constant prompt delay and most-to-least prompting each being found to be more efficient by some comparisons. A third review that did not distinguish between discrete and chained responses found the prompt-delay methods to be equally efficient; both were more efficient than least-to-most prompting (Ault et al., 1989). However, all of these reviews acknowledged limitations on the conclusions that could be drawn. For example, most of the participants in the reviewed studies displayed generalized imitation of an instructor, attended well, waited for teacher assistance, and demonstrated clear preferences when

identifying potential reinforcers. It has been suggested that although constant prompt delay may be more efficient for students who exhibit these behaviors, other prompt-fading strategies may be more appropriate for individuals who lack these skills (Wolery & Gast, 1984).

In summary, it appears that all of the prompting and prompt fading strategies described can be used successfully to teach a wide range of behaviors to a diverse array of individuals. The reviews of the comparative literature have frequently concluded that results were equivalent across prompting procedures and/or have produced contradictory results across reviews (Schuster et al., 1998; Wolery et al., 1992). Although a number of procedural variables can influence efficiency of a specific teaching program, research-based guidance regarding these choices is quite limited.

Chaining

Many behaviors may be considered complex because they require a series of simpler behaviors to occur in a prescribed sequence or chain. Behavior chains can be complicated by the fact that each step or component of the chain involves its own conditioned reinforcers and discriminative stimuli (Kelleher, 1966; Skinner, 1938); that is, the consequence following completion of each component in the chain functions as both a conditioned reinforcer for the previous behavior and a discriminative stimulus for the next one. Teaching a chained response typically begins with a task analysis of the chain, then proceeds using backward chaining, forward chaining, or a total (whole) task presentation format.

During backward chaining, one component of the task is trained at a time in a reverse sequence, starting with the last component. When the learner meets the mastery criterion for the last component, training commences on the second-to-last component. Additional components are taught in backward order during subsequent trials, which include the learner also performing the components that have already been mastered. In an example of backward chaining, undergraduates practiced simulated aircraft carrier landings, initially from 2,000 feet, then 4,000 feet, and finally from 6,000 feet (Wightman & Sistrunk, 1987). During forward chaining, one step is trained at a time in a forward sequence, starting with the first step. Subsequent components are trained one at a time when the previous component has been performed at mastery criterion, until the entire task has been mastered. In total- or whole-task chaining, the learner performs all of the components on every instructional trial. Extensive prompting may be necessary to permit the student to complete the entire chain on each trial.

Although there have been a few notable exceptions, chaining studies reported in the research literature generally have employed similar teaching methods (Spooner & Spooner, 1984). Reverse chaining is a variation that incorporates some elements of whole-task and backward chaining. The student is physically guided through each component, with the exception of the last one, which the learner performs independently (Sternberg & Adams, 1982). Once the student has mastered the last component, he or she is physically guided through all but the last two components, then the last three, and so on, until the student performs the entire task correctly and independently. In backward chaining with leap-aheads (Spooner, Spooner, & Ulicny, 1986), not every component is directly taught. Rather, some components of the chain are merely probed. The purpose of this modification is to speed up acquisition of the chain by not spending time on components that do not require direct instruction.

Rationales have been proposed as to why each of the chaining techniques might be superior to the others. For example, it has been proposed that backward chaining is best because each trial of backward chaining results in delivery of the natural reinforcer (i.e., completion of the task), whereas completing the initial components during forward chaining results in only conditioned reinforcement (Spooner et al., 1986). However, consequences may vary in their effectiveness as reinforcers. For example, when teaching the chain of tooth brushing, one of the natural consequences is the avoidance of dental work, which may be too temporally removed from instruction to be of much value to young children. Because every component is practiced during each trial, total task presentation may benefit from an increased number

of stimulus presentations and opportunities for conditioned reinforcement. However, total task presentation may also suffer from increased training time as a result of practicing every step during each trial. Forward chaining may be the easiest chaining method for instructors to use because the components are introduced in the same sequence in which they occur in the chain. In addition, there is some evidence that forward chaining may lead to the best retention of the chain over time (Watters, 1992).

More recently, Smith (1999) showed that the type of chaining impacts where in a task sequence errors are most likely to occur; errors are least likely to occur at the beginning of the sequence during forward chaining and at the end of the sequence with backward chaining. This finding may influence which chaining technique should be used in any given instance because some chains are especially susceptible to interruption if errors are made. Thus, chains that are unlikely to be completed following an error may be best taught using forward chaining.

Direct comparisons of the different chaining methods have shown mixed results, with some studies favoring use of forward chaining (Ash & Holding, 1990; Watters, 1990, 1992), backward chaining (Wightman & Sistrunk, 1987), or total-task presentation (Spooner, Weber, & Spooner, 1983). At least one study also showed no difference in preference between different chaining techniques (Hur & Osborne, 1993). It has been suggested (Spooner & Spooner, 1984) that these differing results may be due to differences in the dependent variables used to measure effectiveness (e.g., time to criterion, number responses to criterion, error rate), though there may also be real differences in chaining effectiveness for specific populations or tasks. In reality, there are likely advantages and disadvantages of each chaining format. As with other methods described in this chapter, acquisition of skills using different chaining techniques is likely to be idiosyncratic across populations and highly influenced by the skill being taught.

Strategic Instruction

Strategies are more complex sequences of behavior that include assessment, planning, execution, and evaluation of a course of action. Although they may share a number of features with behavioral chains, they are generally more complex, more varied across occurrences, and more adaptable across diverse situations. A critical component is that behavioral strategies are not necessarily the specific behaviors used to resolve a specific problem; rather, they are a behavioral process by which behaviors are chosen, ordered, and evaluated toward solving diverse problems. Although skills and strategies are important elements of achievement and behavioral competence, the two can be distinguished based on the unique roles that they play in achievement and learning. Alexander and Murphy (1999) describe *skills* as procedural knowledge that students develop to a level of automaticity, which enables the performance of tasks effectively with speed and accuracy. For example, skilled readers are able to read words fluently, without having to attend to and blend the individual letter sounds that make up words (Logan, 1997).

Providing opportunities to practice skills until they achieve a level of automaticity or fluency allows students to attend to more complex dimensions of the task (e.g., comprehending text after mastering decoding and sight words). For example, McCutchen (1996) proposed that younger students frequently exhibit little planning, revising, or other strategic behaviors of writing because the act of transcribing text is so effortful for them. One critical goal of effective education is to provide students with sufficient opportunities to practice fundamental skills (e.g., decoding, computing basic math facts) such that they can develop adequate fluency to use those basic skills in a strategic manner (Pressley & Woloshyn, 1995). Similar to basic skills, students learn and then perform strategies better when they are explicitly taught, supported by their environment, and rewarded (Duffy, Roehler, Sivan, & Rackliffe, 1987; Manset-Williamson & Nelson, 2005).

Unfortunately, many curricula used by schools fail to teach explicit strategies (Fleischner & Marzola, 1988; Vaughn, Moody, & Schumm, 1998), which is especially problematic for students described as having developmental delays or learning disabilities (Parmar, Cawley, & Miller, 1994; Wong, Harris, Graham, & Butler, 2003).

Fortunately, there is an extensive literature base supporting models of strategy instruction (SI) for teaching students with and without learning difficulties in the areas of reading, writing, and mathematics (Alexander et al., 1998; Pressley & Woloshyn, 1995). There are several common components to different approaches to SI.

One common component of effective SI approaches is to provide students with needed background skills, explain the strategy to them, model the use of the strategy being taught, and explain why the strategy should be used. For instance, Self-Regulated Strategy Development (SRSD), an empirically validated curriculum for teaching writing strategies, involves explaining to students how good writers might use a strategy (e.g., planning, listing main ideas) and the benefits of using the strategy. Teachers then model the strategy for students by writing essays while asking themselves questions aloud, followed by modeling self-instruction procedures (e.g., self-evaluation and self-reinforcement). A second common component of SI is providing students with opportunities to practice problems in a programmed sequence moving from simpler exemplars to more complex problems. Teachers provide students with corrective feedback, reinforcement, and many models, allowing students to practice skills collaboratively. Collaborative practice, where possible, enables teachers to support students while gradually providing them with greater independence. To foster independence and generalization, students are also provided with mnemonics for remembering steps to the strategies, as well as self-monitoring and/or prompt cards. These steps are practiced verbally until students memorize the steps of the strategy. Efforts to promote generalization and adaptation of strategies also include providing students with opportunities to practice a strategy using various types of materials (Pressley & Woloshyn, 1995).

Even if students have been taught a strategy, they must be willing to exert the additional response effort to put the strategy into use (Alexander et al., 1998). Therefore, another common component of many SI curricula is the training of students in self-monitoring, self-recording, self-assessment, and self-reinforcement. These behaviors have been described by some authors as self-regulatory behaviors. In order to teach self-regulatory behavior, teachers meet with students individually, review students' prior work (i.e., establish a baseline score), explain the benefits of the self-regulatory behavior, and help students to establish goals for self-monitoring. Self-regulatory behaviors are also modeled verbally by teachers each time they model the academic strategy being taught. Teaching self-regulatory behaviors has been shown to increase students' understanding of their academic abilities, which enables them to make a connection between the use of strategies and their successful performance. Ideally, this success and connection motivates them to use strategic behavior in academic, vocational, and everyday life situations. Evidence of students making this connection has been provided through studies demonstrating that students taught explicitly to use self-regulatory behaviors experience greater acquisition, maintenance, and generalization of SRSD strategies (De La Paz, 1999; Pressley & Levin, 1987)

Direct Instruction

Direct Instruction (DI) focuses on teaching students skills and strategies to a level of mastery, using explicit teacher-directed instruction (Grossen, 2004). A guiding principle of DI is that students can learn, and that failure to learn is the function of inappropriate teaching and/or curriculum rather than a characteristic of the students. The development of DI began in the 1960s, in response to Siegfried Englemann's and Carl Bereiter's desire to accelerate the learning rate of low-performing students whose older siblings had been diagnosed with mental retardation. The goal was to develop a curriculum to enable students whom many believed could not learn to read to learn at a pace that would allow them to catch up to their nondisabled peers. Extensive research suggests that the *Corrective Reading Program*, initially published in 1973 (Englemann, 1999), substantially accomplished this end. Over 30 years of data suggest that if the program is implemented consistently and with integrity, students' rate of growth in reading increases at two to three times the normal rate, allowing struggling students to catch up to their peers (see Grossen, 1998, for a review of the re-

search). Although the initial focus of DI was on what might be considered more basic academic skills, its application has broadened to include numerous complex skills and strategies, including, but not limited to, critical reading (Darch & Kame'enui, 1987), chemistry (Carnine, 1989), earth science (BFA Educational Media, 1991), expressive writing (Walker, Shippen, Alberto, Houchins, & Cihak, 2005), U.S. history (Carnine, Crawford, Harniss, & Hollenbeck, 1994), and problem solving (BFA Educational Sciences, 1991).

DI curricula share several common characteristics designed to ensure that students with various needs will succeed. For instance, placement in a DI curriculum is driven by an assessment of the student's instructional needs. This helps to ensure that students are able to experience success, then build on that success. Brief, frequent tests are used throughout instruction to provide teachers with information regarding students' skills development, as well as the effectiveness of their teaching. Students are commonly placed in homogenous skills groups based on rate of progress and performance on less frequent mastery tests. Placing students with others who have similar skills ensures that all students in a group need the same level of guidance during lessons (e.g., modeling, feedback), and it decreases the probability that students become frustrated because they either already know what is being taught or do not have the prerequisite skills to participate in instruction. However, it is important to note that groupings are temporary because teachers use data gathered during lessons and from mastery testing frequently to alter group membership.

Another common characteristic across most DI materials is that lessons are streamlined to the extent practical. Englemann argues that in order for struggling students to catch up, it is important not to waste time teaching information that students do not need to know (Engelmann, 2004). Thus, DI lessons are organized as logical developmental sequences, so that students know the rules, concepts, operations, and strategies necessary to learn what is being taught in each lesson (Kozloff, LaNuiziata, Cowardin, & Bessellieu, 2000). For instance, students learning to decode words are not necessarily taught the names of letters, only letter sounds because knowing letter names is not needed when sounding out words. Instruction is also streamlined, in that the skills, concepts, and strategies taught are generalizable, enabling students to apply what they learn to not only the individual items used as examples but also to the widest array of new items and situations. Engelmann and Becker (1978) referred to this as "general case programming." Students are shown sets of items that comprise examples and nonexamples in a predetermined sequence that allows them to recognize differences easily and appropriately generalize what they have learned (Watkins & Slocum, 2004).

Interestingly, there is a misperception that DI focuses only on rote learning and promotes passive learning (Adams & Engelmann, 1996; Leontovich, 1999). However, several investigations have suggested that DI promotes generalization to a greater extent than alternative programs supported by constructivists, who commonly argue that teachers should only guide students as they discover rules and strategies on their own. To examine this issue, Klahr and Nigam (2004) assigned 112 third- and fourth-grade students to either a DI or a discovery learning condition. The objective of instruction was for students to learn an elementary science objective known as control-of-variables strategy (CVS). Students in the DI condition were provided with information on how and why CVS works, shown examples and nonexamples of CVS, and explained the differences between the examples. In the discovery learning condition, students were simply provided with identical materials and allowed to develop their own experiments. Acquisition assessments then had students develop four of their own experiments, and a generalization assessment had students evaluate two science fair projects. Results not only replicated previous studies (Chen & Klahr, 1999), indicating that the acquisition of CVS was greater for DI students, but students' evaluation of the science fair project also extended the literature by providing evidence that DI students were able to generalize what they learned to a greater extent than were the students in the discovery learning condition.

To increase students' learning and help to maintain active student engagement, DI lessons are taught at a brisk pace and are devel-

oped to provide students with more learning/response opportunities than typical instruction. This is achieved by having teachers and students use common teacher–student communication within and across lessons. Using consistent language when defining concepts, stating rules, and employing strategies helps to prevent students from becoming confused by variations in teachers' language. Consistent verbal and/or nonverbal signals also allow for frequent group responding in unison. Unison responding, whether done verbally or by having all students write their answers on dry-erase boards, helps to increase academic engagement time because each student has the opportunity to respond to each question, thus receiving practice in performing the operation correctly. Unison responding also allows teachers frequently to assess each student's understanding of the lesson, ensuring that all students master an operation prior to proceeding to the next operation in the sequence (Watkins & Slocum, 2004).

The format of instruction is also consistent across lessons. A model, lead, test and delayed test model is used (Kozloff et al., 2000). Teachers first model what is being taught. Then the teacher and student work through skills and operations together. As students become more proficient in performing a skill and/or strategy, the format of instruction systematically changes. The teacher's role as the source of information decreases, teacher prompts decrease, teachers' corrective feedback fades from being immediate to delayed, and problems increase in complexity. These shifts in format ensure that students experience initial success with learning and continue to experience success, increasing the probability that they remain motivated to continue to learn. Gradual planned changes in instructional format also help students to master skills and become more independent as they apply the learned skills and/or strategies. Teaching basic skills to a level of mastery increases the likelihood that students maintain, generalize, and adapt what they know to new situations (Binder, 1996). After modeling, teachers test students' acquisition through unison responding and provide immediate corrective feedback to all students if any student makes a mistake. Group and individual delayed tests are conducted later in the same lesson as well as during subsequent lessons, both to ensure that students are maintaining what they have learned and to promote further generalization of operations (Kozloff et al., 2000).

As previously stated, extensive evidence demonstrates the effectiveness of DI (see Grossen, 1998, for a review of the research). In addition to effectiveness, another common finding across the research reviewed by Grossen (1998) is the importance of adhering to the procedures and formats outlined by DI curricula. The precise sequence of teaching skills and/or strategies, and the clarity and consistency of instructions, are keys to the effectiveness of DI. DI therefore provides scripts for teaching in order to increase teachers' integrity and the planfulness with which instruction is provided (Watkins & Slocum, 2004). DI as a method or as a specific curriculum provides a relatively comprehensive approach to instruction that includes the teaching of basic skills progressions through to the development of more complex behavioral chains and incorporates explicit strategy instruction as a part of a model for teaching. DI includes assessment of the behaviors to be taught, student needs, shaping, prompting, chaining, strategy instruction, and recursive plan revision based on assessment data.

SI, DI, and Generalization

Both SI and DI devote considerable attention to generalization from the outset of teaching. To state the obvious, the goal of establishing new behaviors is rarely, if ever, for those behaviors to occur only in the teaching context. Typically, the goal of teaching is for new behaviors to be evident across contexts, persons, and time. Additionally, it is commonly hoped that teaching students some new behavior will in turn lead to response generalization or to students exhibiting a range of related behaviors that were never explicitly instructed. The likelihood of students retaining and generalizing what they have learned, whether it is a simple or complex behavior, is increased substantially when generalization is planned as part of the curriculum rather than an afterthought (Goldstein & Martens, 2000).

One technique that is used in both DI and SI to promote generalization is to provide students with numerous opportunities

to practice skills and strategies as a means of promoting mastery. Evidence suggests that teaching students to a high level of fluency rather than just accuracy promotes maintenance, generalization, and adaptation (Binder, 1996). Data also suggest that providing students with overlearning opportunities further increases retention and generalization. Overlearning is achieved by bringing students to levels of mastery, then providing additional practice opportunities (Driskell, Copper, & Willis, 1992). SI and DI are also designed to promote generalization by ensuring that students experience frequent reinforcement. Methods to ensure success include incorporating teacher assistance in the form of modeling and performance feedback as a primary component of instruction. Teacher assistance is graduated, such that students experience success but also are required independently to apply the skills and strategies that systematically increase in level of difficulty.

Another method used by both SI and DI curricula to promote generalization is to model and to provide practice opportunities using various examples of times when it is appropriate to use the skill or strategy being taught (Troia, 2002). For instance, when teaching students a writing strategy, the SRSD model suggests that teachers instruct and reinforce students' use of the strategy not only during writing instruction but also when they are writing for other classes. DI also provides examples of when it is *not* appropriate for students to apply a skill or strategy. These multiple exemplars are sequenced to help students distinguish between appropriate times to use or not use a skill or strategy. The manner in which DI lessons are sequenced also ensures that students must frequently employ previously taught skills and strategies when learning new skills and strategies. Such purposeful sequencing helps students to realize that skills and strategies build upon one another and should not be forgotten (Watkins & Slocum, 2004).

Another way in which SI curricula promote generalization is by teaching students to reinforce their own behavior for appropriate application of a strategy, even when teachers are not available. Although it is initially necessary for teachers to provide reinforcement for accurate skills and strategy use, students are also taught to evaluate their work independently (Goldstein & Martens, 2000). SI curricula program for natural reinforcement of strategy use by explicitly teaching students to use self-regulatory skills, such as self-monitoring. The essential purpose of self-regulatory skills is to promote the independent use of appropriate skills and/or strategies/behaviors across settings and times (Brooks, Todd, Tofflemoyer, & Horner, 2003). Self-regulatory skills can help students coordinate their various skills to achieve success on specific tasks (Perels, Gurtler, & Schmitz, 2005). A teacher generally teaches self-management skills by first evaluating students' performance, then showing and explaining the evaluation to the students (i.e., modeling). After the teacher provides examples of how he or she rates the student's behavior, both student and teacher evaluate the student's behavior and compared the ratings. Differences in evaluations are discussed, and accurate evaluations are reinforced (i.e., performance feedback). After students become accurate evaluators of their behavior and/or strategy use, the teacher's assistance is gradually faded (Shapiro, DuPaul, & Bradley-Klug, 1998). Ideally, students use these self-regulatory skills across settings, thus helping them to evaluate problems, decide an appropriate strategy to employ, evaluate the outcome of strategy use, and reinforce appropriate responding (Pressley & Levin, 1986; Troia, 2002).

Conclusion

Behavior analytic approaches to establishing new behaviors have demonstrated success in the research literature. Perhaps the most unique successes have occurred in domains in which the individuals who received instruction and have subsequently acquired the skills were generally thought to be incapable of learning these skills, or were thought to be limited to a very slow rate of progress in learning those skills. The success of teaching procedures derived from applied behavior analysis for students with special needs appears to have, in turn, occasioned the broader application of these teaching procedures to students who are typically developing or nearly so. Findings with more typically developing students have paralleled the positive results from populations of students with disabilities. Specifically, typically developing children and children with

mild special needs have learned more and faster when instructed within a graduated approach that included systematic establishment of new behaviors, reinforcement of responding, and explicit teaching of more elaborate behavioral strategies (Grossen, 1998).

Interestingly, the history of behavior analytic approaches to developing complex behavior in some ways parallels the development of a teaching program for an individual. Specifically, for those procedures designed to establish discrete behaviors, the applied behavior analysis response establishment literature is best developed. These procedures are typified in the use of shaping and prompting to establish stimulus control. Closely paralleling the literature on shaping and prompting, the literature on developing procedures for combining sequences of behaviors and chaining to achieve more complex ends is also well developed. The literature on the teaching of flexible behavioral strategies is better developed than one might initially assume, but to some degree it is fragmented. Although some of the literature related to establishing strategic behavior appears in traditional behavior analytic outlets (e.g., Roberts, Nelson, & Olson, 1987), much of it appears in research outlets that are described as more broadly educational than behavior analytic.

It is important that behavior analysts engaged in the establishment of new behaviors keep the long-term view in mind. The long-term goal of teaching is not to bring individual operants under stimulus control, but to help clients and students develop the complex, flexible repertoires that are adaptive, that remain in contact with reinforcement, and that confer adaptive advantage and endure. Developing these complex behavioral repertoires requires a complex array of behavior analysis procedures that progress from teaching discrete behaviors to explicitly supporting development of the generalized and strategic behavior that form effective, flexible response classes.

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CHAPTER 16

Teaching Verbal Behavior

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Consider the following vignette involving Lori, a speech–language pathologist, and her students:

Lori is eating popcorn in a classroom while she prepares a lesson for her preschool students, who are on the playground. Lily walks into the classroom, approaches Lori, and says, "Popcorn!" Lori smiles and gives Lily popcorn. Jack walks into the classroom and sees the popcorn. He grabs for the bag without saying anything. Lori looks at him and says, "What do you want?" Jack says, "Popcorn!" Lori smiles and gives Jack popcorn. Char walks into the classroom, sees the popcorn, and grabs for the bag while remaining silent. Lori says, "What do you want?" but Char continues to grab for the bag while remaining silent. Lori then says, "Say 'popcorn.'" Char immediately says, "Popcorn!" Lori smiles and gives Char popcorn.

If Lori completed a checklist for each child based on these interactions that included the statement, "Can the child say 'popcorn'" the correct answer would be "yes." However, if Lori was asked, "Did each child do the same thing?" the correct answer would be "no." Although the form of the response "popcorn" was the same, each example involved a different controlling relation—thus, a different operant response. The difference in perspective between the former and latter question is the heart of a functional analysis of verbal behavior. Although it is useful to know the *form* of verbal behavior, it is more important to understand the *functional control* of verbal behavior. This chapter reviews how a functional analysis of verbal behavior can provide guidance regarding the complex issues associated with teaching communication and language to those with limited or no verbal repertoire.

Skinner's Analysis of Verbal Behavior

B. F. Skinner (1957) wrote *Verbal Behavior* to demonstrate how a behavior analytic approach can be applied to what we commonly call language. Early in the book, he provided a simple definition of the term *verbal behavior* as "behavior reinforced through the mediation of other persons" (p. 2). In general, a "speaker's" actions are reinforced through the mediation of a "listener." With this definition, the form of the action of the speaker—vocal, gestural, visual, and so forth—is

irrelevant with regard to defining examples of verbal behavior. Skinner was explicit regarding this orientation: "In defining verbal behavior as behavior reinforced through the mediation of other persons, we do not, and cannot, specify any one form, mode, or medium" (p. 14). Thus, at times our behavior influences the environment in direct ways: A child ties his own shoelaces and can immediately run around. At other times, our behavior influences other people whose actions lead to reinforcement: A child asks his brother to tie his shoes and runs around after his brother helps with the laces.

Skinner added an important refinement to the definition of verbal behavior later in the book when he wrote, "the 'listener' must be responding in ways which have been conditioned *precisely in order to reinforce the behavior of the speaker*" (p. 225, original emphasis); that is, the actions of the "listener" are actions he or she acquired as a member of a verbal community: It is the verbal community that selects certain forms (particular vocal configurations such as spoken words, form of particular graphic lines such as writing, particular hand postures and movements such as sign language, etc.) to function in certain ways within the community. When children or adults have no or limited verbal behavior, it is our job to teach them the skills, so that they can become effective members of our verbal community.

We contrast the behavioral approach advocated by Skinner and the traditional approach to language development and intervention of Chomsky (1965), Brown (1973), and Piaget (1951), who conceptualized language in terms of the form, or topography, of the learner's verbal repertoire (i.e., vocabulary, grammar, syntax), with little regard for function. From the traditional perspective, language development is the function of hypothesized innate developmental, neurological, and/or cognitive structures. A language deficit (or delay) is said to occur when the learner's verbal repertoire is deficient in comparison to the verbal repertoire of a typically developing learner of the same age. The language deficit often is said to be related to a hypothesized neurological abnormality. Intervention tends to focus on the acquisition of forms, from sounds to words to larger structures, while minimizing the function of such forms during acquisition.

In contrast, the behavioral approach to language, or verbal behavior, stems from a contingency analysis of such behavior. In the behavioral approach, language development can be traced to specific environment–behavior relations, or contingencies of reinforcement. Although Skinner did not deal extensively with language deficits in his book, his analysis has been applied to teaching language to children and adults with language difficulties (see Barbera & Rasmussen, 2007; Frost & Bondy, 2002; Sundberg, 2008; Sundberg & Partington, 1998). However, some behaviorally oriented language training programs (e.g., Lovaas, 2003; Maurice, Green, & Luce, 1996) have not used Skinner's (1957) analysis as a framework for teaching verbal behavior. In our view, Skinner's analysis is essential for developing successful training programs. In the sections that follow, we illustrate the basic tenets of Skinner's approach to verbal behavior and illustrate how it may be applied in specific training protocols.

Primary Verbal Operants

In Skinner's (1957) analysis, *verbal operants*—the units of language—are classified by the antecedent and consequent stimuli that control them. Skinner described several primary verbal operants and their controlling relations. A *mand* is "a verbal operant in which the response in reinforced by a characteristic consequence and is therefore under the control of relevant conditions of deprivation or aversive stimulation" (pp. 35-36). Such "relevant conditions of deprivation or aversive stimulation" may be described as motivating operations, which include establishing and abolishing operations (Laraway, Snycerski, Michael, & Poling, 2003; Michael, 1993). For example, a girl who is deprived of liquid for a period of time (establishing operation) is more likely to request water. The form of response ("water") is specified by its consequence (water). Unlike other primary verbal operants, the mand is *not* controlled by any prior stimulus, or any specific aspects of the environment or verbal behavior of others. If the motivating operation is sufficiently strong, there need not be a cup of water, water fountain, faucet, or any specific stimulus present, including things

said by others, for the girl to emit the relevant response.

In contrast, other primary verbal operants involve control by prior stimuli, either verbal or nonverbal. With the primary verbal operant called the *echoic*, the speaker's response is controlled by a prior verbal stimulus, and the response bears formal similarity to the stimulus. For instance, the girl responds, "Ball," after her teacher says, "Ball," when there is no ball in view. Skinner (1957) describes echoic behavior as arising from "educational" reinforcement, in which a listener arranges explicit reinforcement (e.g., praise) when the sound patterns of the prior verbal stimulus and response match. Unlike the mand, reinforcement for the echoic is unrelated to its form. Generalized conditioned reinforcers such as "Correct," "Yes," or "That's right" may therefore strengthen the echoic response. In similar fashion, another verbal operant called the *textual* involves control by a prior verbal stimulus in the form of text or other visual stimuli, with the response bearing point-to-point correspondence with the text, such as in reading out loud. Like the echoic and textual, an *intraverbal* is a verbal operant that is evoked by a prior verbal stimulus; however, the response lacks point-to-point correspondence with the stimulus. For example, a parent asks, "What day is it today?" and the child responds, "Thursday," or the teacher says, "Two, four, six … " and the child responds, "Eight." The intraverbal is also maintained by generalized conditioned reinforcement.

A *tact* is a verbal operant in which a response of a given form is controlled by "a particular object or event or property of an object or event" (Skinner, 1957, p. 82). The presence of a car, for example, increases the likelihood of the child emitting the verbal response "Car." The object evokes the response because the verbal community has arranged generalized conditioned reinforcement for the response in the presence of this particular object. Skinner also illustrated that tacts can occur in the presence of novel objects or events to which the speaker has had no previous exposure. In generic extension, for instance, the speaker emits the relevant tact because the novel object shares physical properties with previous objects, in the presence of which a certain response has been reinforced. Generic extension accounts for the child who, upon seeing a car he has never seen before, says, "Car." A group of objects sharing common physical properties that evoke an extended tact are described as a *stimulus class*.

The Listener

It is important to emphasize the role of the listener in these primary verbal relations, including the functional sources of control for the listener's behavior. According to Skinner (1957), an analysis of both speaker and listener behavior is necessary to understand the "total verbal episode" (p. 36). The mand primarily benefits the speaker, such as when a girl requests and receives water. Other primary verbal operants, such as the tact, largely benefit the listener. For example, when a speaker says, "It's going to rain" in response to a dark sky, the verbal response brings the listener into closer contact with certain forms of reinforcement with which he or she would otherwise have no contact. The stimulus may evoke the listener to carry an umbrella or to delay a walk outside, producing reinforcement in the form of avoiding an aversive stimulus. Thus, competent speakers extend a listener's contact with the stimulating environment.

Of course, all verbal operants are under the control of a listener or audience. Skinner (1957) emphasized the importance of the audience by dedicating an entire chapter on the characteristics of the audience in *Verbal Behavior*. Effective language training programs must explicitly teach the speaker to engage the listener. For example, once beginning communicators have learned to make a request of an attentive listener, they may need to be taught to recruit the attention of a listener who is not already attending, for example, by walking over to the adult to whom a request will be made (Cipani, 1990). In applied settings, it is also important that interventions increase the consistency of communicative partners' attention and responses to communicative attempts by the speaker (Goldstein, Kaczmarek, Pennington, & Shafer, 1992). This is necessary to support the efforts of the beginning communicator and his or her communicative attempts.

Multiple Control

The verbal operants discussed thus far involve control by a single variable (motivating operation, or prior verbal or nonverbal stimulus). However, most verbal behavior involves multiple control (see Bondy, Tincani, & Frost, 2004). *Multiple control* occurs when a single response is controlled by more than one variable, or a single variable controls more than one response (Skinner, 1957). An example of the first type of multiple control is when the verbal community arranges reinforcement for a given response in the presence of more than one stimulus. For example, a girl receives reinforcement for saying "Ball" in response to the printed word *ball* (textual), a picture of a ball (tact), and the question "What do you throw?" (intraverbal). An example of the second type of multiple control, in which a given variable strengthens multiple responses, is when deprivation of liquids strengthens verbal responses such as "Water, please," "May I have a drink?", "I'm thirsty," and so on.

A critical type of multiple control to consider in relation to teaching verbal responses is that which produces "impure" verbal operants (Skinner, 1957, p. 151), or those that are simultaneously strengthened by more than one variable. For example, when deprived of liquid and presented with a cup of juice, the boy is more likely to say, "*Juice,* please." The motivating operation and prior nonverbal stimulus have a combined effect, producing an impure verbal operant, which we can identify as the mand–tact. Another instance of an impure verbal operant occurs when the girl says "Ball" in response to both her teacher's question "What is it?" and a picture of a ball. The impure operant, controlled by prior verbal (question) and nonverbal (picture) stimuli, is an intraverbal–tact. Several variables may combine to produce a response. A mand–tact–intraverbal, for example, is controlled by a motivating operation, nonverbal stimulus, and verbal stimulus, such as when the mother asks, "Would you like some juice?", with a cup of juice present, and the girl says, "Yes, please." In this manner, we can identify specifically the potential sources of control and design teaching sequences to establish multiply controlled operants.

An important question, especially when planning to teach verbal skills, involves the relationships among the different verbal operants. For example, does acquisition of a response form under one set of variables lead to emission of the same response form under a different set of variables? There is good evidence to suggest that verbal operants are often functionally independent (Kelly, Shillingsburg, Castro, Addison, & LaRue, 2007; LaMarre & Holland, 1985; Oah & Dickinson, 1989; Twyman, 1996; Petursdottir, Carr, & Michael, 2005); that is, a response topography learned with one set of controlling variables will not necessarily occur in the presence of different variables, unless explicitly taught. A response topography taught as a mand, therefore, will not automatically occur as a tact, or vice versa. Functional independence exists with verbal operants under both simple and multiple control. For example, a boy who is taught to say "tree" in response to the question "What is it?" and a picture of a tree (intraverbal–tact), may *not* say "Tree" in the presence of the picture of the tree by itself (tact) because the learned response involves a different controlling relation (picture of the tree plus the question).

The analysis of multiply controlled verbal operants becomes particularly relevant in the design of communication training programs. A number of behaviorally oriented language training programs seek to establish complex verbal operants (e.g., Leaf & McEachin, 1999; Lovaas, 2003; Maurice et al., 1996). Although in some instances explicit control transfer procedures are recommended, this is not always the case. Lovaas (2003), for instance, describes procedures for establishing intraverbal–tacts in the form of naming responses ("What is it?" + object). Lovaas does not, however, describe procedures to transfer stimulus control from the question + object (intraverbal–tact) to the object by itself (tact). Without explicit stimulus control transfer procedures, the child is likely to develop a highly selective repertoire, in which naming responses occur only in the presence of objects accompanied by questions. In contrast, a more functional naming repertoire involves response topographies that occur in a variety of stimulus combinations, including presentation of the object by itself.

The determination of controlling variables helps direct teaching protocols for a variety of relevant situations. For example, a seemingly "simple" verbal skill, such as "Martin will learn the word *swing*," may have many possible sources of control:

1. Martin learns an echoic: He says "swing" when the teacher says "swing," and he receives praise.
2. Martin learns an echoic–mand: Upon hearing his teacher say "swing," he says "swing" and is put on the swing.
3. Martin learns a mand: While in the classroom, Martin turns to his teacher and says "swing," and then is put on the swing.
4. Martin learns a mand–tact: Upon seeing a swing, Martin turns to his teacher and says "swing," and then is put on the swing.
5. Martin learns an intraverbal–mand: Upon hearing his teacher ask, "What do you want to do?" (and without a swing in sight), Martin says "swing" and is put on the swing.
6. Martin learns a pure tact: Upon seeing the swing, he says "swing," and the teacher says "Yes, I see it too" (but does not put him on the swing).
7. Martin learns an intraverbal–tact: When his teacher points to a swing and asks, "What is that?", Martin says "swing," and is praised (but does not go on the swing).
8. Martin learns an intraverbal–mand–tact: Upon seeing a swing and hearing his teacher ask, "What do you want to do?", Martin says, "swing," and gets put on the swing.

In order to teach Martin effectively to say "swing," his teacher must determine which variables are relevant and explicitly arrange each variation.

Selecting a Response Modality

As noted, Skinner (1957) wrote that modality is not a determinant of whether a behavior can function as a verbal operant. Therefore, gestures, sign language, and other nonvocal responses may function as verbal behavior. Moreover, there is little reason to suggest that one modality is inherently better than others (see Bondy et al., 2004; Tincani, 2004). Of course, the most common modality for verbal behavior is speech. In typical development, infants acquire nonvocal mands (i.e., pointing/gesturing to an object while looking back and forth between the object and parent) prior to developing specific spoken words (Mundy, 1995). Speech arises out of a set of babbling sounds that appears to be species-specific, not culturally specific; that is, young children around the world tend to produce similar sets of sounds, some of which are reinforced within particular language groups (Werker & Tees, 1999).

A number of issues may interfere with typical language development, from structural problems associated with oral functioning to difficulties in acquiring imitative repertoires (Fey, 1986). When children do not speak, the first strategy of most interventionists is to try to promote speech (see Mirenda, 2003, for a thorough review of this topic). For children who have not acquired speech via the typical pattern, a number of promising strategies have been developed, though none is universally effective (Wankoff, 2005). Broadly speaking, such strategies encourage speech production, often without regard to function; that is, by engaging the child in various playful and reinforcing activities, the therapist tries to increase the production of any sound on the child's part, then attempts to reinforce the frequency of those sounds. Then, the therapist reinforces the child for producing particular sounds (ones that are already within the repertoire) when the therapist makes those sounds, thus developing an echoic repertoire. Next, the child is taught to blend sounds together in increasingly complex patterns forming words and then short phrases (e.g., "Want cookie").

A number of factors may make speech a difficult modality to acquire for many young children, particularly those with developmental disabilities. Speech production requires refined coordination of many actions, including breath support and oral motor movements. A generalized imitative repertoire is particularly critical to the development of speech (Garcia, Baer, & Firestone, 1971; Young, Krantz, McClannahan, & Poulson, 1994). Without generalized imitative responding, an echoic repertoire cannot be developed, and it is highly unlikely that

a comprehensive vocal repertoire will be acquired. The natural mechanism that supports the onset of speech via babbling appears to be relatively time-restricted and may not be available when some children with disabilities begin communication training.

If speech is not available due to reasons discussed earlier, then other modalities may be warranted. Amost all speakers use "body language" and gestures to modify the meaning of their statements (identified as *autoclitics*; Skinner, 1957). Such actions can be refined into sign language, either conforming to the grammar of a specific language or involving a unique set of grammatical rules. One potential advantage is that sign language involves topographically different movements of the hands, thus requiring no external support (Sundberg & Partington, 1998). Some modalities that involve the use of visual icons or symbols can include pictures, symbols, or print media. Some systems may be viewed as "low-tech," such as the Picture Exchange Communication System (PECS; Frost & Bondy, 2002), whereas others are seen as "high-tech," such as the use of various voice output communication aids (VOCAs) that may be prohibitively expensive (Tincani & Boutot, 2005). Writing (either with a keyboard or a writing implement) can be acquired without prior use of speech (Lovaas & Lovaas, 1999). Within our broad culture other modalities exist (including semaphore, and Morse code), but are rarely viewed as appropriate for populations displaying severe communication difficulties.

When selecting a modality, pertinent issues include ease of response acquisition, prompts necessary to support response acquisition, and the role of the verbal community in responding to the user (Mirenda, 2003). Although there is little empirical evidence to guide selection of a modality (see Tincani, 2004), the following considerations may apply. First, if the learner does not have a generalized vocal imitation repertoire, speech may not be readily learned. In such instances, an augmentative and alternative communication system (AAC) should be considered. Sign language may be a viable alternative for learners who lack a vocal imitative repertoire; however, because of the topography-based nature of sign language, a learner must have a generalized motor imitation repertoire to acquire a functional sign language vocabulary. If neither vocal nor motor imitation skills are present, an aided or device-based AAC system should be considered. Aided systems include picture-based systems, such as PECS (Frost & Bondy, 2002) and VOCAs. Relevant factors for selecting an aided system may include (1) the availability of a particular device or system; (2) the ease of use for consumers who will function as primary listeners (parents, siblings, teachers, staff, etc.); (3) the potential for the device or system to accommodate a variety of communication symbols and vocabulary; and (4) the capability of the device or system to produce a repertoire of independent, functional verbal behavior for the listener (Tincani, 2007; Tincani & Boutot, 2005).

Teaching the Mand

Because the mand directly benefits the speaker, it is critical to assess the people, items, and events that function as reinforcers for the learner prior to instruction. A variety of systematic preference assessment strategies have been developed, though a detailed description of each is beyond the scope of this chapter (see Piazza, Roane, & Karsten, Chapter 9, this volume). An extensive line of inquiry has focused on teaching the mand as a component of functional communication training (FCT; Durand & Merges, 2001; Mancil, 2006). The primary purpose of FCT is to reduce challenging behavior by teaching alternative responses (i.e., mands) that produce the same reinforcing consequences (see Fisher & Bouxsein, Chapter 20, this volume, for a detailed discussion of FCT and other reinforcement-based interventions). Other investigators have addressed the question of how best to establish independent or spontaneous mand repertoires, apart from the direct impact of manding on challenging behavior. A number of studies have established the efficacy of time-delay prompting procedures for teaching mand repertoires to people with developmental disabilities (e.g., Halle, Baer, & Spradlin, 1981; Halle, Marshall, & Spradlin, 1979; Kratzer, Spooner, & Test, 1993). For instance, Halle and colleagues (1981) used a 5-second time-delay prompting procedure to produce manding

within a naturalistic setting in children with mental retardation and language delays. The procedure involved the teacher arranging a cue in which a mand was likely to occur (e.g., approaching a child with juice in hand), then allowing the child a 5-second opportunity to perform the specific mand before delivering an appropriate prompt. Progressive time-delay prompting or "errorless" teaching (Touchette & Howard, 1984) is a variation of this technique, in which the cue to request is presented simultaneously with the prompt, then the duration between the cue and prompt is gradually increased as independent responses are performed. Such time-delay procedures may be conceptualized as establishing operations (Michael, 1993) for manding. The blocked response (Shafer, 1995) is another establishing operation technique, in which the learner is blocked or otherwise prevented from completing a behavior chain until an appropriate mand is performed. For example, a child who uses a step stool to access a game on a shelf may be taught to request help when the stool is missing. A common feature of these techniques is a systematic manipulation of the learner's environment to promote a functional manding repertoire. A comprehensive verbal behavior program should capitalize on a variety of communication opportunities available in the learner's natural environment. The next section describes three specific communication skills that are critical for learners with limited verbal repertoires.

Critical Communication Skills

Three basic skills that beginning communicators need to learn are asking for a break, asking for help, and saying *no* to an offered item or activity. These simple skills are important because they allow the individual to exert some control over his or her environment. Asking for a break or for assistance are both types of mands. Saying *no,* such as when rejecting an offered item, allows the individual to escape or avoid an unwanted item or activity. It functions as a qualifying autoclitic within a mand function (see Skinner, 1957, p. 322). When an individual requests an alternative item or activity in the context of an escape or avoidance situation, then such a request can also function as a form of rejection and is thus maintained in part by negative reinforcement. Such choice-making responses may have the collateral effect of reducing challenging behavior associated with escape or avoidance contingencies.

There are a variety of empirically validated strategies for teaching requesting and rejecting behavior. Best practice integrates instruction of communicative responses into daily routines by systematically identifying all potential opportunities for an individual to engage in target behaviors, and imbedding instruction within the naturally occurring event (Sigafoos, Kerr, Roberts, & Couzens, 1994; Ylvisaker & Feeney, 1994). Empirically validated strategies for creating opportunities for verbal behavior focus on teaching communication within real-life activities. These strategies include (1) delaying access to an item or activity that is present until a request is made (Halle et al., 1981), (2) withholding an item necessary to complete a preferred activity (Cipani, 1988), (3) blocking a response or interrupting an activity to create the need for a request (Shafer, 1995; Sigafoos et al., 1994), (4) providing only part of what has been requested to create a new need (Duker, Kraaykamp, & Visser, 1994), (5) intentionally giving an individual the incorrect item (Sigafoos et al., 1994), or (6) delaying offers of assistance until a request for help is made (Sigafoos & Roberts-Pennell, 1999).

In learning how to reject an offer, the communicator is able to escape or avoid nonpreferred items or activities in a socially acceptable manner. Learners who do not learn how to communicate this need may adopt an idiosyncratic behavior that is difficult to interpret (Iacono, Carter, & Hook, 1998), or may learn to escape or avoid through the use of challenging behavior (Carr et al., 1994). As with teaching a child to make a request for preferred items and activities, socially appropriate escape or avoidance is best taught in situations where the child is motivated to escape or avoid an item or activity. If a child's preferences are known, then by presenting a nonpreferred item, the interventionist can create a context for teaching the individual how to reject an offer appropriately (Sigafoos & Roberts-Pennell, 1999).

There are several techniques for teaching rejection or refusal behavior. First, an exist-

ing appropriate behavior can be strengthened to be more effective, specific, or consistent (Warren, Yoder, Gazday, Kim, & Jones, 1993). Second, new forms of rejecting or refusing behavior can be taught. Teaching new communicative behaviors can be done by chaining the new response to an existing, inefficient behavior (Keen, Sigafoos, Woodyatt, 2001) or through the use of prompts (Drasgow, Halle, Ostrosky, & Harbers, 1996). Third, socially unacceptable communicative behaviors can be replaced with acceptable, functionally equivalent behaviors, for example, teaching a child to point to the word *stop* on a communication board to end a task instead of throwing a tantrum (Carr et al., 1994). Fourth, the child must be taught that escape or avoidance will not always be possible even when it has been appropriately requested (Sigafoos, 1998).

Other Issues

How we teach verbal skills and which ones we teach may be influenced by learner characteristics. Some of these variables may be specific to the individual. For example, when initiating mand training, it is advisable to begin with the individual's most preferred reinforcers. The most effective way to teach asking for items is to ensure that the items are effective reinforcers as opposed to items the teacher selects for the sake of convenience. Other factors that may be important when selecting targets for teaching verbal responses relate to the behavioral development of the individual. For example, children learn to tact items and events that are part of the public environment before they can tact private events (see Skinner, 1957, p. 131). In other words, children learn to name common items, such as toys, furniture, and important people, before they learn to comment about things happening within them, such as pain, pleasure, or other emotional changes. Therefore, before teaching a child to comment about a possibly painful knee, we must ensure that he can comment about items or events in his surroundings.

Strategies for teaching verbal behavior such as incidental teaching and pivotal response training (Koegel & Koegel, 2005) depend on a teacher's awareness of the current repertoire of the learner; that is, these strategies seek to expand upon current skills sets in small steps. Each lesson depends more on what the child is doing than simply on what the teacher wants the child to do. Thus, if a child demonstrated a clear preference for a large as opposed to a small ball and can currently ask for a ball, teaching the child to request the "large ball" represents a viable target response. For children who either do not like balls or cannot request a ball (in any modality), trying to teach "large" is not likely to be effective.

Response production issues also may influence which skills are addressed. It is important for clinicians to determine how production issues may interfere with learning. For example, children who display some vocal responses may have difficulty in sound production or blending; similarly, children who sign may show difficulty in forming or stringing together signs; in teaching children to write, some may find it easier to select letters via a keyboard than to produce them with a writing implement. Research on fluency (Johnson & Layng, 1992) suggests that when core response production rates (rate of producing individual sounds, writing individual letters, selecting specific pictures, etc.) are very low, acquisition of more complex skills (e.g., stringing together letters to spell words, speaking in increasingly complex sentences) will be difficult.

It is often risky to assume that an individual learner has a particular attribute that is a general characteristic of the population to which he or she belongs; nevertheless, such characteristics may be considered on a probabilistic basis. For example, children with autism, especially when they enter educational programs, are generally less sensitive than typically developing children to social reinforcers; that is, praise, smiles, words of encouragement, and the like, are usually not highly motivating for young children with autism. If this is the case for an individual child, then lessons that typically result in social consequences—such as tacts, intraverbals, and most autoclitics—will be difficult to acquire. If the teacher replaces the weak social reinforcers with more concrete but powerful rewards—food or toys, perhaps—the outcome would develop a verbal operant that may remain partially controlled by that particular item, as opposed to an operant reinforced by generalized conditioned rein-

forcers. Simply substituting one reinforcer for another can have significant impact upon the operant that is acquired. In this case, the limited availability of effective reinforcers may impact upon the selection of skills to be taught. If social reinforcers are relatively weak, then an initial focus on manding may prove more effective than working on verbal operants associated with social reinforcers.

When social reinforcers remain relatively weak, more sophisticated language skills may remain difficult to acquire. For example, those with Asperger syndrome typically develop global language skills on par with their typically developing peers. However, they continue to have difficulty in acquiring communication skills that relate to social effectiveness—from using and understanding puns and other word play to more general skills associated with successful dating and romantic involvement. Thus, someone may learn to tell a joke but may not understand why it is funny.

Skinner (1957) pointed out the critical role of social reinforcement with regard to the development of language and self-knowledge: "As we have noted, it is *social reinforcement* which leads the individual to know himself. It is only through the gradual growth of a verbal community that the individual becomes 'conscious.' He comes to see himself only as others see him, or at least only as others insist that he see himself" (emphasis added, p. 140). When social reinforcers have limited effectiveness, there will be concomitant limits in language development.

For other populations, such as children with Down syndrome, social reinforcers may be particularly powerful. In such cases, lessons associated with tacting—name that animal, identify that sound, describe the item in the bag—may be highly reinforcing and thus readily acquired. An individual's diagnostic or educational classification does not set or fix educational goals, but it may suggest the types of reinforcers that may be limited or effective.

When teaching manding, it is important to ensure that a range of reinforcers is used. Although it may be relatively easy to manipulate access to concrete rewards such as food, drink, and toys from key caregivers, lessons should extend to activities and social events with an array of potential communicative partners; that is, children should be taught to request items from peers (Schwartz, Garfinkle, & Bauer, 1998) as well as from adults, to talk about play games and related activities with siblings (Taylor, Levin, & Jasper, 1999), and to seek information (Williams, Pérez-González, & Vogt, 2003). Thus, a general training aim is to broaden the array of reinforcers associated with manding, as well as to increase potential mediators regarding various reinforcers.

Summary

Skinner's (1957) work provides a platform on which behavior analysts can develop effective targets and strategies to help children (and adults) acquire or improve their verbal repertoires. When teaching verbal responses, it is essential to consider the relevant motivational and stimulus conditions. Behavior analysts can provide critical guidance regarding the importance of reinforcement when designing lessons, as well as awareness of how context will impact upon the function of new responses. Our emphasis on the function rather than the form of verbal behavior also suggests that we should be adept at helping children develop verbal repertoires using a variety of modalities even while recognizing the societal importance of speech. Indeed, the techniques for teaching verbal responses described in this chapter accommodate a variety of response modalities, including speech, sign language, picture-based systems, and other augmentative devices.

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CHAPTER 17

Staff Training and Management

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Staff Training and Management

Staff training and management represent a long-standing area of focus in applied behavior analysis. Soon after initial demonstrations of the efficacy of behavior analysis for improving the behavior of people with special needs in the 1960s, attention was directed to disseminating the emerging technology among human service personnel. Concern first centered on training service providers in basic behavioral procedures to apply with people who had developmental and related disabilities (e.g., Gardner, 1972). Shortly thereafter it became apparent that the same principles underlying behavior change procedures for people with developmental disabilities were applicable with staff work performance (Hollander, Plutchik, & Horner, 1973; Quilitch, 1975; Welsch, Ludwig, Radiker, & Krapfl, 1973).

Concern over training human service staff to use behavioral procedures and applying behavioral strategies to manage staff performance continues today. Such concern is due to several factors, including recognition that many services for people with disabilities warrant improvement (Reid & Parsons, 2002, Chapter 1). A related factor is the continuing gap between means of promoting desirable behavior reflected in the research literature and how day-to-day services are often provided (Jahr, 1998; Neef, 1995). Dissemination of behavior analysis through staff training and management is considered one means of bridging that gap (Babcock, Fleming, & Oliver, 1998; Liberman, 1983).

Although staff training and management have been a consistent focus within applied behavior analysis since the field's inception, on a relative basis these have not been large areas of focus. Investigations on staff performance in the human services represent a small percentage of published research in behavior analysis. Nonetheless, when considering that investigators have been addressing staff performance for over 30 years, a substantial amount of research has been reported. Such research has resulted in highly relevant information for impacting staff work behavior. Our purpose in this chapter is to summarize the existing knowledge base resulting from behavior analytic research on staff training and management. An additional purpose is to describe gaps in the current knowledge and suggest areas where future research is warranted.

Focus of Chapter

Behavioral research on staff training and management traditionally has been addressed within a somewhat specialty area of applied behavior analysis, typically referred to as *organizational behavior management* (OBM). Although more recently the primary emphasis within OBM has been business and industry rather than human service organizations per se, behavioral research has continued in the latter settings. The focus of the current chapter is on staff training and management specifically in human services. The principles of behavior change and many of the applications are the same in the two types of setting, but there are also significant differences in business and industry versus typical human services (e.g., variations in outcomes reflecting successful operations, personnel policies, potential performance incentives and reinforcers).

As with investigations in behavior analysis in general, most staff research has targeted settings for people with developmental disabilities. Such settings are likewise the focus of this chapter. However, information for impacting staff performance based on research in other settings—and particularly schools—is included where relevant.

Format of Chapter

In accordance with the previously noted purposes, the chapter format consists of two primary sections. The first summarizes technology of staff training and management derived from behavior analytic research to date. The second describes current gaps in the technology and summarizes areas in need of research, based on the noted research gaps, as well as emerging trends in the human services.

Existing Technology of Staff Training and Management

Behavior analytic research on staff performance in the human services generally can be categorized within three areas: (1) training staff work skills, (2) improving ongoing work performance and, (3) maintaining proficient work performance. Although these three areas are closely related and often overlap, they represent a useful means of organizing and describing investigations with staff work behavior.

Behavioral Procedures to Train Human Service Staff

The first investigations using behavioral procedures to train staff typically involved teaching basic behavior modification skills to human service personnel for application for people with developmental disabilities (e.g., Gardner, 1972; Koegel, Russo, & Rincover, 1977; Watson & Uzzell, 1980). Two major findings resulted from the early staff training research. First, professional and paraprofessional staff could be taught to apply behavioral procedures to change reliably the behavior of individuals with highly significant disabilities. Although such a research outcome is not surprising now, at the time, the outcome was noteworthy. In particular, it was demonstrated that behavioral procedures could be applied in existing service settings to teach important skills to people with severe and profound cognitive disabilities, who previously were considered unteachable (Whitman, Hantula, & Spence, 1990). Successful teaching demonstrations played an important role in major changes in residential, vocational, and educational opportunities subsequently offered to people with developmental disabilities across the United States as part of the deinstitutionalization, right-to-education, and community inclusion movements.

A second major outcome of initial studies on training staff to apply behavioral procedures pertained to what constituted effective training. It was demonstrated that typical training approaches relying on verbal procedures (i.e., lecture and written material) may be useful for teaching knowledge about job skills but are rarely effective for training staff how to perform the skills (Gardner, 1972). To train staff in skills necessary to perform job duties, more performance-oriented training procedures were necessary, such as modeling and trainee practice (for summaries, see Jahr, 1998; Reid, 2004; Reid, Parsons, & Green, 1989, Chapter 3).

Implications of findings from early behavioral research regarding effective staff training procedures have proven especially note-

worthy. The findings shed light on a primary reason for many problems with nonproficient staff performance in the human services: In many cases, staff members have not had effective training in the skills they are expected to perform. Human service agencies usually provide various types of staff training, but the training frequently relies on verbal approaches that research has shown to be insufficient for training performance skills.

Another outcome of early training research was that it set the foundation for the development of a highly effective technology for training human service staff work skills. The development and evaluation of that technology has been reported in a number of reviews (e.g., Adkins, 1996; Demchak, 1987; Jahr, 1998; Reid, 2004). The technology also has been synthesized into rather straightforward approaches applicable for training a wide variety of work skills, such as how to conduct discrete trial teaching (Sarokoff & Sturmey, 2004), to perform systematic preference assessments (Lavie & Sturmey, 2002), and to provide courteous service (Johnson & Fawcett, 1994).

A prototypical illustration of a behavioral approach to staff training is provided in Table 17.1. The table includes two critical features of effective staff training programs: *competency-* and *performance-based* training components (Reid, Rotholz, et al., 2003). *Competency-based* refers to clearly specifying the behaviors constituting the skills being taught, establishing a criterion for adequately performing the behaviors, and continuing training until that criterion is achieved by each participating trainee. *Performance-based* refers to use of procedures that involve a trainer demonstrating the skills as part of the training and requiring trainees to perform the skills being trained.

TABLE 17.1. Prototypical Staff Training Approach

1. Specify desired skills to be performed.
2. Verbally describe the skills and the rationale for their importance.
3. Provide a written summary of the skills.
4. Demonstrate the performance skills.
5. Support staff in practicing the target skills.
6. Provide positive and corrective feedback based on staff proficiency in performing the skills.
7. Repeat Steps 4–6 until staff members proficiently demonstrate the skills.

Although an ample amount of research has validated the efficacy of the behavioral technology of staff training, investigations also have demonstrated that staff training in and of itself does not necessarily result in staff members appropriately applying their newly acquired skills (Alavosius & Sulzer-Azaroff, 1990; Greene, Willis, Levy, & Bailey, 1978; Smith, Parker, Taubman, & Lovaas, 1992). In short, *staff training is often necessary for enhancing staff job performance, but it is rarely sufficient*. To ensure that staff members proficiently apply skills acquired through staff training programs, follow-up management procedures are usually needed during staff members' regular job routine.

Behavioral Procedures to Improve Ongoing Work Performance

The second major area of behavior analytic research with human service staff is the use of behavioral procedures to improve day-to-day work performance. This area pertains to situations in which staff members have the requisite skills to perform their jobs, but daily job performance does not represent adequate application of those skills. Investigations designed to improve ongoing work performance represent the largest area of behavior analytic research involving human service staff.

Research on improving ongoing staff performance has generally been considered in light of the traditional *antecedent–behavior–consequence,* or *A-B-C, model* in behavior analysis. The behavior is represented by the staff performance that is desired. Procedural applications are then categorized as *antecedent interventions*, designed to prompt or otherwise set the occasion for the behavior, or *consequence interventions*, intended to reinforce the behavior or punish competing (undesirable) behavior in the workplace. Another category of interventions has involved *self-control procedures*, in which the intent is to assist staff members in controlling their own behavior to improve work performance. In a fourth category of *multifaceted interventions*, various types of antecedent, consequence, and/or self-control procedures have been used in combination.

A number of reports have reviewed investigations involving antecedent, consequence, self-control, and/or multifaceted interventions with staff performance (Alvero, Bucklin, & Austin, 2001; Phillips, 1998; Reid, 2004; Reid et al., 1989, Chapter 4). A detailed review of the studies is not repeated here. Rather, key points in the existing technology for improving ongoing staff performance are summarized in accordance with the respective types of procedures.

Antecedent Interventions for Improving Performance

The most commonly investigated antecedent approach for improving work performance has been staff training. Other antecedent interventions (often implemented following initial training endeavors) have included instructions to staff (Fielding, Errickson, & Bettin, 1971) modeling how to perform a work duty, in which desired performance is demonstrated within staff members' worksite by a supervisor or similar authority figure (Gladstone & Spencer, 1977; Wallace, Davis, Liberman, & Baker, 1973), as well as prompts or cues to perform a work task, such as brief duty cards (Sneed & Bible, 1979). These types of interventions are attractive because, with the possible exception of modeling, they typically require relatively little time and effort. However, antecedent interventions often are characterized by inconsistent effectiveness in terms of significantly impacting staff performance (for reviews, see Phillips, 1998; Reid & Whitman, 1983).

Research demonstrating inconsistent effectiveness of antecedent interventions has important implications. Antecedent interventions such as instruction, whether presented vocally by a supervisor or in written form, represent the most common means of attempting to improve staff performance in human service settings. Consequently, supervisors often attempt to improve staff performance using procedures that repeatedly have been shown to be inconsistently effective (cf. Sturmey, 1998).

Given the popularity of antecedent procedures despite their inconsistent effectiveness prompts the question of why such strategies are employed so frequently. One likely answer relates to a pervasive problem in the human services: lack of relevant training of supervisors and related personnel in evidence-based procedures for improving staff performance (Reid, Parsons, Lattimore, Towery, & Reade, 2005; Sturmey, 1998). Lacking skills in the latter procedures, supervisors likely resort to strategies with which they are familiar, such as simply telling staff members what they should do on the job. Another likely reason is that supervisor instructional behavior is reinforced intermittently, in that staff members sometimes change their work performance following instructions from a supervisor.

Clearly, some staff members respond to supervisory instructions by altering their work behavior in some situations. Increased investigatory attention is warranted to determine conditions in which instructions and other antecedent interventions are likely to be effective. For example, staff behavior may be more likely to change following an instruction if the targeted behavior involves minimal response effort or represents a one-time, discrete event versus behavior involving more considerable effort or requiring repeated activity. It also seems likely that the staff would be more responsive to supervisory instructions if supervisors had a history of following staff (non)compliance with feedback or other consequences (discussed below). If investigations could identify conditions in which antecedents are more and less effective, then a more selected and efficacious use of such approaches could be made available for routine application.

Consequence Interventions for Improving Performance

Behavior analytic research involving consequences has focused on reinforcing desired staff performance, with relatively little attention directed to punishing undesired performance. Early investigations often employed tangible consequences as potential reinforcers, such as money (Katz, Johnson, & Gelfand, 1972), trading stamps (Bricker, Morgan, & Grabowski, 1972), and free meals (Shoemaker & Reid, 1980). Due in large part to practical considerations with tangible consequences, such as cost to an agency and lack of supervisory control necessary to provide money frequently on a contingent basis, recent investigations have targeted more available consequences, among which the most frequently investigated consequence has been performance feedback.

Feedback contingent on designated staff behavior has been presented in a variety of formats, including spoken (Realon, Lewallen, & Wheeler, 1983), written (Kneringer & Page, 1999), privately presented to individual staff (Shoemaker & Reid, 1980), and publicly presented to groups of staff (Hutchison, Jarman, & Bailey, 1980). Although the feedback has relative advantages and disadvantages, each type has generally been effective in increasing targeted staff behaviors (for reviews, see Alvero et al., 2001; Balcazar, Hopkins, & Suarez, 1986; Ford, 1980). The most commonly reported presentation process involves feedback that includes positive comments (e.g., praise) regarding desired staff performance. Some debate exists regarding the mechanism underlying contingent feedback as a behavior change intervention with staff, such as rule-governed versus reinforcement processes (Malott, Shimamune, & Malott, 1992). Nonetheless, there is ample evidence that feedback can improve staff performance.

Despite the frequently demonstrated efficacy of feedback relative to staff performance in the research literature, systematic use of feedback is not common practice in human service agencies (Harchik, Sherman, Hopkins, Strouse, & Sheldon, 1989; Sturmey, 1998). Two reasons are likely regarding the lack of widespread use of contingent feedback. One reason is that supervisors require specific skills to provide feedback effectively, and they often do not receive appropriate training in such skills (Reid et al., 2005; Sturmey, 1998). A second reason is that systematic provision of feedback requires consistent effort on the part of supervisors. Consequently, effective presentation of feedback to staff by supervisors is likely to require feedback to supervisors from upper management itself.

As indicated earlier, there has been little research on consequences designed to punish inadequate staff performance. Available research has not shown very effective results in terms of consistent changes in staff performance (e.g., Gardner, 1970; Repp & Deitz, 1979). Nonetheless, supervisors often attempt to change staff performance through punishment strategies. One early survey indicated that over 90% of supervisors in settings serving people with developmental disabilities relied on punishment procedures for managing staff performance problems (Mayhew, Enyart, & Cone, 1979). Such results are disconcerting when we consider evidence suggesting problems with the efficacy of such approaches, as well as potentially detrimental effects on an agency's workforce accompanying punishment strategies (Sturmey, 1998).

Self-Control Interventions for Improving Performance

A small but relatively persistent area of research on improving staff performance has been the evaluation of self-control procedures, involving staff members' use of goal setting, self-recording, and to a lesser extent, self-reinforcement. Often each of these procedures has been used in conjunction with one or more of the other self-control strategies. A primary rationale for evaluating self-control procedures from a management perspective is that because the procedures have been effective behavior change interventions in areas other than staff management, it seems logical that they may promote behavior change among human service staff. Additionally, self-control procedures can require less time and effort for agency management because staff members are implementing the procedures to enhance their own performance in contrast to requiring implementation by a supervisor (Williams, Vittorio, & Hausherr, 2002).

Investigations on self-control interventions with human service staff have reported mixed results. In some cases, self-control procedures were accompanied by significant improvements in staff performance (e.g., Burgio, Whitman, & Reid, 1983), whereas in others the improvements were inconsistent across staff members and/or were temporary in nature (Doerner, Miltenberger, & Bakken, 1989; Petscher & Bailey, 2006; Richman, Riordan, Reiss, Pyles, & Bailey, 1988; Suda & Miltenberger, 1993). Even in research on the former, it was often difficult to separate effects of self-control procedures from effects of simultaneously occurring supervisor actions. There is also concern that supervisory actions may be necessary to promote staff use of self-control procedures (Adkins, 1996), which reduces the time-efficiency advantage of the procedures. There is some indication, however, that an advantageous application of self-control pro-

cedures may be to maintain improvements in staff performance that initially accompany supervisory interventions (Brackett, Reid, & Green, 2007; Kissel, Whitman, & Reid, 1983). Nonetheless, overall research involving self-control procedures to improve staff performance suggests that such approaches can be effective, but the conditions under which they are effective are unclear and warrant continued research.

Multifaceted Interventions for Improving Performance

Most interventions for improving staff performance have been multifaceted, involving a number of behavior change procedures applied in combination. Typically, an initial training or instructional procedure is followed by application of performance consequences and, to a lesser degree, self-control procedures. The primary purpose of research with multifaceted interventions has been to demonstrate a reliable means of improving a designated area of staff performance. The rationale generally has been that combining various procedures, any one of which may effectively change staff performance, enhances the likelihood of success of the intervention relative to reliance on only one particular procedure.

Although different strategies comprise multifaceted interventions, an underlying conceptual basis for the interventions rests with the basic *A-B-C model* noted earlier. There have also been attempts to streamline and provide more systemization to multifaceted interventions by employing a rather generic *behavioral supervision model* (Hawkins, Burgio, Langford, & Engel, 1992; Reid & Shoemaker, 1984). Coinciding with a recent emphasis in the human services to provide consumer-centered services (Ivancic & Helsel, 1998), an updated version of this model has been developed through an *outcome management* approach to staff training and management (Reid & Parsons, 2000, 2002), which has demonstrated its efficacy in several human service settings (Parsons, Rollyson, & Reid, 2004; Reid, Green, & Parsons, 2003; Reid et al., 2005) by identifying desired outcomes for agency consumers to attain, then specifying respective staff performances necessary to assist consumers in attaining the outcomes. These and other primary steps comprising an outcome management approach to working with staff are summarized in Table 17.2.

TABLE 17.2. Basic Steps of Behaviorally Based Outcome Management

1. Specify consumer outcome to be attained.
2. Specify staff performance necessary to assist consumers in attaining designated outcome.
3. Train staff in targeted performance using performance- and competency-based training procedures.
4. Monitor staff job performance on the job.
5. Provide supportive feedback for proficient staff performance.
6. Provide corrective feedback for nonproficient staff performance.

Multifaceted programs have improved staff performance in a wide variety of situations. However, because of reliance on a number of intervention strategies, these approaches require certain supervisory skills, as well as consistent time and effort. The latter features likely represent one reason that systematic, multifaceted behavioral approaches to staff training and management are more prevalent in the research literature than in routine practice (see comments in subsequent chapter sections).

Behavioral Procedures to Maintain Performance

The third major area of behavioral staff research is maintenance of behavior change following training and management interventions. Maintaining changes in staff performance is often considered a subcategory of training or management research rather than a specific category itself. However, we address maintenance as its own category for two reasons. First, maintaining initially obtained improvements in staff performance is a critical variable regarding the social significance of behavioral research and application in the staff area. Second, maintaining desired staff performance has proven difficult.

The difficulty associated with maintaining changes brought about by behavioral staff training and management interventions was recognized early in the history of behavior analysis. Such recognition was aptly noted by Liberman (1983), who acknowledged that observed effects of behavioral interventions with staff performance often ended as soon

as investigators completed a staff study in a given human service agency. Subsequently, there has been repeated recognition of the need to actively promote maintenance of initial improvements in staff performance accompanying behavioral interventions (Babcock et al., 1998; Phillips, 1998).

Although the importance of maintaining staff behavior change, and difficulties in this regard, are well acknowledged, there has been much less research in this area relative to training and management interventions initially to improve staff performance (Phillips, 1998). One likely reason for the relative lack of maintenance research is the time involved in assessing and promoting maintained behavior change. Investigators must work with agency personnel initially to implement and evaluate a training or management program, then continue reliable observations for extended maintenance periods. Furthermore, to evaluate variables *functionally affecting* maintenance, experimental manipulations must follow the initial intervention designed to improve performance, and must in turn be followed by continued observations.

Despite difficulties in conducting maintenance research, available data are encouraging about use of behavioral procedures to maintain effects of training and management interventions (Phillips, 1998; Sturmey, 1998). There have been several demonstrations of long-term maintenance of staff behavior change, encompassing time periods over several years (e.g., Harchik, Sherman, Sheldon, & Strouse, 1992; Parsons, Schepis, Reid, McCarn, & Green, 1987; Pollack, Fleming, & Sulzer-Azaroff, 1994; Richman et al., 1988). These data suggest that behavioral management interventions are accompanied by sustained improvements in staff performance as long as some components of the initial interventions remain in place. As described earlier, however, sustaining the application of procedures by supervisors to maintain changes in staff behavior can also be problematic.

One means of attempting to maintain effects of interventions with staff has been to incorporate behavioral procedures, such as supervisory feedback, within an agency's routine management system. Although there have been some notable demonstrations of institutionalizing behavioral procedures within an agency's operation (Christian, 1983; Fixsen & Blasé, 1993), having feedback and related systems in place has not always proven effective for maintaining desired staff behavior (Green, Rollyson, Passante, & Reid, 2002). More specifically, contingencies seem necessary to ensure that supervisory personnel carry out the maintenance systems. In short, much is left to be learned about incorporating effective maintenance systems within an agency's routine operation.

Gaps in Staff Training and Management Technology and Future Research Areas

As indicated in preceding sections, considerable knowledge has resulted from behavior analytic research on staff training and management. The components of effective training programs have been well identified, and a very effective technology has been developed for teaching performance skills to human service staff. Using the *A-B-C model* as a conceptual basis, a wide variety of procedures has been developed to improve the ongoing performance of staff, and particularly in regard to application of consequence and multifaceted interventions. Within the parameters with which behavioral procedures have been investigated for maintaining changes in staff behavior, findings also have been promising for long-term performance improvements.

As also noted in preceding sections, the knowledge base and technology for training and managing staff performance are not complete. Several problematic areas have already been identified, along with areas warranting research attention (e.g., identifying conditions in which antecedent and self-control procedures are likely to be effective). This section provides a synthesis of other significant gaps in the existing technology and, correspondingly, areas warranting future research.

What remains to be accomplished in the staff training and management domain of applied behavior analysis generally can be viewed from two perspectives. The first is continued development of ways to expand the technology for training and managing staff performance. The second is how better to disseminate and incorporate the technology within the routine operation of human

service agencies. These two areas of need have been noted by a number of prominent OBM researchers and practitioners (Harchik & Campbell, 1998; Parsons, 1998; Sturmey, 1998).

Expanding the Technology of Training and Mangement

Like its parent discipline of applied behavior analysis, OBM and related areas of behavioral staff training and management are continuously evolving. The evolution occurs as research enhances our understanding of human behavior, as well as our ability to promote socially valued behavior in different contexts. The evolution also occurs as new or previously unaddressed problem areas are targeted by behavioral researchers. The evolutionary process driven by knowledge and technology derived from research represents the evidence-based foundation that separates behavioral staff training and management from almost every other approach to supervision in the human services (Reid & Parsons, 2002, Chapter 2). As such, it is anticipated and desired that the behavioral technology of staff training and management will continue to be expanded and refined.

Training and Managing Use of New Behavioral Technologies

In one way, research on staff training and management in the human services follows research on ways of changing the behavior of people with special needs. As research in behavior analysis demonstrates new or better means of teaching individuals and overcoming challenging behavior, for example, staff training and management research is then undertaken to disseminate those means to human service staff.

How research on staff performance follows other behavior analytic research is illustrated with developments pertaining to the functional assessment of challenging behavior among people with developmental disabilities. A very considerable amount of research over the last two decades is on assessing the function of challenging behavior and developing function-based interventions. Recently, research has begun to appear on training practitioners in functional assessment technologies (Moore et al., 2002; Wallace, Doney, Mintz-Resudek, & Tarbox, 2004). Similar developments have occurred in other areas, such as working with staff to apply recent advancements in identifying preferences among people with disabilities (Lavie & Sturmey, 2002; Roscoe, Fisher, Glover, & Volkert, 2006). Training and managing staff members' application of new technologies derived from behavior analytic research represents an area of continuing research importance.

Expanding Training and Management Research to Other Problematic Performance Areas

Although behavioral research has addressed numerous types of staff behavior in the human services, there are still important, frequently problematic performance areas that have not been thoroughly addressed. For example, staff turnover represents one of the most troublesome issues facing many human service agencies, yet it has received infrequent attention from behavioral researchers (Strouse, Carroll-Hernandez, Sherman, & Sheldon, 2003). In some cases, addressing performance issues that heretofore have received little research attention is likely to involve rather straightforward applications of existing training and management procedures. In other cases, more detailed analysis and refinements are likely to be necessary.

One area of staff performance that has received relatively little research attention and is likely to require procedural refinements is staff implementation of interventions for agency consumers who display challenging behavior. Promoting staff implementation of procedures to reduce problem behavior is a concern of many behavior analysts. As discussed elsewhere (Shore, Iwata, Vollmer, Lerman, & Zarcone, 1995), this performance area includes features that can differ significantly from other areas of staff responsibilities, such as difficulty observing relevant staff performance due to unpredictable occurrence of target behaviors among consumers.

Training and Managing Use of Behavioral Technologies in New Venues

Just as behavior analysis is continuously evolving as a professional discipline, the

human service field at large tends to evolve over time. If behavior analysis is to be practiced within new and altered venues of service provision (e.g., in-home services with primary care providers), then behavioral technologies must be amenable to those venues. Successfully applying behavior analysis within new venues of service provision represents another area for future research.

How research is needed on behavioral staff training and management as new venues of service provision develop is represented in the change from institutional to community living for people with disabilities in the United States. Much of the early staff training research occurred in institutional settings. As the community living trend became more widespread, a need arose to demonstrate how to impact staff performance in community settings (Harchik & Campbell, 1998). For example, much of the early research on institutional staff performance involved the frequent presence of a staff supervisor for intervention implementation. Community living arrangements often have infrequent supervisor involvement with staff. Consequently, a need has arisen for research on ways to improve staff performance without frequent supervisory presence.

Use of New Information Technology in Training and Management

Information dissemination has been revolutionized in recent years. Internet access, training videos and DVDs, and interactive software, for example, are now readily available to many human service agencies. To date, though, with relatively few exceptions (e.g., Catania, Almeida, Liu-Constant, & Reed, 2009; Moore & Fisher, 2007; Neef, Trachtenberg, Loeb, & Sterner, 1991), behavioral research has not focused on these potential ways of enhancing training and management practices in the human services.

New information technologies offer a number of attractive features for teaching important work skills to human service personnel. To illustrate, training DVDs may represent a means of providing relevant information and procedural demonstrations that require minimal trainer time relative to more traditional training procedures (Macurik, O'Kane, Malanga, & Reid, 2008). Hence, research evaluating these approaches to staff training seems warranted. However, caution is also warranted, based on what research has shown to represent effective training of staff job skills. Most of the information technologies still rely heavily on dissemination of verbal information (with the possible addition of increased opportunities for performance-based modeling), which previous research has shown to be more useful for enhancing staff knowledge than for training in actual performance skills. As research with new information technologies proceeds, it would be prudent to determine how performance-based training can be incorporated within the new training approaches.

Expanding Adoption of Behavioral Training and Management

The lack of widespread adoption of the behavioral technology of staff training and management within human service settings has been noted in this chapter and elsewhere (Babcock et al., 1998; Crow & Snyder, 1998; Sturmey, 1998). Until this evidence-based approach to working with staff is more widely used in the human services, its social significance will remain limited. The following sections present several research areas that seem relevant to achieve wider scale use of the existing technology.

Developing Personnel Preparation Programs in Training and Management

One means of incorporating staff training and management technology into human service settings is to ensure that professionals entering those settings are knowledgeable about the technology and skilled in its application. Traditionally, professionals have received little or no training in this area (Schell, 1998). There are indications, however, that more attention is being directed to behavioral staff training and management in personnel preparation programs. For example, some university programs that train behavior analysts are including courses with content on staff training and management, due in part to inclusion of knowledge pertinent to these areas as requirements for obtaining behavior analyst certification (Moore & Shook, 2001). Nonetheless, only

a small number of university programs currently focus on OBM, and their emphasis is often on business and industry rather than human service organizations.

Training Supervisors in Behavioral Training and Management

Supervisors in the human services cannot be expected to be proficient in behavioral staff training and management unless they have had training in these areas. A relatively small but increasing number of investigations has addressed supervisor training (e.g., Clark et al., 1985; Fleming, Oliver, & Bolton, 1996; Methot, Williams, Cummings, & Bradshaw, 1996; Parsons & Reid, 1995). Expansion of supervisor training is likely to be enhanced if evidence-based curricula are developed for application with working supervisors. One such curriculum has recently been developed by the American Association on Intellectual and Developmental Disabilities (Reid, Parsons, & Green, 2011).

In considering research on supervisor training, attention to the results of staff training research is warranted, as summarized earlier. The latter research suggests that supervisor training is not likely to have a major or lasting impact unless subsequent supervisory application of behavioral procedures with staff is prompted and reinforced by upper management. With few exceptions (e.g., Gillat & Sulzer-Azaroff, 1994; Methot et al., 1996), there has been a significant lack of research addressing the behavior of senior managers or executives in human service settings.

Maintaining Human Service Performance

The need for research on maintaining improvements in staff performance following training and management interventions is closely related to the need for research on supervisors and senior managers. Research to date suggests that improved staff performance is likely to be maintained only as long as some relevant components of initial interventions continue to be implemented. In turn, as noted, specific actions by senior management are usually needed to promote continued supervisory use of intervention components.

Another area of research that is relevant to maintaining supervisor performance pertains to the acceptability of behavioral management procedures. The importance of identifying acceptable management procedures to supervisors to promote continued use of the procedures with staff has long been recognized (Reid & Whitman, 1983). Correspondingly, a number of investigators have attempted to evaluate acceptable components of supervisory procedures (see Parsons, 1998, for a review). However, as the Parsons review indicated, there are concerns regarding the validity of typical measures of supervisory acceptance (i.e., questionnaire responses). Continued research on means of making management procedures acceptable to supervisors and determining valid measures of acceptability is warranted.

An additional potential means to promote maintenance of appropriate staff behavior involves use of functional assessment procedures with staff performance. Human service staff members have many tasks to perform and many contingencies on their work duties. Investigations on improving staff performance often impose new contingencies without apparent regard for existing contingencies in the workplace. As a result, competing contingences exist relative to staff behavior, and when investigators discontinue their research procedures, staff behavior resumes within the context of the more common contingencies. One way of avoiding this obstacle is to assess staff work patterns to identify when to impose new contingencies that do not compete with existing contingencies on work behavior (Green, Reid, Perkins, & Gardner, 1991). For example, Green and colleagues conducted a structural analysis of staff work activity to target periods of frequent nonwork behavior for increasing selected duties. Targeting periods of nonwork behavior allowed for increased staff performances, without competing with the completion of other duties expected of staff.

The Green and colleagues (1991) investigation also highlights staff performance problems due not necessarily to competing contingences on work duties but to an apparent lack of contingencies on certain work duties. A number of staff investigations has addressed reducing staff time spent in nonwork activities (Brown, Willis, & Reid, 1981; Green et al., 1991; Iwata, Bailey, Brown, Foshee, & Alpern, 1976). A reasonable assumption of this research is that staff

time was spent in nonwork activities due to lack of supervisor contingencies on such behavior (or lack of contingencies on more desired performance).

More detailed analysis of contingencies, or lack of contingencies, on staff behavior in human service agencies seems likely to result in information relevant for promoting sustained improvements in staff performance. The significance of functional assessments of staff performance recently has received increased attention (Austin, 2000; Sturmey, 1998). We support the development of this line of research and offer it as an important means of furthering the contribution of applied behavior analysis for promoting quality staff performance.

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PART VI

INTERVENTIONS FOR DECREASING PROBLEM BEHAVIOR

CHAPTER 18

Developing Antecedent Interventions for Problem Behavior

Richard G. Smith

Behavioral interventions to treat problem behavior typically involve the manipulation, or management, of some environmental event or condition, with the intended result that problem behavior is eliminated or at least reduced. When the events or conditions that are managed occur prior to the behavior itself, the treatment is called an *antecedent intervention*.

Antecedent interventions can be broadly classified into two categories: *Default interventions* are treatments whose effects do not depend on specific identification of the variables that set the occasion for and maintain the problem behavior. Interventions such as antecedent exercise, environmental enrichment, protective equipment, and restraint are considered default interventions in that they are effective for problem behaviors maintained by a range of sources of reinforcement. By contrast, *function-based interventions* are designed to directly manipulate at least one component of a particular operant contingency that has been identified to maintain the problem behavior. Interventions such as noncontingent reinforcement (NCR, also referred to as "fixed-time [event]"; Vollmer, 1999), which usually refers to the delivery of the type of reinforcement thought to reinforce problem behavior on a time-based, or response-independent schedule, are considered function-based interventions.

Antecedent interventions can be further classified according to the specific mechanism by which they decrease behavior. Some interventions affect motivating operations (MOs) (Laraway, Snycerski, Michael, & Poling, 2003) for problem behavior, whereas others may alter discriminative functions. MOs momentarily alter the effectiveness of events and stimuli as behavioral consequences and also the probability of behavior that has produced those consequences in the past (Laraway et al., 2003). For example, NCR involves repeated, response-independent provision of stimuli or events thought to maintain problem behavior and therefore may decrease behavior by abolishing the reinforcing effectiveness of those stimuli or events. Thus, NCR would be classified as an MO-based procedure. Other antecedent interventions may manage environmental conditions or stimuli associated with differential consequences for problem behavior, altering discriminative control over the behavior. For example, antecedent stimuli

that have been correlated with the unavailability of reinforcing consequences produce a decrease in occurrences of target behavior in their presence (this is known as an "S-delta" [SΔ] function[1]). Finally, some interventions reduce problem behavior because they arrange the environment in some way that renders the target behavior difficult or impossible to complete. Interventions such as protective equipment and mechanical restraint fall into this category.

In the following sections, antecedent behavioral interventions designed to reduce or eliminate behavior are described. A brief review of the literature pertaining to each intervention is presented, and procedural variations, functional properties (i.e., the mechanisms underlying their effects on behavior), strengths, and limitations are discussed. Default interventions are discussed first, followed by a treatment of function-based interventions.

Default Interventions

Some antecedent procedures decrease behavior regardless of the operant function of the target behavior; that is, knowledge of the consequences that maintain problem behavior is not necessary when using these types of interventions. As a result, the precise mechanisms associated with the effects of these procedures (i.e., the behavioral principles that describe their effects) may not be as well understood as when procedures are systematically designed to correspond with a particular contingency of reinforcement. Although the ability to prescribe treatment without requiring a prior functional analysis seems clinically expedient, some of these procedures are associated with significant limitations and side effects; therefore, their use in practice should be considered only in light of the relative merits and limitations of alternative, function-based approaches.

[1]It should be noted that interventions based on discriminative control require manipulation of both antecedent and consequential events to establish and maintain their effectiveness; thus, they are not properly characterized as "exclusively" antecedent interventions (i.e., the clinician must actively control consequences in order to maintain the effectiveness of the antecedent stimulus).

We refer to treatments whose effects are not dependent on the operant function of problem behavior as *default* treatments; however, this does not mean that operant accounts of their effects are not possible or relevant. Similar to function-based treatments, some default interventions may alter discriminative stimuli (S^Ds) or MOs for problem behavior; however, in the case of default treatments, it is not necessary to have information about the nature of the contingency maintaining problem behavior in order to identify a potentially effective intervention.

Antecedent Exercise

An intervention that has been shown to decrease problem behavior is *antecedent exercise* (e.g., Allison, Basile, & MacDonald, 1991; Bachman & Fuqua, 1983; Baumeister & MacLean, 1984; Celiberti, Bobo, Kelly, Harris, & Handleman, 1997; Kern, Koegel, & Dunlap, 1984; Lochbaum & Crews, 2003; McGimsey & Favell, 1988; Powers, Thibadeau, & Rose, 1992), which usually consists of involving participants in a program of effortful activities, such as aerobic exercise (e.g., jogging, walking, dancing, roller skating) or strength training (e.g., weight lifting). Behavioral observations are conducted after (typically within a few minutes) completion of the exercise. This intervention has been shown to treat effectively a range of behavior disorders exhibited by persons with developmental disabilities, including self-injurious behavior (SIB) (Baumeister & MacLean, 1984), aggression (McGimsey & Favell, 1988; Powers et al., 1992), inappropriate vocalizations (Bachman & Fuqua, 1983; Powers et al., 1992), off-task behavior (Bachman & Fuqua, 1983), out-of-seat behavior (Celiberti et al., 1997), and stereotypy (Celiberti et al., 1997; Kern et al., 1984; Powers et al., 1992). Antecedent exercise has also been used with varying degrees of empirical support and reported success to treat depression (Doyne, Chambless, & Beutler, 1983), anxiety disorder (Broocks et al., 1998), and pain disorder (Turner & Clancy, 1988) in persons without developmental disabilities.

It is important to note that in contrast to other interventions involving effortful activity, such as overcorrection (Foxx & Azrin, 1972, 1973), antecedent exercise is imple-

mented independently of occurrences of the problem behavior. Whereas overcorrection involves requiring participants to engage in effortful activities contingent on problem behavior, antecedent exercise involves engaging participants in effortful activity prior to observation sessions. Because antecedent exercise is not presented as a consequence for problem behavior, the process of punishment cannot account for its effectiveness in decreasing problem behavior.

Mechanisms Underlying the Effects of Antecedent Exercise

Although the production of a general state of fatigue is an intuitively appealing account of the effects of antecedent exercise, research outcomes seem inconsistent with this interpretation. For example, increases in on-task behavior (Powers et al., 1992), appropriate responding (Kern, Koegel, Dyer, Blew, & Fenton, 1982) and the absence of overt signs of fatigue (Baumeister & MacLean, 1984) following bouts of exercise indicate that the response-decreasing effects of this intervention are at least somewhat specific to problem behavior. In fact, *increases* in several forms of appropriate behavior following antecedent exercise have been reported across a range of studies (e.g., Baumeister & MacLean, 1984; Celiberti et al., 1997; Kern et al., 1982; Powers et al., 1992). These outcomes are somewhat paradoxical in that this specificity of action appears to correlate most clearly with the social acceptability of the classes of behavior affected: Behavior that is considered problematic decreases and socially acceptable behavior increases following periods of exercise.

A possible mechanism by which antecedent exercise decreases problem behavior is via alteration of the reinforcing effectiveness of the consequences that maintain problem behavior, or an MO effect (Smith & Iwata, 1997). However, evidence for this account is indirect and based largely on that the fact that the effects of antecedent exercise are difficult to explain in terms of discriminative operations or conditions that physically inhibit responding. Thus, an MO account should be considered tentative until direct evidence about the behavioral mechanisms underlying the effectiveness of antecedent exercise becomes available.

Strengths and Limitations of Antecedent Exercise

Among the strengths of antecedent exercise as treatment for behavior disorders is that it is not only effective in decreasing a wide range of problem behaviors, but it also results in improvements across several measures of appropriate behavior and physical and psychological health. In addition to the increases in appropriate behavior noted previously, exercise programs have obvious physiological and medical benefits, including improved cardiovascular fitness, improved muscle tone, and associated improvements in adaptive skills. Results of some studies suggest that antecedent exercise may also be associated with decreases in depression and anxiety, as well as improved measures of general psychological health (Lochbaum & Crews, 2003).

Among the limitations of antecedent exercise is an apparent brevity of effects. Most studies have analyzed only the short-term effects of exercise, often immediately following bouts of exercise; however, the results of temporal analyses suggest that the effects of exercise on problem behavior may be transient. For example, two of four participants in one study showed large and immediate reductions in problem behaviors subsequent to vigorous exercise; however, these results waned across 15-minute observation sessions occurring immediately, 1 hour, and 2 hours following exercise periods (Bachman & Fuqua, 1983). Another limitation of antecedent exercise is that it may be inconvenient or impossible to implement in some situations (during academic instruction, etc.).

Enriched Environment

Another way that antecedent conditions can be arranged to decrease problem behavior is to provide a stimulus-enriched environment. Environmental enrichment (EE) involves making preferred items, toys, leisure and recreation items, activities, and/or social interaction available on a continuous, response-independent basis. A number of studies have demonstrated EE to be an effective intervention for SIB and stereotypical problem behavior (Berkson & Davenport, 1962; Berkson & Mason, 1963, 1965; Cuvo, May, & Post, 2001; Horner, 1980; Rapp, 2006; Rihgdahl, Vollmer, Marcus, & Roane, 1997). Although EE may reduce problem behavior

maintained by social reinforcement, much of the EE literature has focused on stereotypical forms of problem behavior, suggesting that it may be most appropriate to treat automatically reinforced behavior.

Mechanisms Underlying the Effects of EE

There are at least two reasonable accounts for the reductive effects of EE. First, EE may involve straightforward competition between behavior allocated toward EE stimuli and problem behavior; that is, EE may reduce problem behavior indirectly by providing alternative, competing sources of reinforcement. Research results indicating that EE is more effective when highly preferred versus less preferred stimuli are used (e.g., Vollmer, Marcus, & LeBlanc, 1994) are consistent with the notion that highly preferred stimuli compete effectively with the consequences maintaining problem behavior. One study showed that rotating sets of noncontingently available stimuli resulted in more durable decreases in problem behavior than did continuous availability of one set of stimuli (DeLeon, Anders, Rodriguez-Catter, & Neidert, 2000). These outcomes suggest that when the reinforcing effectiveness of alternative sources of reinforcement waned (due to repeated or extended contact) relative to the effectiveness of the form of reinforcement maintaining problem behavior, the subject reverted to problem behavior. Rotating alternative stimuli apparently maintained the relative effectiveness of those stimuli and more effectively suppressed problem behavior.

On the other hand, when EE materials produce stimulation similar to the consequences that maintain problem behavior, EE may directly reduce problem behavior by functioning as an abolishing operation (AO) for problem behavior. In this case, EE would be considered a function-based treatment because its effectiveness would depend on a functional "match" (or at least a relationship of substitutability) between stimuli used in EE and those that maintain the problem behavior. By providing a similar type of stimulation as that suspected to maintain problem behavior, the reinforcing effectiveness of the maintaining reinforcer may be temporarily reduced, or abolished, through satiation or habituation (Murphy, McSweeney, Smith, & McComas, 2003). Research indicating that antecedent availability of stimuli similar to those suspected of maintaining problem behavior ("matched" stimuli) more effectively suppresses problem behavior than "unmatched" stimuli (e.g., Favell, McGimsey, & Schell, 1982; Piazza et al., 1998) is consistent with this account. Indeed, Piazza, Adelinis, Hanley, Goh, and Delia (2000) demonstrated that matched stimuli were more effective in decreasing problem behavior than stimuli that had been ranked as more preferred during a pretreatment preference assessment. These results indicate that mere competition among reinforcing options may not completely account for the effects of EE, and that, at least in some cases, EE may qualify as a function-based treatment.

Strengths and Limitations of EE

There are several clear benefits to the use of EE in practice. First, EE is a simple, straightforward, easily implemented, and cost-effective intervention. It appears to be especially effective to decrease stereotypical and automatically reinforced behavior because it provides either a source of competing reinforcement or an alternative means to access reinforcement similar to that maintaining problem behavior. Providing a wide array of alternative forms of stimulation makes sense when the operant function of problem behavior is unclear or difficult to assess directly. In such cases, the probability that a stimulus will function to compete effectively with or replace problem behavior can be increased simply by providing a large number of alternatives. The probability of finding an effective alternative stimulus appears to be enhanced further if an attempt can be made to match the sensory properties of those stimuli with those associated with the problem behavior. Although EE does not directly teach new or alternative behavior, the availability of alternative activities and items appears to be associated with improvements in appropriate object-directed behavior (Horner, 1980).

Restraint, Protective Equipment, and Other Forms of Response Restriction

Restraint, protective equipment, and other direct means to prevent occurrences of problem behavior also have been reported in the

literature. These types of interventions physically impede the occurrence of behavior by restricting movement or otherwise preventing completion of the target response. Although these procedures are unquestionably effective in decreasing or eliminating problem behavior, they are generally viewed as highly intrusive, undesirable, and generally inadequate approaches to intervention that should only be used in emergency situations (e.g., when problem behavior poses immediate and serious risk to the participant or other people, or will result in substantial property damage).

Procedures to physically restrict responding are typically categorized according to their form. *Personal restraint* involves caregivers' physically securing and holding body parts, so that problem behavior cannot occur, and is often employed after an episode of problem behavior has begun (i.e., as a consequence-based intervention). However, personal restraint may also be implemented on an antecedent basis in situations where problem behavior is highly likely to occur. For example, caregivers may physically restrain a child during dental visits if that child has engaged in tantrums during previous dental exams and procedures. *Mechanical restraint* involves securing limbs and body parts with devices designed for this purpose, such as four-point restraints, arm splints, and straightjackets. Mechanical restraint, like personal restraint, is most frequently used to stop ongoing episodes of problem behavior, but it may also be used as proactive, antecedent intervention when severe problem behavior is anticipated. Finally, *protective equipment* is similar to restraint, in that mechanical devices are used; however, protective equipment typically permits the wearer to engage in unrestricted motion but prevents problem behavior from producing damage (e.g., a padded helmet to prevent trauma resulting from headbanging). Protective equipment is usually less-confining than restraint and may include devices such as safety goggles, helmets, and lap or wheelchair belts. Whereas restraint devices may be used to prevent the occurrence of a range of problem behaviors (e.g., aggression, property destruction, SIB), protective equipment is primarily useful for SIB because the devices are designed to protect the wearer from injury.

Strengths and Limitations of Restraint and Protective Equipment

As previously stated, restraint and protective equipment are extremely effective to eliminate problem behavior while they are applied. They are designed specifically to restrict occurrences of targeted responses; thus, no targeted problem behavior typically occurs during restraint periods. However, there are serious limitations and side effects associated with this type of intervention. First, many restraint procedures are highly intrusive in that they disrupt ongoing activities and often prevent the occurrence of appropriate alternative behavior, as well as problem behavior; that is, a wide range of activities, including educational and appropriate social interactions, may be limited when restraint is used. Thus, highly restrictive restraint procedures (e.g., four-point restraints, straightjackets) may be both nonconstructive, in the sense that no alternative, replacement behavior is actively taught, and actively impede the acquisition of alternative behavior because all movement—appropriate and inappropriate—is restricted. Second, for some people, restraint appears to have aversive properties. For example, some research has indicated that contingent application of restraint can suppress behavior that produces it (e.g., Lerman, Iwata, Shore, & DeLeon, 1997)—one of the defining effects of aversive stimulation. Therefore, for some individuals, restraint may function as an aversive procedure; thus, issues associated with aversive treatment must be considered. For example, attempts to apply antecedent restraint may (and often do) occasion avoidance or escape behaviors such as running away or aggression. Additionally, if restraint appears to be aversive, caregivers may sometimes threaten individuals with contingent restraint (e.g., "If you do that again I'll put you in a straightjacket") or actually use it as punishment. Alternatively, some individuals who engage in SIB also actively seek out opportunities to be placed into restraints, or "self-restrain" (e.g., Baroff & Tate, 1968). In some cases, restraint may occur almost continuously, interfering with active engagement in habilitative or other desirable behavior. In extreme cases, individuals may engage in problem behavior to produce access to restraint (Smith, Lerman, & Iwata,

1996; Vollmer & Vorndran, 1998). Finally, restricting an individual's ability to engage in a particular response may result in an increase in the motivation to engage in that response. For example, research outcomes have shown that limiting access to leisure activities can result in subsequent increases in engagement in those activities, presumably due to a period of deprivation from the reinforcing aspects of those activities (Klatt, Sherman, & Sheldon, 2000). Similarly, restricted access to problem behavior, such as SIB, may increase subsequent levels of the behavior for some individuals (Blevins, 2003; Rapp, 2006). Thus, in some cases, restraint may merely postpone and ultimately exacerbate the very behavior it is intended to reduce.

Function-Based Interventions

If the operant function of problem behavior is known, function-based interventions can be developed. Function-based interventions are designed to correspond specifically to a maintaining contingency of reinforcement. As such, intervention procedures vary according to the type of contingency identified to maintain the problem behavior. As indicated earlier, antecedent interventions derived from knowledge or hypotheses about the variables maintaining problem behavior can be further classified as involving discriminative and/or motivating operations. Below, function-based antecedent interventions are discussed, and procedural variations corresponding to various operant functions of problem behavior are described. After a discussion of noncontingent reinforcement and stimulus control strategies, some specific approaches to treat problem behavior maintained by escape are presented.

Noncontingent Reinforcement

NCR procedures involve presentation of an event or stimulus identified as the reinforcing consequence for problem behavior on a time-based, or response-independent, schedule. Typically, but not always, the event or stimulus is withheld contingent on problem behavior (i.e., problem behavior is placed on extinction). Initial schedules in NCR arrangements are often very "dense" in the sense that delivery of the maintaining reinforcer occurs very frequently (Hagopian, Fisher, & Legacy, 1994). Subsequently, the NCR schedule may be systematically "thinned," usually on the basis of low measures of problem behavior (e.g., Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993), until a schedule that is manageable in natural environments is reached (or until the effective parameters of NCR become apparent because further thinning of the schedule results in unacceptable increases in problem behavior). NCR has been shown to be an effective intervention for a range of problem behaviors, including SIB (Vollmer et al., 1993), aggression (Lalli, Casey, & Kates, 1997), disruption (Fisher, Ninness, Piazza, & Owen-DeSchryver, 1996), food refusal (Cooper et al., 1995), inappropriate vocalizations (Falcomata, Roane, Hovanetz, Kettering, & Keeney, 2004), pica (Goh, Iwata, & Kahng, 1999), and pseudoseizures (DeLeon, Uy, & Gutshall, 2005). For a very detailed and comprehensive recent discussion of NCR, see Carr and LeBlanc (2006).

The term *noncontingent reinforcement* has been criticized as a technically inaccurate label because (1) reinforcement involves a contingency by definition (i.e., the process of reinforcement is defined, in part, by a contingency between a response and a consequence), and (2) it is unclear what, if anything, is reinforced when NCR is used (Poling & Normand, 1999). The validity of these criticisms has been acknowledged (Vollmer, 1999) and many researchers now use more technically precise descriptors, referring to the time-based delivery of stimuli or events (e.g., fixed-time [FT] 1-minute attention). However, many authors continue to use the term NCR, and its utility as "shorthand" for a general class of interventions involving response-independent delivery of stimuli and events has been established (Vollmer, 1999). Therefore, in the following discussion, the term NCR describes general procedures, and more descriptively accurate nomenclature is used in the procedural details.

NCR with Problem Behavior Maintained by Social Positive Reinforcement

As with all function-based interventions, NCR procedures vary according to the functional properties of the problem behavior.

For example, if problem behavior is known to be maintained by positive reinforcement in the form of attention from caregivers, then NCR would consist of presenting attention on a time-based schedule and withholding attention following problem behavior. In an early and influential application of NCR, Vollmer and colleagues (1993) showed that ignoring their participants' attention-maintained SIB and providing attention on time-based schedules produced immediate and substantial decreases in SIB. Initially, continuous attention was provided; however, the schedule values were subsequently faded to one brief presentation of attention every 5 minutes (FT 5 min) for each participant. NCR has been used to treat a range of problem behaviors maintained by positive reinforcement, including SIB (Vollmer et al., 1993), destructive behavior (Hagopian et al., 1994), bizarre speech (Mace & Lalli, 1991), and others. Although most NCR procedures incorporate both time-based stimulus presentation and withholding of maintaining stimuli for problem behavior (i.e., extinction), several studies have shown that stimulus presentation alone (without extinction) can be sufficient to produce substantial decreases in problem behavior (e.g., Fisher et al., 1999; Lalli et al., 1997).

A few studies have investigated NCR arrangements in which stimuli other than those identified to maintain problem behavior (i.e., "arbitrary" stimuli) are presented (Fischer, Iwata, & Mazaleski, 1997; Fisher, DeLeon, Rodriguez-Catter, & Keeney, 2004; Fisher, O'Connor, Kurtz, DeLeon, & Gotjen; 2000; Hanley, Piazza, & Fisher, 1997). For example, Hanley and colleagues showed that time-based presentation of a stimulus identified as preferred via formal preference assessment was as effective as presentation of attention (the consequence identified to maintain problem behavior) to treat two participants' destructive behavior. Fischer and colleagues (1997) extended these findings, showing that continuous access to preferred stimuli decreased the positively reinforced problem behavior of two participants, even when the behavior continued to produce the consequences identified to maintain the behavior. Although use of stimuli other than those identified to maintain problem behavior is not technically a "function-based" application, nearly all of the research on this topic has been conducted in the context of known maintaining variables; therefore, NCR using arbitrary stimuli is discussed in this section.

Preference assessment procedures have been useful to select the stimuli used in arbitrary NCR arrangements. Fisher and colleagues (2000) showed that stimuli identified as highly preferred via paired-choice preference assessment (Fisher et al., 1992) more effectively suppressed problem behavior than did less-preferred stimuli. Researchers have used competing stimulus assessments to empirically identify preferred stimuli that occasion low levels of problem behavior and high levels of stimulus engagement (Fisher et al., 2000, 2004). For example, Piazza and colleagues (1998; Fisher et al., 2004) identified a pool of preferred stimuli using a paired-choice preference assessment. Subsequently, each stimulus was made available to participants while problem behavior continued to produce the identified maintaining reinforcer (attention in Fisher et al., 2004). Effective competing stimuli were identified when low levels of problem behavior and high levels of stimulus engagement were observed.

Noncontingent presentation of arbitrary stimuli as treatment for problem behavior represents a promising alternative to the use of "functional" stimuli, in that it permits flexibility in the range of usable stimuli and may not require extensive pretreatment assessment to identify the specific form of the maintaining consequence. However, empirical support for the use of arbitrary stimuli in NCR is limited at this time, and several questions about the conditions under which arbitrary stimuli will or will not decrease problem behavior, optimal procedures, stimulus selection, and the mechanisms underlying the reductive effects of this procedure remain.

NCR with Problem Behavior Maintained by Social Negative Reinforcement

NCR for behavior maintained by escape from aversive stimuli or activities consists of providing time-based breaks from those events. For example, following functional analyses indicating that the SIB of two adult participants with developmental disabilities was maintained by escape from aversive training activities, Vollmer, Marcus, and Rihgdahl

(1995) implemented NCR interventions in which breaks from training activities were presented independent of the participants' current behavior. Initially, schedules were very dense, with one participant receiving no training tasks and the second receiving only 15 seconds of training prior to each 20-second break. However, the researchers were able to decrease systematically the schedule of breaks based on low levels of problem behavior during previous sessions, until one participant received a 30-second break once every 10 minutes and the other participant received a 20-second break every 2.5 minutes. Although only a few studies have evaluated the use of noncontingent escape as treatment, the investigations reported in the literature have produced similar outcomes with disruptive behavior during speech therapy (Coleman & Holmes, 1998), problem behavior of children with disabilities during instruction (Kodak, Miltenberger, & Romaniuk, 2003), and disruptive behavior of children without disabilities during dental routines (O'Callaghan, Allen, Powell, & Salama, 2006).

Some researchers have found that access to positive reinforcers on time-based schedules can produce decreases in problem behavior maintained by negative reinforcement. For example, several studies have investigated the effectiveness of NCR using positive reinforcers as treatment for negatively reinforced food refusal (e.g., Cooper et al., 1995; Piazza, Patel, Gulotta, Sevin, & Layer, 2003; Reed et al., 2004; Wilder, Normand, & Atwell, 2005). The outcomes of these studies have been somewhat mixed, suggesting that, for some individuals, NCR with positive reinforcement may be sufficient to decrease problem behavior and increase food acceptance (Wilder et al., 2005), whereas for others, it is necessary to combine NCR with other treatment components, such as extinction, to produce clinically acceptable effects (Piazza et al., 2003; Reed et al., 2004).

NCR with Problem Behavior Maintained by Automatic Reinforcement

NCR for automatically reinforced behavior typically involves an attempt to identify the automatically produced reinforcer for the behavior, followed by provision of that event on a time-based schedule. In a groundbreaking study, Favell and colleagues (1982) provided noncontingent access to stimuli that corresponded to the topographies of SIB of six participants. For example, for two participants who engaged in eye poking, toys and items with striking visual properties (e.g., brightly colored toys, lights) were presented. For participants who engaged in hand mouthing or pica, toys that could be mouthed or small food items were noncontingently available. Results suggested that access to items that "matched" the form of sensory reinforcement suspected of maintaining problem behavior resulted in substantial decreases in SIB for some participants.

Subsequent research has further investigated the potential importance of providing stimuli that appear to match the functional properties of automatically reinforced problem behavior in NCR arrangements. For example, Piazza and her colleagues (1998) conducted a series of analyses to identify the specific sources of reinforcement maintaining the pica of three participants and to evaluate the effects of treatments that corresponded to the outcomes. Results indicated that the participants' pica was maintained, at least in part, by automatic reinforcement. An assessment of the effects of matched versus unmatched stimuli showed that, for two participants, matched stimuli more effectively reduced pica. Subsequently, analyses of specific characteristics of matched stimuli, such as taste and texture, were conducted. Results indicated that food with a more "firm" texture more effectively decreased pica than did less firm food items.

Piazza and colleagues (2000) extended this general line of reasoning to other topographies of problem behavior. These investigators compared the effects of access to matched versus unmatched stimuli to treat diverse topographies of automatically reinforced behavior (e.g., climbing on furniture, jumping out of windows, aggression, saliva play, hand mouthing) exhibited by three children with developmental disabilities. A condition in which stimuli that produced stimulation similar to that suspected of maintaining problem behavior was compared with one in which "unmatched" stimuli were continuously available, and a condition of relative stimulus deprivation, in which no toys or leisure items were available. Results indicated that although unmatched stimuli

reduced problem behavior, matched stimuli nearly eliminated problem behavior for all three participants.

Although these outcomes highlight the importance of selecting items that appear to produce stimulation similar to that suspected of maintaining problem behavior in NCR arrangements, other findings suggest that in some cases a "match" may not be necessary. As previously discussed in relation to the use of arbitrary stimuli in NCR treatments for problem behavior maintained by social positive reinforcement, several researchers have investigated the use of competing stimulus assessment to identify stimuli to be used in NCR arrangements with automatically reinforced problem behavior (e.g., Piazza, Fisher, Hanley, Hilker, & Derby, 1996; Rihgdahl et al., 1997; Shore, Iwata, DeLeon, Kahng, & Smith, 1997). By making alternative stimuli and problem behavior simultaneously available, it is possible to identify particular stimuli associated with high levels of engagement and low levels of problem behavior. Because it is often difficult to identify the specific form of maintaining stimulation (and, therefore, to identify a matching stimulus) or to implement extinction procedures when problem behavior is automatically reinforced, the use of competing stimulus assessment seems a particularly promising approach to the selection of stimuli to be used in arbitrary NCR arrangements.

Mechanisms Underlying the Effects of NCR

The behavioral principles that describe the effects of NCR have received considerable attention in the literature. One account of NCR's effects is that dense and repeated contact with the source of reinforcement for problem behavior functions as an AO, which temporarily decreases both the effectiveness of the reinforcer and the occurrence of the class of behavior maintained by that reinforcer (Laraway et al., 2003). Although most researchers have invoked satiation of the maintaining reinforcer to explain this decrease in reinforcer effectiveness, some suggest that habituation may better account for these effects (Murphy, McSweeney, Smith, & McComas, 2003). *Habituation* refers to a decrease in responsiveness to stimuli following repeated presentation of those stimuli (Thompson & Spencer, 1966) and is typically associated with respondent, rather than operant, behavior. However, Murphy and colleagues (2003) reviewed research findings that appear to support a habituation account for many operant phenomena, including NCR.

The two accounts have different implications for intervention. For example, habituation is facilitated by fixed, rather than variable-time (VT) schedules of stimulus presentation (e.g., Broster & Rankin, 1994); therefore, a habituation account predicts that FT schedules should be more effective than VT schedules to decrease problem behavior. In fact, some basic research outcomes suggest that VT schedules do more effectively suppress responding (e.g., Lattal, 1972; Neuringer, 1973; Ono, 1987), and the results of one applied investigation showed slightly more rapid decreases in VT versus FT conditions (Van Camp, Lerman, Kelley, Contrucci, & Vorndran, 2000). Another characteristic of habituated behavior is that unpredictable changes in the stimulus presented disrupt habituation (this is known as *stimulus specificity*); therefore, NCR effects should be enhanced by ensuring a minimum of variation in type, magnitude, and mode of stimulus presentation. Although basic research outcomes are consistent with this account (e.g., Swithers & Hall, 1994; Whitlow, 1975), no applied research has investigated the effects of stimulus specificity using time-based schedules.

Regardless of whether one characterizes the effects of repeated stimulus exposure as satiation or habituation, the outcomes are consistent with the notion that NCR schedules decrease target behavior due to an AO effect, in which the procedure results in a decrease in the "value" of the maintaining reinforcer. Alternatively, NCR may decrease behavior due to a disruption of the reinforcement contingency. Most NCR procedures contain an extinction component, in that presentation of the consequence identified to maintain problem behavior is not contingent on that behavior. The relationship between behavior and consequence is further disrupted by the response-independent presentation of the reinforcer. Therefore, decreases in target behavior may at least in part be a function of extinction. Several studies have investigated the relative contributions of extinction and AOs to NCR reductive effects.

For example, some researchers have shown that when NCR schedules were combined with concurrent schedules of contingent access to the NCR stimulus responding to the alternative source of reinforcement was typically low when NCR schedules were dense but increased as NCR schedules were thinned (e.g., Goh, Iwata, & DeLeon, 2000; Marcus & Vollmer, 1996). Others have observed levels of problem behavior subsequent to the implementation of NCR, either under conditions of extinction (e.g., Kahng, Iwata, Thompson, & Hanley, 2000) or reinforcement (e.g., Simmons, Smith, & Kliethermes, 2003). If extinction, rather than an AO, is responsible for decreases in problem behavior during NCR, then levels of problem behavior would be expected to return rapidly to baseline levels (or higher); if an AO were responsible, then problem behavior would be expected to remain at lower levels for some time following NCR. Outcomes of investigations using these procedures have shown both effects: Problem behavior occurs at relatively low levels following dense schedules of NCR but increases following presentation of NCR according to leaner schedules. These outcomes, combined with those showing decreases and increases in consumption of alternative reinforcement corresponding to dense and lean NCR schedules, suggest that both AO and extinction processes may contribute to NCR effects, perhaps at different points during the thinning of NCR schedules.

An alternative account of the effects of NCR is that the delivery of reinforcers on time-based schedules results in adventitious reinforcement of alternative behaviors, which in turn compete with problem behavior. Using an inventive laboratory preparation to model NCR procedures, Ecott and Critchfield (2004) investigated the effects of NCR on classes of target and alternative behavior. With college student participants, these researchers designed an experimental environment in which (1) multiple behaviors could be measured, and (2) the range of available alternative behavior was constrained, so that measures were likely to capture changes in alternative behavior as a function of NCR. Results indicated that behavior previously maintained by programmed reinforcement decreased, whereas alternative behavior increased during NCR, suggesting that alternative behavior was adventitiously reinforced during NCR. The patterns of response reallocation seen in this experiment were consistent with a *matching law account* (e.g., McDowell, 1989), which holds that relative rates of responding among response options correspond to relative rates of reinforcement for those options. These outcomes may be particularly relevant for arbitrary NCR arrangements that seem inconsistent with AO or extinction accounts; that is, arbitrary NCR procedures may reinforce alternative behavior, thus "tipping the scales" toward behavior maintained by the alternative source of reinforcement rather than problem behavior. Because the forms of behavior that may be captured by adventitious reinforcement are not specified in NCR, clinicians using NCR strategies should closely monitor the behavior of participants to ensure that NCR does not result in adventitious reinforcement of nontargeted, undesirable behavior.

Strengths and Limitations of NCR

A large and growing body of research indicates that NCR can be very effective in decreasing or eliminating problem behavior. Its effects are very rapid and can mitigate the negative side effects of extinction, such as response bursts, aggression, and escape or avoidance of the treatment context (Vollmer et al., 1993). When functional reinforcers are used, NCR does not result in deprivation; thus, problem behavior may not reemerge as rapidly when treatment procedures are occasionally disrupted than when using procedures that do not ensure frequent contact with the maintaining reinforcer (Simmons et al., 2003). NCR has also been characterized as benign, socially acceptable, and relatively easy to apply (Vollmer et al., 1993).

Despite its apparent strengths, there are limitations associated with NCR. NCR not only does not directly establish appropriate alternative behavior, but it may also limit the effectiveness of training efforts due to potential AO effects. For example, Goh and colleagues (2000) showed that although NCR successfully decreased problem behavior, alternative mands did not increase until substantial decreases in the density of the NCR schedule had been achieved (which was accompanied by an increase in problem behavior for one participant). Another potential

limitation is that, as suggested previously, NCR may result in adventitious reinforcement of unspecified behavior—including, potentially, the behavior targeted for decrease, or other forms of problem behavior. Indeed, apparent adventitious reinforcement of behavior targeted for reduction has been reported in the literature (e.g., Hagopian, Crockett, van Stone, DeLeon, & Bowman, 2000; Marcus & Vollmer, 1996). The use of differential reinforcement schedules has been suggested as a way to overcome this limitation (e.g., Vollmer, Rihgdahl, Roane, & Marcus, 1997).

Stimulus Control Strategies

Schaefer (1970) showed that SIB could be established in rhesus monkeys by presenting food following the response. Furthermore, the monkeys engaged in higher levels of SIB when a control stimulus that had been correlated with the contingent food procedure was present than when it was absent. Based on this and similar observations, one can conclude that problem behavior can be brought under "stimulus control" through differential reinforcement. Stimulus control develops when an antecedent event, stimulus, or condition acquires the power to regulate behavior because of a history of differential consequences when it is present versus absent (Michael, 2004). These stimuli become "discriminative" in the sense that they are predictive of or "signal" changes in contingencies and behavior therefore differentiates in their presence.

Although stimulus control is generally considered an antecedent behavioral process, it involves both antecedent and consequential manipulations. The differential consequences from which discriminative control derives are ultimately responsible for the effectiveness of discriminative stimuli; therefore, stimulus control strategies should be considered in light of the particular characteristics and effects of the associated consequences with which they are associated. For example, when considering the use of antecedent stimuli that have been correlated with punishment as a consequence for target behavior, the negative side effects associated with punishment, such as aggression and attempts to escape the stimulus, must be considered.

Stimulus control has been used in a number of ways to treat behavior disorders. For example, discrimination training has been used to treat behavior that may not be problematic per se, but that occurs under improper circumstances. For example, removing and consuming food from the refrigerator in itself is not inappropriate; however, removing and consuming food that belongs to another person, or food stealing, is prohibited. Maglieri, DeLeon, Rodriguez-Catter, and Sevin (2000) paired mild reprimands and a warning sticker on prohibited foods to decrease the food stealing of a girl with moderate mental retardation and Prader–Willi syndrome. Subsequently, the girl consumed only foods not marked with the warning sticker, even when contingent reprimands were delayed and/or intermittently administered.

Another way in which stimulus control procedures have been used in the treatment of behavior disorders is to promote generalization of treatment effects in contexts and at times when intervention procedures cannot be conducted. For example, Piazza, Hanley, and Fisher (1996) conducted a response interruption procedure for pica in the presence of a signal card. Subsequently, pica was suppressed in the presence of the card, even when the response interruption procedure was not conducted. Similarly, McKenzie, Smith, Simmons, and Soderlund (2008) delivered reprimands contingent on eye poking when their participant was wearing wristbands but not when the wristbands were absent. Eye poking decreased when wristbands were worn, not only in the treatment environment but also at times and in places where reprimands were not (and never had been) delivered.

Discrimination training procedures also have been used to signal changes in contingencies during reinforcement-based treatments for problem behavior. For example, when conducting functional communication training (FCT) procedures, it may not always be possible to deliver the reinforcer identified to maintain problem behavior following alternative responses. When alternative communication responses cannot be continuously reinforced, they may extinguish, and problem behaviors may increase (e.g., Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998). Therefore, procedures to mitigate the potential decrement in treatment effects in

such cases would be useful. For example, Fisher, Kuhn, and Thompson (1998) taught two participants to mand for "functional" and "alternative" reinforcers. Subsequently, specific stimuli were correlated with the availability of the functional and alternative reinforcers. Results showed that problem behavior decreased when either functional or alternative reinforcers were available, and that participants manded appropriately for functional and alternative reinforcers in the presence of the relevant discriminative stimuli (i.e., the mand for the functional reinforcer, but not the mand for the alternative reinforcer, occurred in the presence of the stimulus correlated with availability of the functional reinforcer and vice versa). Thus, the stimulus control procedure offered a means for managing problem behavior when it was not possible to deliver the reinforcer that had previously maintained problem behavior contingent on the FCT response.

Among the strengths of stimulus control procedures is that they can bring behavior under control of consequential contingencies without necessitating frequent or prolonged contact with those contingencies. In particular, the use of aversive consequences can be decreased through antecedent presentation of stimuli that have been correlated with those consequences. Consider the effects of visible patrol cars on highway speeding; we are more likely to observe speed limits in the presence of patrol cars (which are correlated with an increased probability of receiving a speeding ticket) than in their absence. It is not necessary to punish speeding frequently to have this effect, only to present a stimulus that signals a higher probability of punishment. All "warning" stimuli operate on the same principle; unwanted behavior decreases not because it is punished, but because a presented signal warns that punishment is likely to follow that behavior.

Antecedent Interventions for Escape Behavior

A relatively wide array of antecedent interventions has been developed specifically to decrease problem behavior maintained by negative reinforcement in the form of escape from or avoidance of task requirements or other aversive events. The relative abundance of antecedent strategies for escape behavior is likely due to the fact that events and conditions that motivate escape behavior often are presented by other people and are therefore readily amenable to manipulation. For example, epidemiological data indicate that for over 93% of individuals exhibiting negatively reinforced problem behavior, escape from task demands, specifically, maintained their escape behavior (Iwata et al., 1994). Because task requests are presented by others, it is possible to alter how they are presented in a variety of ways, so as not to set the occasion for problematic escape behavior. Most of these strategies focus on changing the context in which task requests are presented to decrease the aversiveness of the activity, thus lessening the motivation to escape (i.e., arranging an AO for escape). Below, several types of antecedent strategies tailored specifically to escape behavior are presented (see Miltenberger, 2006, for a comprehensive discussion of antecedent interventions for negatively reinforced behavior).

Elimination of Aversive Stimulation

Perhaps the most straightforward approach to antecedent intervention for escape behavior is to remove from the environment the aversive event that motivates the behavior. By definition, escape behavior occurs in the presence of an aversive stimulus; therefore, removal of that stimulus should result in elimination of escape behavior, and a large body of literature indicates that it does so. For example, the functional analysis literature is replete with examples in which problem behavior occurs in the presence, but not the absence, of task demands (e.g., Carr, Newsom, & Binkoff, 1980; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994; Iwata et al., 1994). Although the removal of task demands (or other aversive antecedent stimuli) is undeniably effective to reduce problem behavior maintained by escape, it is an impractical and unrealistic approach for all but the most serious cases; it simply is not possible to remove all potentially aversive responsibilities and requirements for most people. However, in extreme cases in which the presentation of task requests or other stressful events sets the occasion for severe and dangerous behavior, it may be necessary to withhold as many of these events as is possible on a temporary (emergency) basis. Additional procedures may then be used to

reintroduce back into the environment the antecedents associated with problem behavior.

A notable case in which removal of aversive stimulation is the treatment of first choice is when problem behavior (specifically, SIB) is occasioned by pain or discomfort associated with illness, injury, or other biological factors. Several researchers have suggested that conditions such as allergies (Kennedy & Meyer, 1996), constipation (Carr & Smith, 1995), menstrual discomfort (Carr, Smith, Giacin, Whelan, & Pancari, 2003; Taylor, Rush, Hetrick, & Sandman, 1993), otitis media (Carr & Smith, 1995; Cataldo & Harris, 1982; O'Reilly, 1995), and sleep deprivation (Kennedy & Meyer, 1996) may be associated with escape-maintained problem behavior. In cases where a medical or biological condition is suspected to contribute to the motivation of SIB, the condition should be treated immediately. If problem behavior persists following treatment, then additional interventions may be considered.

Fading in Aversive Stimuli

One way to bring aversive events back into the environment is through stimulus fading (e.g., Pace, Ivancic, & Jefferson, 1994; Pace, Iwata, Cowdery, Andree, & McIntyre, 1993; Zarcone et al., 1993; Zarcone, Iwata, Smith, Mazaleski, & Lerman, 2004). *Fading* involves the gradual and systematic reintroduction of stimuli that occasion escape behavior back into the environment. For example, Zarcone and colleagues (1993) first eliminated task demands that occasioned SIB in three individuals. Subsequently, task requests were slowly and systematically reintroduced back into the environment while SIB was extinguished. Results indicated that although extinction alone produced more rapid decreases in SIB, it produced initial increases in SIB (i.e., an extinction burst) that were not observed during fading. Attempts to use fading procedures without extinction have met with mixed results, with some researchers producing encouraging outcomes (e.g., Pace et al., 1994) and others failing to maintain initial decreases in problem behavior without extinction (e.g., Zarcone et al., 1994).

The behavioral processes underlying the effectiveness of fading procedures are not well understood. In extinction, fading may permit behavior to contact extinction contingencies in the presence of a relatively weak establishing operation (EO); that is, extinction may proceed more smoothly if the antecedent stimuli that motivate escape are altered to decrease their aversiveness. When fading is effective without extinction, it may be because slow but repeated exposure reduces the overall aversiveness of stimuli; indeed, graduated exposure to stimuli that occasion escape or avoidance, or "desensitization," is a widely used procedure to treat phobias (e.g., Shabani & Fisher, 2006). The precise mechanism responsible for this effect is not understood, although habituation (Murphy et al., 2003) offers a potentially viable account.

High-Probability Sequence/Behavioral Momentum

Like fading, high-probability (high-*p*) sequences can be used to facilitate reintroduction of aversive stimuli into the environment. Using this procedure, a difficult, or "low-*p*" task request (one that has been associated with a low probability of compliance and/or may occasion problematic escape behavior) is issued immediately after a series of easy or "high-*p*" requests (requests associated with a high probability of compliance and no escape behavior). High-*p* sequences have been used to increase compliance with low-*p* requests (e.g., Mace et al., 1988), as well as to treat problem behavior maintained by escape (e.g., Mace & Belfiore, 1990). Researchers have invoked the metaphor of "behavioral momentum" to describe these effects. According to this account, a high density of reinforcement for low-*p* requests increases "mass" and creates "velocity" in compliance, which makes this class of behavior resistant to change (Nevin, 1996). Thus, compliance persists and problematic escape behavior is unlikely to occur when a high-*p* request is presented. High-*p* sequences have been used successfully to treat many forms of noncompliance (e.g., "do" and "don't" commands [Mace et al., 1988], academic tasks [Belfiore, Lee, Vargas, & Skinner, 1997; Wehby & Hollahan, 2000], and medical routines [McComas, Wacker, & Cooper, 1998]); however, the results of research on its use with active escape behavior (e.g., SIB, aggression) suggest that extinction may be

a necessary component and, in some cases, using the high-*p* sequence without extinction may exacerbate escape behavior (Zarcone, Iwata, Mazaleski, & Smith, 1994).

Altering the Aversive Stimulus

It is possible, in some cases, to alter some feature of the aversive stimulus or event that sets the occasion for escape behavior, so as to reduce its evocative effect. For example, Cameron, Ainsleigh, and Bird (1992) showed that, given a prompt to wash himself, the self-injurious escape behavior of one participant was more likely to occur when using bar rather than liquid soap; thus, investigators simply altered the task so that the participant was no longer required to use bar soap during self-care routines. Similarly, researchers have shown that changes such as the use of a computer instead of pencil and paper for writing (Ervin, DuPaul, Kern, & Friman, 1998), or the use of checkers or a calculator as counting aids during math tasks (McComas, Hoch, Paone, & El-Roy, 2000) can apparently function as AOs, effectively decreasing aversiveness so that tasks no longer evoke escape behavior. In spite of these encouraging results, it may not always be possible to alter aversive events in ways to make them more benign (e.g., there may be occasions when liquid soap, computers, checkers, or calculators are unavailable); thus, practitioners should be aware that when it is not possible to avoid contact with aversive events, problem behavior will likely return to pretreatment levels.

Altering the Aversive Context

Another way to reduce the aversiveness of task requests or other aversive conditions or events is to alter features of the context in which those conditions or events are presented. With contextual interventions, the aversiveness of task requests or other identified events is altered through changes in the surrounding environment. Thus, contextual interventions do not involve direct manipulation of the aversive stimulus or event per se; rather, manipulation of other aspects of the environment in turn decreases the evocative function (aversiveness) of the stimulus or event. A number of contextual variables have been shown to alter the occurrence of problematic escape behavior, and many of these have been manipulated as treatment. For example, task demands embedded within pleasant stories (Carr et al., 1976) or within preferred activities (Carr & Carlson, 1993) have been shown to decrease escape behavior. Similarly, Dunlap, Kern-Dunlap, Clarke, and Robbins (1991) increased on-task behavior and decreased problem behavior in one participant by altering session length, type of motor activity, and the functional nature of tasks presented to her.

Several researchers have shown that offering a choice among putatively aversive activities can decrease escape behavior (e.g., Dunlap et al., 1994; Dyer, Dunlap, & Winterling, 1990; Vaughn & Horner, 1997). Some research outcomes suggest that this effect will be observed even if the choices by researchers are yoked to those of participants (Dyer et al., 1990) or if the pool of participants' choices is derived from low-preference tasks shown to evoke high levels of escape behavior (Vaughn & Horner, 1997).

Research outcomes have shown that temporally distant routines and events can sometimes set the occasion for later occurrences of problem behavior (some have termed these influences *setting events*, but see Smith & Iwata [1997] for a discussion of issues associated with that term). For example, Kennedy and Itkonen (1993) showed that one participant's problem behavior at school was more likely to occur on days when she awakened late. A second participant's problem behavior was correlated with the number of stops on her ride to school. Each participant's problem behavior decreased when these situations were eliminated from their routines. When it is not possible to eliminate events that set the occasion for problem behavior, it may be possible to "neutralize" their influence. For example, Horner, Day, and Day (1997) found that prior postponements or delays in planned activities exacerbated the escape-maintained problem behavior of two participants during subsequent instructional routines. Neutralizing routines (the opportunity for one participant to draw and write, and the opportunity for the other participant to reschedule the event and look at a yearbook) were conducted on days when the conditions correlated with problem behavior were present, prior to instructional sessions. For both participants, substantial reductions

in problem behavior were observed on days when neutralizing routines were conducted.

Some other contextually based interventions include altering the timing of task requests so as not to interrupt preferred activities (e.g., Fritz, DeLeon, & Lazarchick, 2004), presenting stimuli associated with a positive mood (e.g., Carr, Magito McLaughlin, Giacobbe-Grieco, & Smith, 2003), and presenting corrective feedback prior to (as antecedent prompts) rather than following task trials (Ebanks & Fisher, 2003), among others. The effectiveness of most contextual strategies appears to be due to AO effects, in which changing an apparently unrelated condition alters the motivational properties of aversive events; that is, they decrease the aversiveness of the events that motivate escape. Additional research is necessary to identify the specific mechanisms associated with the effectiveness of various contextual strategies.

Summary

A wide array of antecedent interventions has been used as treatment for behavior disorders. Some strategies decrease the motivation to engage in the behavior; others signal differential consequences for the behavior; and still others physically impede the occurrence of behavior in some way. Although each type of intervention is associated with unique benefits and limitations, all share the common characteristic that they are implemented prior to the occurrence of problem behavior. Thus, a shared strength among antecedent strategies is that they do not require the occurrence of problem behavior for their effectiveness (a possible exception is certain discrimination-based interventions, as previously discussed). In some cases, problem behavior may not occur at all upon the first implementation of treatment.

Antecedent interventions also may complement or accelerate the effects of consequence-based interventions. In particular, antecedent strategies have frequently been paired with extinction procedures to decrease negative side effects associated with extinction (e.g., Zarcone et al., 1994). However, antecedent strategies have been incorporated into treatment packages including differential reinforcement (e.g., Kodak et al., 2003; Marcus & Vollmer, 1996; Shabani & Fisher, 2006), punishment (e.g., Thompson, Iwata, Conners, & Roscoe, 1999), and pharmacological interventions (e.g., Allison et al., 1991) as well.

A shared limitation of antecedent strategies is that they do not build new, alternative forms of behavior (i.e., they are not "constructive"). This is due to the operant nature of learned behavior; the establishment of new behavior or maintenance of alternative behavior requires that reinforcing consequences be arranged. Certainly, antecedent manipulations, such as the use of prompts and instructions, are incorporated into repertoire-building interventions, but because the component that is primarily responsible for the effectiveness of these strategies (i.e., reinforcement) is implemented following occurrences of behavior, they are not considered to be antecedent strategies. Also, as previously discussed, some antecedent strategies, such as NCR, may actually interfere with acquisition of alternative behavior due to habituation or satiation effects. When combining NCR with procedures to increase appropriate behavior, practitioners should closely monitor the outcomes and use alternative reinforcers or varied consequences to ensure adequate progress. Thus, antecedent strategies—alone—do not systematically establish or maintain positive alternatives to problem behavior.

Although antecedent procedures have been shown to be effective in treating behavior disorders, it is recommended that they typically be implemented as components in a comprehensive treatment package that includes both antecedent and consequential strategies. Antecedents alone can alter behavior, and consequences alone can affect behavior that produces them; however, combining both antecedents and consequences can enhance the effects of each, improving the ability of antecedents to evoke (or suppress) behavior and providing more opportunities to contact more effective consequences. Thus, it is recommended that antecedent and consequential approaches be carefully matched in behavior intervention programs so as to maximize the potential effectiveness of each strategy. As shown in this chapter, a wide range of proven antecedent strategies is available for integration within comprehensive treatment packages to treat severe prob-

lem behaviors effectively and to help establish appropriate alternative repertoires.

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CHAPTER 19

Developing Function-Based Extinction Procedures for Problem Behavior

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In recent years there has been growing emphasis on basing behavioral treatments on the operant functions of problem behavior. The functional analysis approach to behavioral assessment is discussed elsewhere in this volume. But for the purposes of this chapter on extinction, it is important to note that identification of the operant function of behavior is the critical first step in implementing extinction. Extinction procedures involve the discontinuation of reinforcement of a response (Catania, 1992). The effect of extinction is the reduction in responding that follows such an operation. Thus, without identifying the source of reinforcement for problem behavior, it is not possible to discontinue reinforcement with any degree of certainty.

In this chapter we discuss three general functional variations of extinction for problem behavior. The first variation is the extinction of behavior maintained by socially mediated positive reinforcement. The second is the extinction of behavior maintained by socially mediated negative reinforcement. The third variation is the extinction of automatically reinforced behavior (whether maintained by automatic positive or automatic negative reinforcement). In addition, we discuss characteristic effects and side effects of extinction, factors influencing the efficacy of extinction, and miscellaneous practical considerations.

Functional Variations of Extinction

Extinction of Problem Behavior Maintained by Social Positive Reinforcement

Extinction is a logical approach for decreasing problem behavior maintained by social positive reinforcement because the source of reinforcement is, by definition, controlled by people (hence, the term *social*). When the source of reinforcement is social, it is possible that people can be taught to withhold reinforcement. For example, suppose an individual engages in aggression that is maintained by positive reinforcement in the form of access to tangible items (e.g., a favorite toy). Perhaps a parent or teacher gives the individual a toy in an effort to "calm him down," resulting in inadvertent reinforcement. Implementation of extinction would then consist of discontinuing delivery of the tangible item (toy) when aggression occurs. Similarly, in the case of problem behavior maintained by positive reinforcement in the

form of social attention, extinction would consist of discontinuing attention contingent on problem behavior.

Historically, extinction has been used frequently to decrease problem behavior presumed to be maintained by positive reinforcement. In early extinction treatment studies, there probably was a presumption about positive reinforcement as the maintaining variable because no pretreatment functional analysis was conducted. In most published studies, the presumption about positive reinforcement as a maintaining variable appeared to be correct. Williams (1959), for example, published a brief report on the case of a child who displayed tantrums at bedtime. Treatment of the tantrums consisted of extinction in the form of social isolation. When the child was placed into bed at his bedtime, all adults left the room and did not reenter. Results showed that extinction was successful at decreasing the tantrums to zero rates within eight sessions, suggesting that the behavior was previously maintained by positive reinforcement. In a similar procedure, Wolf, Risley, and Mees (1964) implemented extinction via social isolation as a method of decreasing the tantrums of a child admitted to a hospital for treatment of problem behavior. They implemented extinction in the form of removal of social contact via isolation contingent on tantrums. Specifically, when the child engaged in a tantrum, he was immediately placed in his hospital room and left alone until the tantrum ceased. Results indicated a decrease to near-zero rates of tantrums following implementation of this procedure. However, these results are difficult to interpret because the "extinction" procedure was structurally similar to time-out. Thus, it is not clear whether the discontinuation of reinforcement or the placement into an austere environment (or both) was responsible for the effects.

Lovaas and Simmons (1969) presented a similar experiment in which they hypothesized that the self-destructive behavior of two children was reinforced by social consequences. As part of the extinction procedure, Lovaas and Simmons isolated each child in a small room and measured the rates of destructive behavior. Extinction resulted in relatively high rates of the problem behaviors initially, followed by a gradual decrease over time for both children. These results supported, once again, the presumption of positive reinforcement as the variable maintaining problem behavior and further supported the use of extinction as treatment. In this latter study, the procedures were more clearly related to extinction (in comparison to Wolf et al., 1964) because placement in social isolation was not contingent on behavior.

With improvements in functional analysis methodologies, modern applications of extinction procedures have eliminated a degree of guesswork. Iwata, Pace, Cowdery, and Miltenberger (1994), for example, examined the effects of extinction based on the function of the behavior versus extinction not based on the function. To do this, they first conducted a functional analysis of the self-injurious behavior (SIB) of three children. A brief description of the results for one participant elucidates the methodology. The individual's functional analysis showed SIB maintained by social positive reinforcement in the form of attention. Following the functional analysis of this participant's problem behavior, two interventions were developed to test the effect of two types of extinction. One intervention targeted the attention variable by eliminating social sources of reinforcement contingent on instances of SIB; the other targeted automatic reinforcement by attempting to attenuate the sensory consequences produced by engaging in SIB. Of the two interventions assessed, extinction targeting attention was the most successful in decreasing the participant's levels of SIB. These findings supported the conclusions of the functional analysis, and also demonstrated the utility of a pretreatment functional analysis in selecting the correct formal and functional properties of extinction procedures (i.e., discontinuing attention rather than discontinuing sensory stimulation).

Although functional analysis methods have been very useful in linking assessment outcomes to extinction treatments, extinction is now rarely used in isolation. Rather, extinction is commonly used as one component of a larger intervention package. As an illustration of this approach, Fyffe, Kahng, Fittro, and Russell (2004) targeted the inappropriate behavior of a client using a packaged treatment in which extinction was a component. Following a functional analysis that showed the client's inappro-

priate sexual behavior was reinforced by contingent attention, Fyffe and colleagues implemented a treatment package that used functional communication training to teach the child to request attention using an attention card, and all attempts at inappropriate sexual behavior were placed on extinction. During extinction, inappropriate sexual behavior was ignored except for blocking. Results indicated a reduction in inappropriate sexual behavior relative to baseline conditions. Similar studies have shown the efficacy of extinction when it is combined with differential reinforcement of alternative behavior (Rehfeldt & Chambers, 2003; Wilder, Masuda, O'Connor, & Baham, 2001), functional communication training (Fyffe et al., 2004; Hanley, Piazza, Fisher, & Maglieri, 2005), and noncontingent reinforcement (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). Given that these treatment approaches are discussed elsewhere in this book, we mentioned them here only to highlight the relevance of extinction. In fact, Mazaleski, Iwata, Vollmer, Zarcone, and Smith (1993) found that differential reinforcement of other behavior (DRO) was ineffective when the extinction component was left out of the intervention.

Extinction of Behavior Maintained by Socially Mediated Negative Reinforcement

Another significant contribution of the functional analysis approach is the demonstration that a high proportion of behavior problems are sensitive to negative reinforcement, such as escape from instructional activity (Iwata et al., 1990), self-care activities (Steege, Wacker, Cigrand, & Berg, 1990), and social proximity (Vollmer et al., 1998), among other escape and avoidance contingencies. In fact, large-scale summaries of functional analysis outcomes have shown that anywhere from about 33% to about 48% of problem behavior is sensitive to negative reinforcement (Derby et al., 1992; Iwata, Pace, Cowdery, et al., 1994).

The finding that a substantial proportion of problem behavior is sensitive to negative reinforcement is important for extinction interventions for at least two reasons: (1) Discontinuation of social attention might actually reinforce the problem behavior; thus, formal or structural "extinction" procedures may not always truly be extinction procedures; and (2) discontinuation of escape requires an entirely different approach to extinction than was previously considered in the applied literature. There appears to have been a strong presumption in the early applied behavior analysis literature that problem behavior is always maintained by attention. For example, many procedures related to extinction had time-outs or "planned ignoring"–type components (Fyffe et al., 2004; Pinkston, Reese, LeBlanc, & Baer, 1973; Wolf et al., 1964). These procedures are related to extinction insofar as discontinuation of attention occurred in that context. Of course, publication practices have always been such that mainly positive results are published and negative results are not published, so it is impossible to say how many failed attempts at extinction occurred due to a faulty assumption that the behavior was reinforced by attention.

For negatively reinforced behavior, extinction requires that the aversive stimulation be unchanged as a function of behavior; that is, escape or avoidance is discontinued. For example, if instructional demands are presented and problem behavior occurs, then the instructional demands or requested activity would remain in effect. Extinction of negatively reinforced behavior was first explicitly evaluated in basic research. Hineline (1977) pointed out that early conceptualization of extinction of negatively reinforced behavior was incorrect. For example, some experimenters believed that extinction would involve eliminating the aversive stimulation that was either escaped or avoided. In contemporary usage, that approach equates to elimination of the establishing operation and does not involve discontinuation of reinforcement as a consequence to behavior (Smith & Iwata, 1997). Thus, simply removing instructional demands from an educational environment to eliminate escape behavior is not an extinction procedure. In the laboratory, extinction of negatively reinforced behavior involves continued presentation of aversive stimulation despite the occurrence of behavior previously reinforced by escape or avoidance. A more accurate parallel in application, then, would be when a teacher persists with academic instructions and academic activities even when escape-maintained problem behavior has occurred.

Several early applications can be construed as extinction of negatively reinforced behavior, but most have at least one confounding variable. Thus, the effect of extinction alone in early examples is difficult to ascertain. In one example reported by Heidorn and Jensen (1984), a participant's SIB was highly correlated with demand situations, suggesting that it was escape behavior. The treatment involved continued presentation of demands and physical guidance to complete the requested task demand when SIB occurred. These components may represent extinction-like features of an intervention insofar as the behavior no longer produces escape. However, the second component also resembled punishment insofar as possibly aversive stimulation was presented immediately contingent on SIB. Also, the procedure involved a number of other components, such as praise and food reinforcement, along with differential negative reinforcement (session termination contingent on compliance). Despite the multicomponent treatment package, the approach described by Heidorn and Jensen was innovative with respect to the escape extinction component.

Iwata, Pace, Kalsher, Cowdery, and Cataldo (1990) reported the first study to apply escape extinction explicitly as a treatment for problem behavior following a functional analysis. Functional analyses showed that all participants displayed escape-maintained SIB. During both baseline and treatment, a three-step prompting sequence was used to present task demands. During baseline, SIB produced escape from the instructional sequence. During treatment, SIB no longer produced escape, and SIB was met with guided compliance. In five of six cases, the extinction plus physical guidance resulted in decreased SIB. In the sixth case, response blocking was required (an additional case involved different procedures and is therefore not included here). Like the Heidorn and Jensen (1984) study, a possible interpretive limitation of the approach described by Iwata and colleagues is that the physical guidance component of the procedure possibly functioned as punishment insofar as presumably aversive stimulation (forced engagement with the task) occurred immediately contingent on SIB. A pure extinction approach would have been to continue with the three-step prompting sequence when behavior occurred. Thus, at least in some of the cases, the effects of the procedure likely stemmed from both punishment and extinction. However, from a practical standpoint, the immediate contingent physical compliance is probably the best approach to ensure that no escape interval, however brief, should follow occurrences of problem behavior maintained by negative reinforcement.

As with extinction of positively reinforced behavior, extinction of negatively reinforced behavior is most commonly applied in the context of other procedures (essentially, treatment packages). For example, most applications of differential negative reinforcement involve extinction of problem behavior combined with negative reinforcement of compliance or some other alternative behavior, such as communication (Reed, Rihgdahl, Wacher, Baretto, & Andelman, 2005; Vollmer & Marcus, 1995). Similarly, noncontingent escape (escape presented on a fixed-time schedule) typically involves an extinction component insofar as the problem behavior no longer directly produces escape (although it is possible that escape occurs contiguously with problem behavior on some occasions).

Food refusal is a good example of a clinical disorder that has been successfully treated using escape extinction as one component of an intervention. In most studies targeting food refusal, however, reinforcement is available for alternative behavior as part of a treatment package, and the function of the behavior is not always identified (Cooper et al., 1995; Hoch, Babbit, Coe, Krall, & Hackbert, 1994; Piazza, Patel, Gulotta, Sevin, & Layer, 2003). For example, Patel, Piazza, Martinez, Volkert, and Santana (2002) evaluated two types of reinforcement procedures as a treatment for food refusal. First, reinforcement procedures implemented without extinction were found to be relatively ineffective in decreasing food refusal. Second, escape extinction was added to the reinforcement procedures, such that inappropriate behavior no longer produced escape. When a therapist presented a spoon or cup to the child for consumption of food, the food was not removed until the child took the bite or drink. Nonacceptance of the food was followed by verbal prompts to take a bite or drink, and expelled food was represented. Upon adding the escape extinc-

tion component to the reinforcement procedures, food acceptance increased for each of the three participants.

Ahearn, Kerwin, Eicher, Shantz, and Swearingen (1996) implemented a similar examination of escape extinction as treatment for food refusal. They examined the efficacy of two treatment packages for chronic food refusal hypothesized to involve negative reinforcement contingencies. One treatment package consisted of physical guidance in the form of manually guiding a child to accept food contingent on noncompliance; the second treatment package involved nonremoval of the spoon until the child accepted the food. In both treatment packages, when the child accepted a bite without expulsion of the food, social interaction and access to preferred stimuli were presented for a brief period of time. In addition, during the physical guidance treatment package, there was a possible punishment component associated with physical guidance. Both treatment packages were found to be effective; however, the treatment involving physical guidance was associated with more corollary behaviors, such as negative vocalizations, disruptions, and SIB.

Because the early studies involving extinction of negatively reinforced behavior were generally confounded with other treatment components (e.g., punishment, reinforcement), and because more recent approaches have used extinction in combination with other procedures logically derived from a functional analysis (e.g., differential negative reinforcement), there is no definitive study on the effects of escape extinction. From a practical standpoint, the Iwata and colleagues (1990) procedure is most representative of a treatment component that would be recommended for escape-maintained problem behavior. However, from a conceptual standpoint, it may be interesting for future researchers to isolate the extinction and physical guidance (possible punishment) components.

Extinction of Automatically Reinforced Behavior

The defining characteristic of automatic reinforcement is that the reinforcement is not socially mediated (Vaughan & Michael, 1982). As it relates to behavior problems, automatically reinforced behavior is sometimes called *self-stimulation* (e.g., Lovaas, Newsom, & Hickman, 1987), or *sensory reinforced behavior* (e.g., Rincover, 1978). It is important to note that automatic reinforcement does not necessarily connote positive or negative reinforcement; it could be either. For examples, head hitting could be reinforced by endorphin release (positive reinforcement; Sandman & Hetrick, 1995), or self-scratching may attenuate an itching sensation (negative reinforcement).

From a procedural standpoint, extinction of automatically reinforced behavior is likely to be more challenging than extinction of socially reinforced behavior. With socially reinforced behavior, other people in the environment can be taught to discontinue reinforcement. With automatically reinforced behavior, the reinforcement occurs as a direct result of the behavior and, therefore, cannot be discontinued easily by another person.

One approach to extinction of automatically reinforced behavior is called "sensory extinction" (Rincover, Cook, Peoples, & Packard, 1979). The term *sensory extinction* is somewhat a misnomer insofar as it is not the sensory stimulation but the behavior producing stimulation that is extinguished. Nonetheless, the term has gained widespread usage, so we use it here for the sake of consistency. In the sensory extinction approach, the putative source of automatic reinforcement is somehow cut off, or blocked. For example, in one individual, Rincover (1978) reduced stereotypical object spinning by blocking the auditory feedback produced by the object. This was accomplished by putting carpet on the table where the object was spun. Sensory extinction–like approaches also have been used as treatment for SIB. For example, a helmet can be used to block the sensory products of head hitting (Dorsey, Iwata, Reid, & Davis, 1982; Rincover & Devany, 1982).

There are some difficulties in interpreting the results of early sensory extinction studies. Because the early treatment studies were conducted in the absence of a functional analysis, it is possible that other sources of reinforcement were altered when protective equipment was applied. For example, Rincover and Devany (1982) provided a protective helmet for one participant in a classroom setting and noted an extinction-

like effect on headbanging. However, it is possible that the behavior was maintained by teacher attention, and the teacher felt safe in not attending to the behavior because the child was "protected" (Vollmer, 1994). Another interpretive limitation (especially with the use of helmets) is that the behavior is somehow punished. For example, it may now hurt one's hand to hit a hard helmet.

Later studies evaluated protective equipment as treatment for automatically reinforced SIB and stereotypy following a functional analysis. For example, Mazaleski, Iwata, and Rodgers (1994) showed that both sensory extinction and contingent application of gloves as treatment for automatically reinforced hand mouthing were effective. The effects of contingent application suggest that wearing protective equipment may either be aversive (e.g., if it does not feel comfortable) or may yield a "time-out" type of effect (contingent withdrawal of the opportunity to obtain automatic reinforcement).

Response blocking has also been conceptualized as a method of extinction for automatically reinforced problem behavior (by virtue of blocking the automatic response products). However, the effects of response blocking are not clearly attributable to extinction in all cases. For example, Lerman and Iwata (1996) developed a methodology for distinguishing between extinction and punishment effects associated with response blocking. In their study, they systematically varied the number of self-injurious responses that were blocked. It was hypothesized that if blocking were a form of extinction, responses blocked intermittently would be exposed to an intermittent schedule of reinforcement, in which case, intermittent response blocking could lead to maintenance of or even an increase in the behavior. Alternatively, if response blocking functioned as punishment, the same intermittent blocking of responses would result in an intermittent schedule of punishment. In that case, intermittent response blocking could lead to a decrease in behavior.

Lerman and Iwata (1996) found that in the case of an adult female engaging in chronic hand mouthing, response blocking functioned as punishment; once response blocking was introduced with this individual, whether intermittently or continuously, her self-injury decreased to near-zero rates. In a replication of the Lerman and Iwata study, Smith, Russo, and Le (1999) examined the function of response blocking on the eye poking behavior of an adult female. With this individual, response blocking was found to function as extinction. During intermittent blocking, eye-poking increased relative to baseline levels, indicating that an intermittent schedule of reinforcement was in effect. Taken together, the results of these studies indicate that the effects of response blocking can be attributable to extinction in some cases and punishment in others. In cases where response blocking serves as extinction, its use might be contraindicated when it cannot be implemented with near-perfect integrity. In cases when response blocking serves as punishment, however, intermittent implementation may still be effective. Thus, a distinction between extinction and punishment effects of blocking is more than merely a conceptual issue.

Characteristic Effects and Side Effects of Extinction

As demonstrated in the animal laboratory by Skinner (1938), operant behavior eventually wanes and possibly even stops occurring when it is no longer reinforced. This general effect has been obtained repeatedly in studies on behavior disorders, ranging from SIB (Roscoe, Iwata, & Goh, 1998), to nighttime sleep disruptions (Blampied & France, 1993), to bizarre vocalizations (Wilder et al., 2001). Thus, the extinction effect of primary clinical interest is that problem behavior eventually decreases in frequency, duration, and intensity. However, other effects and side effects are frequently discussed and sometimes reported in relation to extinction, perhaps because some of the potential effects are undesirable. These effects and side effects include, but are not limited to, the extinction (or response) burst, response variation, aggression, emotional behavior, and spontaneous recovery. We have selected these five effects–side effects for discussion because of their direct clinical relevance. It is important for behavior analysts to recognize the possibility of these effects and side effects, so that care providers can be informed to expect their occurrence, at least in some cases.

Extinction Burst

The *extinction burst* is the temporary increase in the frequency, intensity, or duration of a target response that can occur with the onset of extinction (Cooper, Heron, & Heward, 1987). This effect can be detrimental for at least two reasons. One, if the target behavior is dangerous, such as SIB or aggression, even a temporary increase in frequency, intensity, or duration may result in greater injury or destruction. Two, the temporary elevation in behavior may make parents and other care providers less inclined to follow through with a treatment because it is too aversive to watch high levels of dangerous behavior (hence, they might "give in" and reinforce the behavior to make it stop temporarily) (Sloman et al., 2005).

Although the extinction burst is frequently presented in textbooks as a common side effect of extinction, Lerman and colleagues have presented data to suggest that extinction bursts may not be as prevalent as once believed. Lerman and Iwata (1995) reported that response bursts occurred in 36% of 113 published and unpublished treatment cases when extinction was used in isolation (not in a treatment package). When extinction was used as one component of a larger treatment package, only 12% of cases were characterized by bursting. In a follow-up study, Lerman, Iwata, and Wallace (1999) found response bursting in 62% of the cases when extinction was implemented in isolation and in 39% of the cases when extinction was combined with other procedures, such as noncontingent reinforcement or differential reinforcement. The follow-up study is especially important to consider because the treatment cases were participants in a highly controlled treatment clinic where extinction procedures were only in effect during data collection (at least at the onset of extinction, when bursting might occur). In the earlier study, extinction treatments occurred on an inpatient unit and may therefore have included interventions throughout the day, even if data were only collected in short sessions. This difference may account for the higher level of response bursting in the latter study (i.e., the response burst was perhaps not captured during data collection in some cases in the earlier study). A general conclusion can be drawn that response bursting is somewhat likely when extinction is used in isolation, and far less likely when extinction is used in combination with other procedures.

Response Variation

Another commonly reported effect of extinction is *response variation*, which involves an increased tendency for the organism to display novel, or at least diverse, forms of behavior. From a layperson's perspective, it appears that the individual is "trying" to find new or at least other ways of obtaining reinforcement. For example, if a child asks politely for a reinforcer and the request is denied, he or she may begin to whine or attempt to "steal" the item. At times, extinction-induced response variation is highly desirable. For example, when extinction is used as one component of shaping, response variation is critical to provide the behavioral "stuff" from which differential reinforcement can produce new and desired response forms (Grow, Kelley, Roane, & Shillingsburg, 2008). Also, when extinction is a component of a behavioral treatment for behavior disorders, response variation can be desirable if appropriate behavior begins to emerge. On the other hand, response variation can be dangerous if new or diverse forms of destructive behavior emerge.

To date, no studies have explicitly examined response variation as an effect or side effect of extinction for behavior disorders. Nonetheless, response variation is commonly reported in basic research and has been documented for decades (e.g., Antonitis, 1951). Also, although not the focus of the studies, some applied research has reported the emergence of different response forms when a target response is placed on extinction. For example, Lerman, Kelley, Vorndran, and Van Camp (2003) found that when a participant was blocked from tapping her head or tooth, there was a collateral increase in instances of hand wringing. Similarly, Lerman, Kelley, Van Camp, and Roane (1999) found that placing screaming on extinction resulted in an immediate increase in unprompted hand clapping, which was then reinforced as an alternative response.

The applied research on extinction-induced response variation is difficult to interpret. It is almost certainly a factor for consideration

given the wealth of basic research showing the phenomenon. Yet in some cases, it is possible that the newly emerged response is actually a response topography that was a member of the same functional response class (i.e., was previously reinforced by the same reinforcer being withheld for some other target response).

Aggression

Just as with extinction-induced response variation, basic research shows that aggression can emerge as a result of withholding reinforcers previously presented either contingently or noncontingently (e.g., Azrin, Hutchinson, & Hake, 1966). In addition, the evidence for extinction-induced aggression in humans is fairly clear (e.g., Frederiksen & Peterson, 1974; Kelly & Hake, 1970; Todd, Morris, & Fenza, 1989). For example, Kelly and Hake (1970) examined the effect of extinction on a punching response in laboratory subjects that was comparable to aggressive responses seen in humans in nonlaboratory settings. When button pressing was effective as an avoidance response, few punches were observed. When button pressing was placed on extinction, however, punching increased for seven of nine participants.

In clinical examples of extinction-induced aggression, it is sometimes difficult to interpret the phenomenon. In some cases, the aggressive behavior may simply be a member of the same operant response class, and it begins to emerge when some other aberrant behavior is no longer reinforced. For example, Vollmer and colleagues (1993) used extinction in conjunction with noncontingent reinforcement (NCR) as treatment for SIB and reported a "burst" of aggression in one participant when SIB was no longer reinforced. No functional analysis of aggression had been conducted, so it is possible that aggression was reinforced by the same stimulus class (social attention) as the SIB that was targeted for treatment.

Additional evidence for a functional response class interpretation of aggression associated with extinction can be found in research on response hierarchies. For example, in an attempt to clarify undifferentiated functional analysis outcomes in which the target behavior (aggression) was not initially observed and only less severe response forms were observed, Richman, Wacker, Asmus, Casey, and Andelman (1999) placed the less severe topographies on extinction and found that aggressive behavior emerged. Results also showed that the same type of reinforcement maintained the more severe and the less severe problem behavior. In addition, for two of three participants, less severe problem behavior typically occurred prior to more severe problem behavior, indicative of a response class hierarchy.

Emotional Behavior

A phenomenon related to extinction-induced aggression is sometimes called *extinction-induced emotional behavior* or "agitation" (Lerman & Iwata, 1996). Some authors discuss aggression and emotional behavior under the same general heading (e.g., Pierce & Epling, 1995). In humans, "emotional behavior" associated with extinction takes a variety of forms but may include crying, attempting to escape, protesting, acting upset, and so on (e.g., Baumeister & Forehand, 1971; Rovee-Collier & Capatides, 1979; Sullivan, Lewis, & Alessandri, 1992). In basic research, behavior that is sometimes called emotional or agitated also takes a variety of forms (e.g., whisker cleaning in rats, sniffing; Gallup & Altomari, 1969). It is not clear whether these response forms relate directly to the emotional behavior associated with extinction in humans. Just as with response variation and aggression, it is possible that behaviors such as crying and protesting (in humans) have been reinforced in a fashion similar to the target response and, hence, are members of a response class. Whatever the functional properties of emotional behavior, the fact that it is sometimes reported in clinical contexts is important to note for ethical reasons because it is sometimes interpreted as a sign of discomfort. In short, emotional behavior is something about which care providers should be informed, as a possible outcome when implementing extinction.

Apart from ethics, there are practical reasons to consider extinction-induced emotional behavior. First, if a child or client becomes highly emotional, it may be more difficult for care providers to sustain a prescribed treatment with integrity (i.e., the emotional behavior is aversive to the care provider). Second, emotional behavior may

be indicative of an aversive stimulus context for the child or client. If a treatment context containing extinction is aversive, then an individual may begin to escape or avoid that context, including people associated with the treatment. In fact, the notion that high exposure to extinction can be aversive is one basis for the teaching strategy known as *errorless discrimination training* (Terrace, 1963). The idea is that by reducing errors, the participant is more likely to encounter reinforcement and less likely to encounter unreinforced learning trials.

Spontaneous Recovery

Spontaneous recovery refers to the reemergence of behavior after a period of time away from the extinction–test context (Skinner, 1938). Evidence for the spontaneous recovery effect is ample in basic research (e.g., Hatton, 1965; Lewis, 1956; Miller & Stevenson, 1936; Youtz, 1938), and there are some reports found in application (Lerman et al., 1999). Skinner (1938) showed that exposing a previously reinforced response to extinction resulted in decreases in responding to pretraining levels by the end of the first exposure to extinction. When the subject was exposed to extinction a second time, however, responding reappeared at the introduction of the session, with a gradual decrease to pretraining levels by the end of the session. This pattern was repeated during subsequent exposures to extinction, with gradually decreasing response curves.

Spontaneous recovery is likely an important phenomenon to consider in application. For example, suppose a child's nighttime disruptive behavior is reinforced by parental attention (e.g., the parent reliably or at least intermittently comes into the room contingent on disruptive behavior). The parent who decides to place the disruptive behavior on extinction would withhold access to attention by not entering the room, unless it is medically necessary to do so (e.g., France & Hudson, 1990). The expected extinction effect would be an eventual waning of the nighttime disruptive behavior, perhaps within the course of a given night. However, the next night, the parent might expect to see some level of disruptive behavior due to the period of time between extinction trials. In another applied study related to spontaneous recovery, Lerman and colleagues (1999) found that when implementing a treatment, during which the reinforcer delivered for appropriate behavior was of a relatively small magnitude, the highest occurrence of problem behavior was in sessions implemented during the first part of the day, and no problem behavior was seen during sessions implemented at the end of the day.

There are practical reasons to be aware of the possibility of spontaneous recovery. First, if the recovery occurs unexpectedly, care providers may be inclined to infer that an intervention "did not work." Hence, they may be disinclined to continue implementation of the procedure. Care providers should be informed to expect a pattern of recovery, but also to note that the recovery should be progressively lower in magnitude and easier to eliminate. Second, the environment can be arranged to accommodate spontaneous recovery. For example, if safety precautions are typically necessary when instances of severe aggression or SIB occur, such preparations can be made even though prior extinction trials yielded low or eventually even zero rates of problem behavior.

Factors That Influence the Efficacy of Extinction

Several factors influence the efficacy of extinction. Although the list of potential variables influencing extinction is long, some key variables highlighted in this section include schedule of reinforcement during baseline, parameters of reinforcement during baseline, the availability of alternative sources of reinforcement during treatment, and stimulus control (including rules).

Baseline Schedule of Reinforcement

Generally speaking, behavior that is intermittently reinforced during baseline is more resistant to extinction than behavior previously maintained on a continuous reinforcement (CRF) schedule (Ferster & Skinner, 1957). The more intermittent the schedule, the more resistant the behavior to extinction (Lerman & Iwata, 1996). This influence of intermittent reinforcement is known as the *partial reinforcement extinction effect* (PREE). Suppose that, prior to treatment, a

child only sometimes receives access to candy when he or she displays tantrums (i.e., intermittent or partial reinforcement). If, during a given tantrum or two, the child receives no candy (extinction), then the arrangement looks very similar to the baseline arrangement because, due to the intermittency of reinforcement in baseline, he or she had already experienced unreinforced trials of tantrums. Thus, tantrums are likely to persist under conditions of candy deprivation, at least for several more trials. Conversely, if the child had received candy every time he or she displayed a tantrum during baseline (CRF), the change to extinction would be highly discriminable because of recent history in which all instances of tantrums were reinforced. Thus, tantrums are likely to wane more quickly following CRF, relative to the intermittent schedule situation.

The notion of PREE is somewhat complicated when one considers various methods of evaluating extinction effects. In most of the PREE research, measures such as total number of responses during extinction are used to gauge extinction efficacy (Lerman & Iwata, 1996). However, some authors have argued that a more appropriate measure would be the proportion of response rate during baseline (Nevin, 1988). If response rates are relatively high during intermittent reinforcement baselines, the proportional decrease in responding during extinction may in some cases be greater than the proportional decrease in responding following CRF. Although this alternative view of the PREE is important from a conceptual standpoint, the practical value of extinction is that it eventually eliminates (or comes close to eliminating) responding. The vast majority of research shows that this happens more quickly following CRF, although it is true that the findings are sometimes mixed (Lerman, Kelley, Vorndran, Kuhn, & LaRue, 2002).

Two practical advantages seem to emerge from the recognition of baseline reinforcement schedule influences on extinction. One, moving to a baseline CRF schedule prior to treatment generally should have the effect of reducing overall response rates prior to treatment (Ferster & Skinner, 1957). Two, moving to a baseline CRF schedule prior to extinction is likely to produce extinction effects more rapidly if one uses total number of responses (presumably the most clinically relevant measure) as a gauge of treatment efficacy.

Baseline Parameters of Reinforcement

In addition to the reinforcement schedule, Lerman and Iwata (1996) outlined several other baseline reinforcement parameters that appear to influence responding during extinction. These parameters include but are not limited to the raw number of reinforcers given in baseline, the delay to reinforcement during baseline, and the magnitude of reinforcement in baseline.

Generally, basic behavioral research has shown that the longer the acquisition period (i.e., prior to extinction treatment), the more resistance to extinction (e.g., Nevin, Tota, Torquato, & Shull, 1990). We were unable to find any applied research that addresses this phenomenon, but the ubiquitous findings in basic research suggest that the length of the acquisition period should be considered when implementing extinction. For example, an individual with an extremely long reinforcement history may be less responsive to extinction than a person with only a recent reinforcement history. However, this assertion should be considered tentative because basic research also shows that the history effect reaches an asymptote, sometimes after as few as 100 reinforcers (Lerman & Iwata, 1996). If the asymptotic effect of reinforcer number during baseline is true with humans in complex environments, then it is likely that high rate behavior problems will achieve maximal or nearly maximal resistance to extinction very quickly (at least as a function of reinforcer number). For example, a 4-year-old child with a 4-month history of high-rate SIB may easily have encountered thousands of reinforcers for SIB. That young child's SIB may be roughly as resistant to extinction as that of an adolescent with a decadelong history of reinforcement.

Basic research also shows that delay to reinforcement prior to extinction influences extinction effects. Lerman and Iwata (1996) reviewed literature suggesting that if delays to reinforcement are unpredictable (e.g., they do not happen following every response) and variable (e.g., the delay value is different from

trial to trial), then behavior is more resistant to extinction in comparison to conditions with no reinforcer delay. Conversely, if the reinforcer delay is constant and predictable, the effect on resistance is less pronounced or even reversed. The general findings related to delay have powerful implications for extinction-based treatments. Often in clinical, residential, home, or school settings, the consequences for problem behavior are delayed, and the time value of the delay is highly variable (e.g., Borrero, Vollmer, Borrero, & Bourret, 2005). Such a baseline arrangement would decrease the efficacy of extinction. As previously suggested, the PREE could be reduced by intentionally arranging CRF during baseline. Such an arrangement might also reduce the deleterious effects of delay, especially if CRF is also represented by relatively immediate reinforcement at a constant delay.

According to Lerman and Iwata (1996), the basic and applied research on baseline reinforcer magnitude effects is less clear. The basic research shows that if magnitude is defined by amount of reinforcer, then smaller reinforcement magnitudes during baseline produce more resistance to extinction. If the magnitude of reinforcement is defined as the intensity of reinforcement, then the larger magnitudes are associated with greater resistance to extinction. One implication for application is that if problem behavior is maintained by access to tangible reinforcers, such as food (e.g. Vollmer, Borrero, Lalli, & Daniel, 1999), then the efficacy of extinction may depend on whether the individual was receiving small or large *amounts* of food contingent on problem behavior. For example, a person who receives a small snack following aggression may be less responsive to treatment than one who receives a large meal after an aggression episode. Conversely, if problem behavior is maintained by attention, then *high-intensity*, effusive attention during baseline may be associated with greater resistance to extinction. Some applied research is beginning to evaluate qualitative differences in attention as reinforcement. The issue of reinforcer intensity as it relates to social attention may be similar to the issue of "higher-quality" attention (e.g., Fisher, Ninness, Piazza, & Owen-DeSchryver, 1996; Piazza et al., 1999). However, the effects of reinforcer quality on resistance to extinction have not yet been evaluated in the context of behavioral treatments.

Extinction Combined with Reinforcement

When combined with reinforcement of alternative behavior or noncontingent reinforcement, extinction is more effective in reducing problem behavior (Lalli, Casey, & Kates, 1997; Reed et al., 2004; Vollmer et al., 1998). There are several possible reasons for this common finding, but we emphasize two here. One, consistent with the principles of the matching law, the mere availability of alternative reinforcement should reduce behavior rates (Herrnstein, 1974). Two, extinction procedures in isolation would be highly sensitive to treatment integrity failures because an integrity failure equates to intermittent reinforcement of problem behavior.

Relating extinction effects to the matching law is straightforward. The *matching law* posits that the relative rate of a particular response alternative will "match" the relative rate of reinforcement for that response alternative. For example, if twice as many reinforcers are available for problematic behavior than for any other behavior, it is predictable that the individual will engage in twice as much problem behavior (Borrero & Vollmer, 2002; Martens & Houk, 1989; McDowell, 1988). Therefore, if the problematic behavior is placed on extinction, eventually all behavior that produces the functional reinforcer should be behavior other than problematic behavior (i.e., appropriate behavior). By explicitly reinforcing alternative behavior, such as with differential reinforcement of alternative behavior (DRA), a few errors with the extinction schedule should not be too detrimental because the majority of reinforcers would be produced by the DRA schedule.

Thus, combining extinction with reinforcement procedures makes treatment integrity failures less damaging. Whereas some procedures, such as DRA, may be able to "handle" a degree of treatment integrity failure (e.g., Vollmer, Roane, Rihgdahl, & Marcus, 1999), extinction by itself is probably more sensitive to integrity failures. An integrity failure in extinction equates to an

intermittent schedule of reinforcement. As has already been discussed, intermittent schedules of reinforcement can yield highly persistent behavior problems.

Stimulus Control

Basic research has shown that signaled extinction yields more immediate suppression of responding once the relation between the signal and extinction has been learned. Similar strategies have been used in application; for example, Hanley, Iwata, and Thompson (2001) investigated the effect of signaled reinforcement and extinction components in the context of thinning reinforcement schedules following functional communication training with three participants. Generally speaking, results showed the extinction period that constitutes the delay to reinforcement was more effective if it was signaled. Recent research suggests that individuals receiving intervention may actually prefer schedules in which extinction and reinforcement periods are clearly and distinctly signaled (Tiger, Hanley, & Heal, 2006).

One very specific form of stimulus control is instructional control. Obviously, for people who understand language, such stimulus control should be considered as a component of treatment. When an extinction condition is signaled by verbal instructions, the procedure is effective more rapidly (Notterman, Schoenfeld, & Bersh, 1952; Weiner, 1970). For example, one might say, "Beginning today you will no longer receive a toy at the store on days when you scream." This approach makes intuitive sense when one considers common daily occurrences, such as when a friend or colleague suggests, "Do not put your money in the soda machine; it is broken today." Under such conditions, one is far less likely to engage in a response (placing money into the machine). Even if one "tested" the contingencies in effect, presumably the rule plus an extinction trial would yield a more rapid effect than an extinction trial presented in isolation of rules.

Miscellaneous Practical Considerations

In this section, three miscellaneous but potentially critical considerations related to the practical implementation of extinction are explored: We discuss (1) the use of extinction as one component of a treatment package; (2) strategies for the use of extinction when extinction is impossible or impractical; and (3) the interrelationship between extinction and establishing operations.

Treatment Packages

It is important that extinction has been, and should continue to be, a focus of applied research. However, in practical application, it is probably rare that extinction would be used in isolation of other procedures. Most likely, extinction would be implemented as one component of a larger treatment package. Treatment packages containing extinction often take the form of differential reinforcement (McCord, Iwata, Galensky, Ellingson, & Thomson, 2001; McCord, Thomson, & Iwata, 2001; Piazza, Moes, & Fisher, 1996) or noncontingent reinforcement (Hagopian, Wilson, & Wilder, 2001; Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997). In addition, subtle components of interventions may influence the efficacy of extinction. For example, antecedent components (e.g., rules), the modification of establishing operations (e.g., demand fading), or the use of consequent events other than reinforcement (i.e., punishment) all have been shown to influence the efficacy of extinction (Cote, Thompson, & McKerchar, 2005; Lerman et al., 2003; Zarcone, Iwata, Smith, Mazaleski, & Lerman, 1994).

Given how research has shown that at least some undesirable side effects of extinction are attenuated via the use of reinforcement, whether contingent or noncontingent, there does not in most cases seem to be practical utility in using extinction alone (Vollmer et al., 1998). Furthermore, in the context of differential reinforcement, the use of reinforcement can result in the acquisition of replacement behavior. Although the emergence of desirable behavior is possible when extinction is implemented in isolation (e.g., when response variation emerges), it is unlikely that novel appropriate behavior would be maintained in the absence of reinforcement.

Overall, then, one practical recommendation for implementing extinction is to combine the procedure with reinforcement. In addition, other package components should

be explored that might increase the efficiency of extinction, such as the use of rules when the individual receiving treatment can sufficiently respond to the rules (i.e., understand them).

Modification of Extinction

There are circumstances in which extinction cannot be implemented in its pure form. For example, in the case of escape behavior, it may be that because an individual is too large, strong, or elusive to guide physically through a task, escape continues to occur. For a second example, in the case of problem behavior reinforced by attention, it is possible that the behavior is simply too dangerous to "ignore." Such would be the case if the behavior form were aggression or severe self-injury. For a third example, in the case of automatic reinforcement, because the behavior produces its own source of reinforcement, it may be practically impossible to eliminate effectively such automatic stimulation. In these cases, what should be done? A general modification of the extinction-based approach might be expressed as follows: Minimize reinforcement for problem behavior; maximize reinforcement for appropriate behavior.

If problem behavior is conceptualized as choice behavior (e.g., Borrero & Vollmer, 2002), then it follows that choice allocation will be sensitive to dimensions of reinforcement known to influence choice behavior, including rate, quality, magnitude, delay, and so on. Of course, ideally, problem behavior would receive no reinforcement at all. Short of this, a modification of the extinction approach is to minimize access to reinforcement for problem behavior in relation to the reinforcement available for appropriate behavior. In the case of escape behavior displayed by a large, powerful, elusive individual, although it may be impossible to eliminate the escape period, the escape period following problem behavior may be made as brief as possible, and the escape period provided as a consequence for appropriate behavior could be much longer and of higher quality.

In the case of dangerous attention-maintained behavior that cannot be ignored, the value of contingent attention can be minimized along several possible reinforcer dimensions. Thus, the attention required to block severe aggression or SIB might be a brief physical interruption (low-duration reinforcement), with no verbal interaction (low-quality reinforcement). By comparison, the attention available for appropriate behavior could be of much longer duration and higher quality (e.g., an extended conversation). Behavior analysts have only recently explored the notion of qualitative differences in attention as a consequence for both problematic and appropriate behavior (Fisher et al., 1996; Piazza et al., 1999). Other strategies include the use of protective equipment to minimize the need to intervene physically or verbally upon dangerous behavior (e.g., Dorsey et al., 1982).

In the case of automatically reinforced behavior, it may be difficult or even impossible to eliminate the source of reinforcement. An example in which extinction would be difficult is with stereotypical body rocking. Whereas it is theoretically possible to stop people from rocking whenever they start, it would be extremely labor-intensive to do so, and it is likely that the behavior would come under stimulus control of the presence or absence of a therapist. Another example in which extinction would be virtually impossible is the case of automatically reinforced shouting or loud vocalizations (e.g., Rapp, Vollmer, St. Peter, Dozier, & Cotnoir, 2004). Whereas, theoretically, one could provide earplugs (assuming the source of reinforcement is auditory), such an approach is not possible on ethical and educational grounds because the individual would be unable to receive other important auditory stimulation. Thus, again, the general approach of minimizing reinforcement for problem behavior and maximizing reinforcement for alternative behavior might be useful. For example, one might block rocking whenever possible but provide ample access to other vestibular stimulation. Similarly, one might mildly punish loud vocalizations (e.g., via reprimand), while providing ample opportunity to access other auditory stimulation, such as music via headset. Of course, these approaches stray from the straightforward extinction approach that is the topic of this chapter, but they are functionally similar insofar as the notion is to minimize relative reinforcement. The approaches should be considered a practical alternative when extinction is not possible.

Overall, then, a practical alternative to extinction is to identify means of minimizing reinforcement for problem behavior. If an instruction is presented to parents, teachers, and other care providers to "ignore behavior" or to "provide no reinforcement," they may become frustrated because there are clear situations in which it is not possible to adhere to such recommendations.

Establishing Operations

Before implementing extinction, it is important to evaluate the nature of the reinforcement. In part, such an evaluation involves a consideration of establishing operations. For example, suppose a child engages in severe, escape-maintained SIB whenever she is asked to walk from point *A* to point *B*. A straight extinction approach would involve physically guiding her to point *B* after an initial request is made and SIB occurs. But, what if the individual has a broken bone in her foot that has previously been undetected? Clearly, such pain constitutes a motivational operation establishing escape from walking as reinforcement (Michael, 1993). However, it would obviously be unethical to require her to walk. This is an extreme example, but it is intended to make a general point: Without recognition of the motivational variables establishing events as reinforcement, it is not advisable to embark upon extinction.

Perhaps a more common example involves escape from instructional demands. It is possible that the context in which instructional demands occur for a given individual simply represent a period of high effort, with little or no reinforcement available. Thus, an alternative approach to extinction, or at least one that should be considered in conjunction with extinction, is to alter the session context such that a rich schedule of reinforcement is available. This approach may alter the aversive features of the demand context such that the value of escape as reinforcement is reduced. Lalli and colleagues (1999) eliminated escape behavior by merely introducing into the session a rich schedule of positive reinforcement (food reinforcers). Extinction was not used. So what does this have to do with a discussion of extinction? In our view, motivational operations are a critical consideration because it may in fact be inappropriate to implement extinction under some circumstances. For example, should not instructional activity be highly reinforcing for optimal learning to occur? Do we want students to find instructional activity aversive?

Analogous considerations should be made when we identify attention or automatic reinforcement as reinforcers for problem behavior. In some cases, attention may be a reinforcer when the ambient environment is otherwise devoid of attention. In this case, the ethical approach is not to implement extinction (at least not in isolation) but to enrich the ambient availability of attention (O'Reilly et al., 2007) . Similarly, if automatically reinforced SIB occurs because the environment is otherwise austere (i.e., the austere environment establishes stimulation produced by SIB as reinforcement), the ethical approach is not to implement sensory extinction (at least not in isolation), but to enrich the environment.

Another general recommendation for practical implementation of extinction, then, is to consider carefully why events such as escape, attention, or automatic stimulation might serve as reinforcement. In cases in which the motivational operations are aberrant (e.g., excessively harsh demands, environmental or social austerity), it is the motivational operation that should be addressed directly. Only then should extinction be considered as an adjunct component to treatment.

Conclusion

Extinction is one of the most basic behavioral principles. It is also the most direct mode of treatment based on a functional analysis: If a form of reinforcement for problem behavior can be identified, then that reinforcement can be discontinued. Extinction takes a very different form depending on the source of reinforcement. For example, extinction of behavior maintained by negative reinforcement may involve the approach of a therapist (e.g., in order to guide physically), whereas extinction of behavior maintained by positive reinforcement may involve the explicit nonapproach (e.g., in an effort to ignore).

Years of basic and applied research have shown that extinction is generally useful in eliminating target behavior. However, some

studies have reported the occurrence of other effects and side effects, such as the response burst, response variation, emotional behavior, aggression, and spontaneous recovery. Reviews of the literature suggest that negative side effects are perhaps not as common as once believed, and they can clearly be attenuated when extinction is combined with other procedures, such as reinforcement.

Several factors influence the efficacy of extinction, including (1) recognition of the operant function of the target behavior; (2) use of reinforcement or other consequences, including as punishment; (3) the baseline schedule of reinforcement; (4) rules; and (5) discriminative properties of the environment, among others. Recognition of these variables is likely to improve the overall efficacy of extinction-based interventions for severe problem behavior.

Given the complexity and challenges associated with behavior problems, there are at least three additional practical considerations. One, extinction is rarely used in isolation. Two, extinction cannot always be implemented in its pure form even as one component of treatment. Three, motivational factors should be identified when evaluating the appropriateness of extinction as an intervention.

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CHAPTER 20

Developing Function-Based Reinforcement Procedures for Problem Behavior

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When a functional analysis shows that an individual's problem behavior is maintained by social consequences, it becomes possible to alter those consequences in ways that decrease problem behavior and increase appropriate alternative behavior, such as communication responses (Carr & Durand, 1985; Fisher et al., 1993; Horner & Day, 1991; Lalli, Casey, & Kates, 1995; Wacker et al., 1990). For example, an individual whose problem behavior is reinforced by access to adult attention may be taught to obtain that attention only through an appropriate communication response, a differential reinforcement treatment referred to as *functional communication training* (FCT; Carr & Durand, 1985). Even when a functional analysis determines that an individual's problem behavior is reinforced by consequences automatically produced by the response (Piazza et al., 1998), reinforcement procedures may be arranged in ways that decrease the problem behavior, though it continues to produce its reinforcer automatically (e.g., Piazza et al., 1998; Vollmer, Marcus, & LeBlanc, 1994). In this chapter, we first discuss the operant mechanisms responsible for the effectiveness of function-based reinforcement procedures, then the various outcomes of functional analyses and how those results can be used to develop effective reinforcement-based interventions for problem behavior.

Operant Mechanisms in Function-Based Treatments

Iwata and colleagues (Iwata, Pace, Cowdery, & Miltenberger, 1994; Iwata, Pace, Dorsey, et al., 1994) described three operant mechanisms related to the function of problem behavior that should be incorporated into a functional analysis. The first functional component of a functional analysis condition is its *discriminative stimulus*; that is, each functional analysis condition has one or more unique antecedent stimuli that correlate with and signal the specific reinforcer in effect in that condition. The therapist sits in chair reading a magazine only in the attention condition, the client is alone only in the alone condition, demands are presented only in the demand condition, and the therapist plays with the child only in the play condition. In addition, Conners and colleagues (2000) showed that correlating functional analysis conditions with additional salient, discriminative stimuli (i.e., unique therapists and different colored rooms for each condition) can improve the efficiency or clarity of

a functional analysis for some individuals. These results also suggest that correlating baseline and intervention conditions with unique and salient, discriminative stimuli may also lead to more rapid and differentiated treatment effects.

The second functional component of a functional analysis condition is its *motivating operation* (MO; Laraway, Snycerski, Michael, & Poling, 2003), an environmental event that has two effects. One effect of an MO is to increase (or decrease) motivation for a particular reinforcer (e.g., skipping lunch increases motivation for an afternoon snack; eating a big lunch decreases it). The other effect of an MO is to increase (or decrease) the probability of responses that have produced that reinforcer in the past (e.g., walking to the snack room is more probable after skipping lunch and less probable after a big lunch). MOs that increase motivation for a given reinforcer are called establishing operations (EOs), and those that decrease motivation are called abolishing operations (AOs; Laraway et al., 2003).

Each test condition of a functional analysis has a specific EO that is designed to increase motivation for the specific reinforcer associated with that condition (Iwata, Pace, Dorsey, et al., 1994). Deprivation of attention is used in the attention condition to increase the effectiveness of attention as reinforcement and to evoke the target response (if it was reinforced with attention in the past). Similarly, in the alone condition, the client is deprived of stimulation (except for stimulation automatically produced by the target response). Finally, in the demand condition, nonpreferred demands are presented to help establish escape as a negative reinforcer. In contrast, none of the previously mentioned EOs is present in the control condition of a functional analysis (the play condition), which decreases the probability that the target response will be evoked in this condition.

Understanding how EOs influence the probability of the target response during a functional analysis is important in terms of not only assessing the function of problem behavior but also developing an effective treatment; that is, EOs that are manipulated to increase the probability of problem behavior during a functional analysis can also be manipulated in ways to decrease that behavior during treatment. For example, time-based delivery of highly preferred items (e.g., edibles) can reduce negatively reinforced problem behavior to near-zero levels by abolishing the effectiveness of escape as reinforcement (Lomas, Fisher, & Kelley, 2010).

The third functional component of a functional analysis condition is its *reinforcing consequence*. In each test condition of a functional analysis, a specific consequence is delivered following the target behavior on a dense schedule of reinforcement (usually a fixed-ratio [FR 1] schedule). One advantage of delivering the reinforcer following the target behavior on a dense schedule (in combination with not delivering that consequence in the absence of the target response) is that the contingency should be strong and salient (Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001). Strong and salient differential contingencies in the functional analysis conditions should lead to clearer functional analyses. A second potential advantage is that response rates are generally much lower under FR 1 schedules than under intermittent schedules, which may help to minimize risks associated with severe self-injurious or aggressive behavior. A third potential advantage of delivering the putative reinforcer on an FR 1 schedule is that decreases in the target response may occur more rapidly when treatment is introduced if extinction is a component of the intervention (Lerman, Iwata, Shore, & Kahng, 1996).

Treatments for Responses Reinforced by Social Positive Reinforcement

Functional analysis research has shown that a wide variety of problem behaviors (e.g., aggression, self-injurious behavior [SIB], pica, property destruction) are often reinforced by social positive reinforcement. For example, Iwata, Pace, Dorsey, and colleagues (1994) found that 40 of their 152 participants (26.3%) displayed SIB that was reinforced by social positive reinforcement. Social reactions to problem behavior that may inadvertently function as positive reinforcement in the natural environment include the delivery of preferred stimuli, such as attention, food, toys, music, or TV.

Function-based treatment for problem behavior maintained by social positive re-

inforcement generally involves the manipulation of one or more of the three functional components of a functional analysis described earlier (i.e., the consequence for problem behavior, the MO that establishes the effectiveness of that consequence as reinforcement for problem behavior, and the discriminative stimulus that signals the problem behavior will produce that reinforcer). Thus, one reasonable way to begin the process of developing a function-based treatment once a functional analysis has identified the reinforcer(s) for problem behavior is to ask a series of questions related to these three functional components:

1. How can the reinforcer for problem behavior be altered in ways that reduce problem behavior and increase appropriate behavior?
2. How can the relevant MO(s) be altered in order to decrease the probability of problem behavior?
3. How can discriminative stimuli be arranged to signal (a) the availability of reinforcement for the alternative behavior at appropriate times and (b) the unavailability of reinforcement for problem behavior?

We now discuss how these questions can be used to guide treatment development for two commonly prescribed interventions for problem behavior reinforced by social positive reinforcement: FCT and noncontingent reinforcement (NCR).

Functional Communication Training

FCT typically involves manipulation of the consequence for problem behavior in two important ways: (1) when the consequence identified by the functional analysis as the reinforcer for problem behavior is delivered contingent on an appropriate communication response (i.e., a form of differential reinforcement of an alternative response; DRA), and (2) when that consequence is no longer delivered contingent on problem behavior (i.e., operant extinction). For example, if the functional analysis indicates that problem behavior is reinforced by contingent attention, then the individual would be taught to obtain attention via an appropriate communication response and that problem behavior no longer produces attention. The first component (delivering the functional reinforcer contingent on a communication response) is important because the individual receives frequent reinforcement via the communication response, thus avoiding periods of deprivation from attention that may act as an MO that evokes problem behavior (as in an extinction burst; Lerman & Iwata, 1995). The second component is important because problem behavior becomes less probable if it is placed on extinction and no longer produces attention.

Selecting and Teaching the FCT Response

Although FCT is one of the most researched operant interventions, investigators have rarely described how they selected the FCT response (for notable exceptions, see Horner & Day, 1991; Grow, Kelley, Roane, & Shillingsburg, 2008), and only a few studies have provided clear and replicable details on how the FCT response was trained (e.g., Fisher et al., 1993; Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997; Wacker et al., 1990). Horner and Day (1991) studied three components of the FCT response that have direct implications for selecting an appropriate target response. In the first study of the investigation, they showed that a simple and less effortful response was more effective as an FCT response than a more complex and effortful one; that is, problem behavior decreased more markedly when the FCT response consisted of signing a single word (i.e., "break") rather than a complete sentence (i.e., "I want to go, please"). In the second study, Horner and Day showed that the FCT response was more effective when reinforced on a dense schedule (i.e., FR 1) than on a leaner schedule (i.e., FR 3). Finally, in the third study, they showed that the FCT response was more effective when it produced reinforcement almost immediately (1-second delay) than when it produced the same reinforcer after a longer delay (20-second delay).

Based on the Horner and Day (1991) study and our own work, we have developed the following guidelines in selecting and training FCT responses. The communication response should be simple for the individual to emit. It is generally preferable to choose an FCT response that is already in the individ-

ual's response repertoire. For children who speak in complete sentences, a short request would be an appropriate FCT response (e.g., "Play with me, please"). We usually teach children who do not speak to touch a picture card that depicts the functional reinforcer as the FCT response (e.g., touching a picture card that shows the child and adult playing together). If children do not perform the FCT response independently, we help them (using physical guidance), then deliver the reinforcer. We deliver the reinforcer even if we guide children to complete the FCT response initially, so that they are not exposed to deprivation from the functional reinforcer (e.g., attention), which helps to decrease the probability of evoking problem behavior while we are training the FCT response. Over time, we decrease (or fade) the amount of assistance we provide until individuals emit the FCT response independently during 90% of training trials for two consecutive sessions. Finally, the reinforcer identified during the functional analysis should be delivered immediately following each FCT response (i.e., an FR 1 schedule). Thus, in summary, it is important to (1) select an FCT response that is simple for the individual, (2) reinforce the FCT response on a dense (FR 1) schedule, and (3) deliver the reinforcer as immediately as possible following the FCT response.

Response-Independent Delivery of the Reinforcer for Problem Behavior

Another reinforcement-based approach to the treatment of problem behavior is first to conduct a functional analysis to identify the reinforcer for problem behavior (e.g., attention), then deliver that reinforcer on a time-based schedule (Fisher, DeLeon, Rodriguez-Catter, & Keeney, 2004; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). This approach often has been referred to as *noncontingent reinforcement*, but the label has been criticized because the intended (and generally observed) effect of the treatment is a reduction in (and weakening of) the target response, whereas *reinforcement* is defined as an increase in responding due to contingent presentation of a positive or negative reinforcer (Poling & Normand, 1999). Poling and Normand suggested using the term fixed-time (FT) schedules, but this label does not acknowledge the prior functional relation between the target response and stimulus delivered on a time-based schedule during treatment, or the fact that the treatment was empirically prescribed from the results of a functional analysis. We use the term NCR in this chapter to maintain contact with the relevant applied literature, but we acknowledge the inconsistency in referring to a treatment designed to reduce problem behavior as reinforcement.

When NCR schedules are initiated, the stimulus that previously reinforced problem behavior is typically delivered on a dense schedule. For example, Vollmer and colleagues (1993) first introduced NCR as a clinical treatment for SIB reinforced by attention. During baseline, which was identical to the attention condition of the functional analysis, 10 seconds of verbal attention (statements of concern or disapproval) was delivered contingent on each occurrence of SIB. When NCR was introduced, the contingency between SIB and attention was terminated (i.e., extinction), and attention (consisting of praise and general conversation) was delivered almost continuously, independent of the occurrence or nonoccurrence of SIB.

The delivery of attention on a dense, response-independent schedule removes or lessens the establishing operation for problem behavior, which often results in immediate and large reductions in responding. For example, Hagopian, Fisher, and Legacy (1994) compared dense (FT 10-second) and lean (FT 5-minute) schedules of NCR, and found that the former produced large and immediate reductions in destructive behavior, whereas the latter schedule produced smaller and less consistent reductions. Similar differences have been observed when higher and lower magnitudes of reinforcement were delivered on time-based schedules, even when NCR was implemented without extinction (Roscoe, Iwata, & Rand, 2003). Finally, Fisher and colleagues showed that NCR with extinction resulted in greater and more immediate reductions in destructive behavior than the implementation of extinction alone (Fisher et al., 2004).

Choosing between FCT and NCR

Given that both FCT and NCR have generally been found to be effective treatments

for destructive behavior, especially when combined with extinction or mild punishment (Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998), how should a behavior analyst decide which one to use and when? Perhaps the first consideration should be whether one's problem behavior is dangerous and likely to produce imminent harm to oneself or others. If the risk of harm is high, it may be advisable to implement NCR immediately following the functional analysis because FCT generally requires an initial training period, whereas NCR does not. NCR also has the advantage of requiring less monitoring of the individual's ongoing behavior than FCT; that is, with NCR, the caregiver is asked to set a timer and to deliver the reinforcer when the timer goes off, whereas with FCT, the caregiver has to monitor and respond to the individual's FCT response (although most individuals learn to seek out the caregiver and recruit reinforcement with the FCT response).

Another important consideration in choosing between FCT and NCR is whether establishing a communication response in and of itself is an important treatment goal. In such cases FCT would be the obvious choice. FCT may also have an advantage over NCR in cases in which it is unclear how often reinforcement should be delivered in order to remove the EO for problem behavior. For example, exposure to an extended period of time without attention because the parent is on the phone might establish the effectiveness of attention as reinforcement and evoke responses that have effectively produced attention in the past. With NCR, the response that is likely to be evoked in such circumstances is the child's problem behavior (e.g., attention-reinforced SIB). By contrast, with FCT, exposure to the EO is more likely to evoke the FCT response because it has a more recent history of reinforcement with attention than the child's problem behavior.

Treatments for Responses Reinforced by Social Negative Reinforcement

In 1987, Iwata described negative reinforcement as an "emerging technology" in the field of applied behavior analysis. Since that time, research on the unique role of negative reinforcement in the development, maintenance, and treatment of problem behavior has grown exponentially. This is despite criticisms that the distinction between positive and negative reinforcement is ambiguous and without functional significance, and that the distinction should be abandoned (Baron & Galizio, 2005; Michael, 1975).

Negative reinforcement has almost uniformly been defined as an increase in responding due to the response-contingent removal of a stimulus. However, Baron and Galizio (2005), and Michael (1975) before them, argued that reinforcement should be viewed as an increase in responding due to a response-contingent environmental change from one stimulus condition to another. Their argument is based in part on the fact that in certain (or perhaps many) circumstances, it is difficult to determine whether an individual is responding to terminate one event or to gain access to the opposite event. For example, does one turn up the thermostat to escape from cold air or to gain access to warm air? Other behavior analysts have argued that the distinction between positive and negative reinforcement is both useful and sufficiently engrained in the verbal community of behavior analysts that abandonment of the distinction may be unwarranted and certainly is unlikely (Iwata, 2006; Lattal & Lattal, 2006; Sidman, 2006).

Our purpose in discussing this issue is twofold. First, it is important for applied behavior analysts to understand that there is disagreement in the field on whether the distinction between positive and negative reinforcement is a meaningful one. But more importantly, the second reason is that behavior analysts on both sides of this argument would agree that it is important to consider, describe, and analyze the stimulus conditions in effect before and after the target response, regardless of whether one uses the adjectives *positive* or *negative* to modify the term *reinforcement*. We attempt to stress the importance of both sides of the stimulus change by describing and analyzing the relevant EOs and discriminative stimuli that were present before the target response, and retaining the terms *positive* and *negative reinforcement* to describe whether the stimulus change involved the introduction (positive reinforcement) or withdrawal (negative reinforcement) of a stimulus following the target behavior.

Functional analysis research has shown that problem behaviors are often reinforced by termination of demands; in fact, Iwata, Pace, Dorsey, and colleagues (1994) found that 38.1% of their 152 subjects displayed SIB maintained by social negative reinforcement, which was a higher percentage than for any other behavioral function. Other forms of negatively reinforced problem behavior include escape from noise (McCord, Iwata, Galensky, Ellingson, & Thomson, 2001) or from social interaction (Hall, DeBernardis, & Reiss, 2006).

FCT and NCR are both reasonable and effective treatments for problem behavior reinforced by escape from demands or other aversive events, and the issues and considerations discussed earlier (e.g., selecting the FCT response) are equally applicable to negatively reinforced problem behavior. When FCT is used to treat problem behavior reinforced by escape, the individual is taught to request breaks from nonpreferred tasks with an FCT response (e.g., saying "Break please"; handing over a picture card that shows the child leaving the worktable; Hagopian et al., 1998). When NCR is used to treat negatively reinforced problem behavior, escape is provided on a dense, time-based schedule (Vollmer, Marcus, & Rihgdahl, 1995). In most cases, treatments such as FCT and NCR are generally combined with escape extinction (discussed by Vollmer & Athens, Chapter 19, this volume).

One limitation that is common to both of these interventions when initially applied to negatively reinforced behavior is that the individual frequently escapes all, or almost all, of the instructional demands. When this occurs, the individual is not learning new skills or benefiting from the instruction (Fisher et al., 1993). One approach used to address this problem is called *instructional* (or *demand*) *fading*, in which the number of demands presented per session is gradually increased. We return to this approach later when we discuss a variety of procedures that make treatments more practical. Another approach used to reduce problem behavior, while continuing to present instructional demands, is to provide differential reinforcement for compliance rather than for communication (Marcus & Vollmer, 1995).

Selecting compliance as the alternative response in a DRA program has several potential advantages. First, as mentioned earlier, the individual who continues to receive instruction with this intervention is more likely to learn a variety of skills, which may in turn become responses that produce alternative sources of reinforcement. Second, the continued exposure to instructional demands may produce habituation and make their subsequent presentation less aversive. Third, differential reinforcement of compliance can add to the effectiveness of escape extinction in unique and important ways. For example, Cataldo and colleagues have shown that reinforcement of compliance can both increase that response and concomitantly decrease problem behavior, even when the consequences for problem behavior remain unchanged (Parrish, Cataldo, Kolko, Neef, & Egel, 1986; Russo, Cataldo, & Cushing, 1981). Conversely, interventions that directly target reductions in problem behavior (e.g., extinction, time-out) can produce decreases in problem behavior and simultaneous increases in compliance, even though the consequences for compliance remain unchanged. Cataldo and colleagues have hypothesized that compliance and problem behavior are inverse members of an overarching response class called *instruction following,* which may include these two topographically distinct responses in environmental contexts in which compliance historically has produced reinforcement, and problem behavior historically has been punished or placed on extinction (Parrish et al., 1986).

When targeting reductions in problem behavior through differential reinforcement of compliance, it is important to select potent reinforcers. One approach is to provide differential negative reinforcement (i.e., escape) contingent on compliance. With this procedure, the escape contingency found to reinforce problem behavior during a functional analysis is delivered contingent on compliance, and problem behavior is placed on extinction. For example, Vollmer and colleagues (1995) delivered escape on a dense FT schedule and produced immediate and large reductions in SIB. They subsequently leaned the schedule of response-independent breaks from work to 10 minutes for one participant and 2.5 minutes for the other, using procedures similar to the instructional fading procedures described below.

Another approach to the treatment of negatively reinforced problem behavior is to deliver positive reinforcement for compliance. For example, Lalli and colleagues (1999) showed that reinforcement of compliance with a preferred food increased compliance and decreased negatively reinforced problem behavior even though this latter response continued to produce escape. This finding has since been replicated a number of times (e.g., DeLeon, Neidert, Anders, & Rodriguez-Catter, 2001; Kodak, Lerman, Volkert, & Trosclair, 2007). This approach is particularly useful when it is difficult or impossible to implement escape extinction (e.g., when the client is larger and stronger than the therapist).

Lalli and colleagues (1999) suggested two possible operant mechanisms for the effectiveness of differential positive reinforcement of compliance in treating negatively-reinforced problem behavior. One possibility is that the individual prefers the positive reinforcer to the negative reinforcer; the other possibility is that the presence of a highly-preferred positive reinforcer in the demand context acts as an AO that lessens the effectiveness of escape as reinforcement for problem behavior. DeLeon and colleagues (2001) showed that one participant consistently chose the positive reinforcer over escape when given a choice between these two reinforcers following compliance. Conversely, Lomas and colleagues (2010) reduced escape-reinforced problem behavior to near-zero levels through the delivery of a preferred food item and praise on a response-independent variable-time schedule, thus showing that the presence of a highly-preferred stimulus in the demand context can act as an AO and lessen the effectiveness of escape as negative reinforcement of problem behavior. These results indicate that one or both of the operant mechanisms described by Lalli and colleagues may be responsible for reductions in escape-reinforced problem behavior for a given individual.

Finally, in addition to the delivery of response-independent highly-preferred stimuli (e.g., Lomas et al., 2010) or escape (Vollmer et al., 1995), there are a number of additional ways in which motivating operations may be manipulated effectively to treat problem behavior reinforced by escape. For example, Smith (1995) found that escape-reinforced SIB was more probable when novel tasks were presented, when the instructional session duration was longer, and when demands were presented at a higher rate. Other variables found to establish the effectiveness of escape as reinforcement for problem behavior include difficult tasks (Weeks & Gaylord-Ross, 1981), less preferred tasks (Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991), cancellation of a planned and preferred activity prior to the instructional session (Horner, Day, & Day, 1997), and sleep deprivation (O'Reilly, 1995). Conversely, each of these EOs can be reversed in order to abolish or lessen the effectiveness of escape as negative reinforcement for problem behavior. For example, interspersing less aversive tasks (Ebanks & Fisher, 2003; Horner, Day, Sprague, O'Brien, & Heathfield, 1991), gradually increasing the rate or aversiveness of tasks (Pace, Ivancic, & Jefferson, 1994; Pace, Iwata, Cowdery, Andree, & McIntyre, 1993), and providing choices among tasks (Romaniuk et al., 2002) can reduce problem behavior reinforced by escape.

Treatments for Responses Reinforced by Automatic Reinforcement

In the preceding sections we discussed problem behavior reinforced by consequences delivered by other individuals in the environment (i.e., socially mediated reinforcement). However, some aberrant responses persist at high rates in the absence of social consequences (e.g., when the individual is alone), and these responses may be reinforced by consequences that are automatically or intrinsically produced by the response; that is, when a response produces a favorable outcome automatically, and this automatic consequence increases the future probability of the response, the response is said to be maintained by *automatic reinforcement* (Skinner, 1953; Vaughn & Michael, 1982; Vollmer, 1994). An everyday example is loosening a tie, which is reinforced by the discomfort it relieves. Potential examples among individuals with autism or developmental disabilities include rocking, which may produce favorable kinesthetic sensations. Repeatedly dropping colorful objects in front of the eyes may provide favorable visual sensation. Lining up objects may occur because it brings order to

an otherwise confusing environment. Hand flapping may occur during times of physiological excitation because it mitigates the arousal and reduces muscle tension.

Aberrant behavior reinforced by consequences that are automatically produced by the response pose a particular challenge for behavior analysts because we may not be able to control or even observe these consequences. For example, SIB involving the eyes (e.g., eye poking) is about 16 times more likely in individuals who have visual impairments but intact visual sensory–neural pathways (Hyman, Fisher, Mercugliano, & Cataldo, 1990). A reasonable hypothesis regarding the function of this unique form of SIB is that it occurs because the response produces visual-like sensation that functions as reinforcement for the response in someone who is generally deprived of such stimulation. However, it is difficult for a behavior analyst to test whether this hypothesized automatic consequence is actually the functional reinforcer for SIB in these individuals because it is often not possible to manipulate this consequence as a part of a functional analysis or as a treatment component (for a notable exception, see Rincover, 1978).

When a functional analysis suggests that an aberrant response is maintained by automatic reinforcement, one treatment approach is to provide the individual with alternative forms of appropriate stimulation that effectively compete with the automatic reinforcer for problem behavior (Piazza et al., 1998; Wilder, Draper, Williams, & Higbee, 1997). One of the first applications of this approach was implemented by Horner (1980), although it was not based on a functional analysis. The intervention was called an "enriched environment," and involved adding a variety of toys and objects that could be manipulated (e.g., puzzles, stuffed animals, dolls, pull toys, push toys, musical toys, rocking horse) to an otherwise austere institutional environment. This simple intervention resulted in increases in adaptive behavior involving the added objects and reductions in self-injurious and stereotypical behavior.

Vollmer and colleagues (1994) refined and extended this treatment approach by (1) prescribing the "enriched environment" intervention based on the results of a functional analysis (i.e., for aberrant responses that persisted in the absence of social contingencies and were presumed to be maintained by automatic reinforcement) and (2) selecting the toys and or leisure items for enriching the environment based on the results of a preference assessment (Fisher et al., 1992). Piazza, Fisher, Hagopian, Bowman, and Toole (1996) further refined this approach by developing a preference assessment, called the *competing-items assessment*, specifically designed to identify preferred toys and/or leisure materials associated with high levels of item interaction and low levels of aberrant behavior. Although this assessment can be used with problem behavior maintained by social positive reinforcement (e.g., Fisher, O'Connor, Kurtz, DeLeon, & Gotjen, 2000), the competing-items assessment is particularly well suited for identifying preferred stimuli for use in reinforcement-based programs for aberrant behavior maintained by automatic reinforcement.

The competing-stimulus assessment is fairly simple and involves a series of short sessions (e.g., 2 minutes each). In each session a single competing stimulus is presented, and the individual can interact with the competing stimulus, display the automatically reinforced aberrant behavior, or do some of each. Observers record the levels of item interaction and aberrant behavior in each session to identify one or more stimuli associated with high levels of item interaction and low levels of aberrant behavior. These items are subsequently used in reinforcement-based treatments and presented to the individual on a time-based schedule at times when the automatically reinforced aberrant behavior is most likely to occur, which is usually during "down times," when other forms of stimulation are not available.

Increasing the Practicality of Reinforcement-Based Interventions

A common criticism of behavioral interventions is that they are often labor-intensive (relative to drug or milieu treatments), frequently requiring the parent or caregiver to (1) continuously monitor the child's behavior and (2) accurately deliver a variety of prompts and consequences. Thus, behavior analysts have worked to develop and validate intervention components designed to make behavioral treatments easier and more practical to implement.

As previously discussed, FCT is a commonly used, effective treatment for problem behavior. However, it is often labor-intensive when it is first introduced because the FCT response is reinforced on a dense schedule (usually an FR 1) to maximize the likelihood that problem behavior will decrease rapidly to near-zero levels. It is often not practical or even possible for parents or teachers to maintain such a dense schedule in the natural environment (Fisher et al., 1993). A variety of reinforcer-thinning procedures have been developed for the purposes of (1) decreasing the rate of the FCT response to make treatment easier and more practical for caregivers to implement, and (2) bringing the FCT response under stimulus control, so that it occurs only at appropriate times but is not weakened due to exposure to periods of extinction when it is not reinforced (Fisher, Kuhn, & Thompson, 1998; Hanley, Iwata, & Thompson, 2001).

When the FCT response involves the exchange of a picture card, a practical approach to reinforcer-schedule thinning is to restrict access to the picture card immediately following delivery of the functional reinforcer (Roane, Fisher, Sgro, Falcomata, & Pabico, 2004). The absence of the FCT response card serves as a discriminative stimulus for the unavailability of reinforcement and makes it impossible for the participant to display the response at times when it is not likely to produce reinforcement (e.g., if the card is unavailable while the parent is changing the diaper of an infant sibling, the child cannot request the parent's attention at that time).

At the start of treatment, the picture card is continuously available, but after several sessions with high levels of the FCT response and low levels of problem behavior, reinforcement thinning is initiated by restricting access to the card (e.g., out of sight, in the therapist's pocket) for a few seconds following the reinforcement interval. Over time, the duration of the interval in which the response card is unavailable is progressively increased. For example, the therapist might double the length of the response-restriction interval after every two sessions (as long as problem behavior remains low), until a practical schedule is reached. A reasonable endpoint or goal for schedule fading would be to present the FCT card once every 10–15 minutes and allow the child to access the functional reinforcer for 30–60 seconds.

When a vocal operant is used as the FCT response (e.g., "Play, please"; "Break, please"), separate discriminative stimuli are generally used to signal the availability and unavailability of reinforcement for the response. For example, a large square of green paper signaling the availability of reinforcement, and a large square of red paper signaling the unavailability of reinforcement could be alternately hung on the wall according the current schedule of reinforcement. Training trials are typically presented to expose the individual to the contingencies associated with each discriminative stimulus (e.g., using green for the S^D to signal reinforcement, and red for the S^δ to signal extinction). Over time, reinforcer-schedule thinning is accomplished by increasing the length of time S^δ is in effect and decreasing the length of time S^D is presented (Hanley et al., 2001). As indicated earlier, reinforcer-schedule thinning continues as long as the levels of problem remain low.

Several procedures are also available for increasing the practicality and ease of NCR interventions, once initial reductions in problem behavior are achieved through the delivery of dense schedules of NCR. For example, Hagopian and colleagues (1994) gradually faded the dense (FT 10-second) schedule to the lean (FT 5-minute) schedule and obtained near-zero rates of destructive behavior. Importantly, treatment effects were transferred from the clinic to the classroom setting and maintained at 2-month follow-up.

Another approach to increasing the practicality of NCR is to identify alternative reinforcers (e.g., toys) that can be delivered at times when it is difficult or impractical to deliver the consequence that previously reinforced destructive behavior (e.g. Hanley, Piazza, & Fisher, 1997). This approach is especially useful for problem behavior reinforced by attention because caretakers are not always available to deliver attention (e.g., when the parent is in the bathtub); that is, delivering highly preferred toys noncontingently can decrease the probability that attention-reinforced problem behavior will reemerge at times when a parent is busy and cannot deliver attention. Selecting effective alternative reinforcers is important when using such procedures, and the competing-items assessment (described earlier for treating aberrant responses maintained by au-

tomatic reinforcement) can be adapted for problem behaviors reinforced by attention or other social contingencies (Fisher et al., 2000).

As noted earlier, the competing-items assessment (Piazza et al., 1998) involves the presentation of preferred stimuli one at time during short sessions, and measuring the levels of interaction with the item and of automatically reinforced problem behavior. Fisher and colleagues (2000) adapted the competing-items assessment for use with aberrant responses reinforced by attention. During the assessment, problem behavior continues to produce its reinforcer identified via a functional analysis (e.g., attention), and we measure how much the individual interacts with the alternative stimulus relative to how much problem behavior he or she emits. Stimuli that are associated with high levels of item interaction and low levels of problem behavior during this competing-items assessment are often effective for reducing problem behavior when delivered on a time-based NCR schedule (Hanley et al., 1997), even when problem behavior continues to produce contingent reinforcement (Fisher et al., 2000).

A second approach to identifying effective alternative stimuli involves the behavior analyst carefully observing the consequences automatically produced by problem behavior. The purpose of these observations is to generate hypotheses about the nature of the stimulation produced by the behavior, which are then used to identify stimuli that produce the same or similar types of stimulation in the absence of problem behavior. These stimuli have been called *matched stimuli* because they match the stimulation produced by problem behavior (Piazza, Adelinis, Hanley, Goh, & Delia, 2000). Once a preliminary set of matched stimuli has been identified, a competing-items assessment (as described earlier) is completed to identify one or more matched stimuli associated with high levels of item interaction and low levels of problem behavior. Matched stimuli sometimes produce greater reductions in automatically reinforced problem behavior than other alternative stimuli (Piazza et al., 1998, 2000), perhaps because they more effectively remove the establishing operation for problem behavior.

For aberrant behavior reinforced by escape from nonpreferred demands, reinforcement-schedule thinning generally involves increasing the number of instructions or trials the individual must complete before escape is available. This treatment approach has been referred to as *instructional* or *demand fading* (Pace et al., 1993; Zarcone et al., 1993). Instructional fading can be implemented alone (Pace et al., 1994) or in combination with other treatments, such as escape extinction (Zarcone et al., 1993) or FCT (Hagopian et al., 1998).

When instructional fading is implemented, the treatment session is arranged with instructional materials present, but no demands are delivered during the first or first few sessions (i.e., continuous noncontingent escape). After one or a few sessions with little or no problem behavior, a single demand (e.g., "Point to red") is presented about halfway through the session. The number of demands per session is gradually increased each time, until a predetermined criterion is reached (e.g., add one demand after each session in which problem behavior is at least 90% lower than the mean for baseline) (Pace et al., 1993).

When instructional fading is implemented in conjunction with FCT, the number of demands per session generally is not reduced. Rather, a chain schedule is introduced, in which the individual must first complete one demand and then a discriminative stimulus is presented to signal the availability of reinforcement (i.e., escape) for the FCT response. In subsequent sessions, the number of demands that has to be completed is gradually increased (before the discriminative stimulus is presented and escape becomes available for the FCT response). This response requirement (i.e., the number of demands) is only increased if the rate of problem behavior remains low and below a predetermined criterion (e.g., 90% below the mean of baseline) (Hagopian et al., 1998).

Addressing Common Problems in Reinforcement-Based Treatments

Hagopian and colleagues (1998) reviewed a series of 21 cases in which FCT-based interventions were implemented and found that when combined with extinction, FCT was effective in the majority of cases. However, when the schedule of reinforcement was thinned (as described earlier), the effective-

ness of FCT plus extinction was reduced in about one-half of the cases. Similarly, Volkert, Lerman, Call, and Trosclair-Lasserre (2009) observed a frequent resurgence of problem behavior when FCT was placed on extinction or reinforced on an FR 12 schedule. When reinforcement-based treatments are ineffective, the addition of a function-based treatment that includes a punishment component may be warranted (Hagopian et al., 1998).

Concluding Comments

Reinforcement-based treatment procedures based on the results of a functional analysis tend to be efficient and effective. This is because the results of the functional analysis provide highly specific information that directs the intervention development to a small number of relevant antecedents and consequences; that is, the functional analysis results allow us to focus the intervention activities on the pertinent contexts (e.g., demand contexts when escape is the reinforcer, low-attention contexts when attention is the reinforcer) rather than implementing a broad treatment at all times across all environmental contexts. Focusing on one or a few specific contexts allows for easier implementation of the intervention in the natural environment. It also specifies a relatively small number of procedures that can be implemented to reduce problem behavior (e.g., eliminate the contingency between problem behavior and its reinforcer) and increase appropriate alternative behavior (e.g., provide access to the functional reinforcer only following an appropriate communication response). This leads to more efficient treatment development, in that the results of the functional analysis help prescribe a specific treatment and eliminate a broader trial-and-error approach to selecting interventions.

In conclusion, accurate functional analysis results promote quicker development of effective treatments, easier implementation of the intervention in the natural environment (by specifying the contexts in which the treatment is relevant), and generalization and maintenance of treatment effects by utilizing the functional reinforcer to maintain an appropriate alternative behavior in the natural environment (Durand, Berotti, & Weiner, 1993).

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CHAPTER 21

Developing Function-Based Punishment Procedures for Problem Behavior

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Numerous procedures based on the process of punishment have been developed to treat problem behavior. When the contingent presentation of a stimulus decreases the future likelihood of a behavior, the procedure is termed *positive punishment*. Procedural variations of positive punishment examined in the applied literature include the contingent presentation of verbal reprimands, brief physical restraint, and water mist. When the contingent removal of a stimulus decreases the future likelihood of behavior, the procedure is termed *negative punishment,* which can be further divided into two procedures, response cost and time-out. *Response cost* is the contingent removal of a specific amount of a positive reinforcer, and *time-out* is the contingent loss of access to reinforcement for a specific period of time.

Basic research findings on punishment, conducted primarily with nonhumans, have been instrumental in developing an effective technology of punishment. The voluminous applied literature on punishment, now spanning more than 35 years, has demonstrated the advantages and disadvantages of this approach to treatment. The development of safe and effective punishers for individuals with developmental disabilities has been the aim of much of this research.

However, a number of authors have noted that both basic and applied research on punishment have been declining over the last decade (e.g., Baron, 1991; Crosbie, 1998; Kahng, Iwata, & Lewin, 2002; Pelios, Morren, Tesch, & Axelrod, 1999). Although the use of punishment has been controversial for a number of years, the decrease in applied research has been attributed to advances in the functional analysis of problem behavior and greater use of function-based treatment (Kahng et al., 2002; Pelios et al., 1999). Despite advances in treatment with extinction and reinforcement (see Vollmer & Athens, Chapter 19, and Fisher & Bouxsein, Chapter 20, this volume), research findings suggest that punishment currently remains an important option for caregivers of individuals with serious behavior problems (Foxx, 2003). Punishment may be clinically indicated when function-based treatments do not produce acceptable outcomes (e.g., Fisher et al., 1993; Hagopian, Fisher, Thibault-Sullivan, Acquisto, & LeBlanc, 1998; Hanley, Piazza, Fisher, & Maglieri, 2005; Wacker et al., 1990) or when the reinforcers maintaining problem behavior cannot be identified or controlled (e.g., Fisher et al., 1993; Lindberg, Iwata, & Kahng, 1999). Punishment also may be the treatment of choice for life-threatening behavior that must be suppressed rapidly to prevent physical harm (e.g., Foxx, 2003).

Advances in the functional analysis of problem behavior, however, should lead

to improvements in the selection and use of punishers in clinical settings. The term *function-based punishment* may seem counterintuitive because punishment is more likely to be used when the function of behavior is unknown. However, as discussed in more detail below, punishment should only be prescribed with some knowledge of consequences that may be relevant and/or irrelevant to the maintenance of the problem behavior. For the purposes of this chapter, function-based punishers are those that are likely to be effective given this information. Our objectives in this chapter are to provide an overview of punishment procedures, approaches for selecting these interventions, factors that influence the effects of punishment, and strategies for using punishment effectively.

Types of Punishment Procedures

Punishment may be clinically indicated if (1) initial treatments based on reinforcement, extinction, and establishing operations do not produce clinically acceptable decreases in behavior or (2) the behavior warrants immediate intervention with procedures likely to produce rapid decreases in responding (i.e., a treatment package that includes punishment). As described in the following sections, myriad safe and effective punishers are available for clinical use. Although these procedural variations of punishment are often classified on the basis of form (e.g., "overcorrection") and/or function (e.g., "time-out"), many commonly used procedures contain multiple potential punishing stimuli. For example, time-out is frequently combined with some type of physical restraint. In addition, the classification of a procedure as "punishment" is based on its effects on behavior. Thus, although the various procedures described below have been found to function as punishment for some individuals, they may have different functions for others. These alternative functions are discussed later in the section on selection of punishment procedures.

Below, the procedures are divided roughly into two groups for organizational purposes. The first group, referred to as Type 1, or positive punishment, involves the presentation of an aversive stimulus contingent on behavior. The second group, classified as Type 2, or negative punishment, involves the removal of preferred or reinforcing stimuli contingent on behavior. Our purpose in this section is to provide a brief description and summary of research findings on clinical variations of punishment.

Positive (Type 1) Punishment Procedures

A variety of stimuli have been shown to decrease problem behavior when presented contingent on the behavior. These stimuli include verbal reprimands, physical contact, water mist, certain tastes and smells, noise, and shock.

Verbal Reprimands

Brief statements of disapproval or instruction may function as an effective punisher for a variety of behavior problems, including self-injurious behavior (SIB), aggression, pica, and stereotypy. In a number of studies, for example, caregivers delivered a stern "No," or "Don't do that, you'll hurt yourself" contingent on problem behavior to reduce the frequency of the behavior (e.g., Maglieri, DeLeon, Rodriguez-Catter, & Sevin, 2000; Richman, Lindauer, Crosland, McKerchar, & Morse, 2001; Thompson, Iwata, Conners, & Roscoe, 1999; Van Houten, Nau, MacKenzie-Keating, Sameoto, & Colavecchia, 1982). Results of a few studies indicate that a reprimand also can be established as an effective conditioned punisher (e.g., Dorsey, Iwata, Ong, & McSween, 1980; see further discussion below). Factors that may influence the reductive effects of reprimands have been evaluated in several studies. Verbal reprimands were more effective when paired with eye contact and physical contact (e.g., a firm grasp on the shoulder) delivered in close proximity to the behaver, and provided contingent on the problem behavior of other individuals (e.g., Richman et al., 2001; Van Houten et al., 1982).

Response Blocking and Physical Restraint

A variety of punishment procedures involve some type of physical contact between the caregiver and the behaver. These procedures differ in terms of the amount and duration of the contact. *Response blocking*, the least

intrusive form of these procedures, involves the use of brief physical contact to prevent a response from occurring (e.g., Lalli, Livezey, & Kates, 1996; Lerman & Iwata, 1996; Reid, Parsons, Phillips, & Green, 1993). In Reid and colleagues (1993) and in Lerman and Iwata (1996), for example, the therapist blocked hand mouthing by placing his or her hand approximately 2 centimeters from the participant's mouth, thus preventing the insertion of the hand into the mouth (i.e., contact was made between the individual's hand and the back of the therapist's hand). The reductive effects of response blocking may be attributable to extinction rather than to punishment in some cases (Smith, Russo, & Le, 1999).

Physical contact that occurs for the purpose of restricting or limiting an individual's movement (rather than for the purpose of response prevention only) is referred to as *physical restraint*. Numerous variations of physical restraint have been shown to reduce destructive behavior effectively. Restraint procedures have included "hands down" (the therapist held the individual's hands to the side for a specified amount of time; Bitgood, Crowe, Suarez, & Peters, 1980; Hagopian et al., 1998; Lerman, Iwata, Shore, & DeLeon, 1997); "quiet hands" (the therapist physically guided the individual's hands to the side, held them stationary for 5 seconds, and then repeated the motion every 5 seconds for a specified amount of time; Fisher, Piazza, Bowman, Hagopian, & Langdon, 1994), "baskethold" (the therapist stood behind the individual, crossed the individual's arms across the chest, and held them above the wrists for a specified amount of time; Fisher, Piazza, Bowman, Kurtz, et al., 1994), and "movement suppression time-out" (the therapist used the least amount of physical contact necessary to keep the individual motionless while standing in a corner; Rolider & VanHouten, 1985).

In most studies, physical contact was fairly brief (e.g., 30–60 seconds) and implemented in conjunction with other potential punishers (e.g., verbal reprimands, time-out). In fact, time-out from positive reinforcement was a likely component of any physical restraint procedure if access to reinforcing stimuli was unavailable while the individual was restrained. Furthermore, some form of physical contact or restraint was commonly used with many of the punishers described in this section (e.g., overcorrection; aversive smells; time-out). The contribution of this component to the efficacy of other procedures has not been sufficiently explored.

Overcorrection and Other Forms of Contingent Effort

A number of procedural variations of punishment are similar, in that an individual is required to engage in an effortful response as a consequence for problem behavior. This type of punisher has been called *overcorrection* if the contingent response was topographically similar to the problem behavior or related to the problem behavior in some other manner (e.g., considered an appropriate replacement behavior). Developed by Foxx and Azrin (1972), overcorrection consists of two procedural components that are implemented alone or in combination, depending on the nature of the problem behavior. If problem behavior results in some sort of disruption to the physical environment, the individual is required to restore the environment to a state that is even better than its original state (called *restitutional overcorrection*). For example, an individual who turns over a garbage can in the dining room would be required to pick up the garbage can and all of the trash, as well as sweep and mop the entire floor of the room. A second component, called *positive practice overcorrection,* requires the individual repeatedly to practice an appropriate, related behavior. For example, the individual who turns over a garbage can in the dining room would be required repeatedly to place the garbage can gently on the floor. Positive practice alone has been implemented in numerous studies with behavior that does not disrupt the environment, such as stereotypical behavior (e.g., Cipani, Brendlinger, McDowell, & Usher, 1991; Foxx & Azrin, 1973; Rollings, Baumeister, & Baumeister, 1977). One commonly used variation of positive practice is sometimes referred to as *forced movement exercises* (Cooper, Heron, & Heward, 1987; Ollendick, Matson, & Martin, 1978). For example, Foxx and Azrin (1973) reduced head weaving and hand clapping by first interrupting the behavior (e.g., holding the head or hands stationary), then prompting the individual to move the head or hand to one of several positions (e.g., head up, hands

into pockets). Although the length of required practice has varied widely (e.g., from 30 seconds to 2 hours), studies have not obtained a consistent relationship between the duration of overcorrection and treatment effectiveness (e.g., Carey & Bucher, 1983).

The direct and indirect effects of overcorrection are similar to those associated with other contingent effort procedures, despite some claims to the contrary (see MacKenzie-Keating & McDonald, 1990, for a discussion of this issue). Commonly used effort procedures that are not typically classified as overcorrection include contingent demands (i.e., requiring the individual to complete tasks unrelated to the problem behavior; Fischer & Nehs, 1978; Fisher et al., 1993; Watson, 1993), negative practice (i.e., requiring the individual repeatedly to exhibit the problem behavior; Azrin, Nunn, & Frantz, 1980), and contingent exercise (i.e., requiring the individual to perform motor movements unrelated to the problem behavior; Kahng, Abt, & Wilder, 2001; Luce, Delquadri, & Hall, 1980). In Kahng and colleagues (2001), for example, a girl with severe mental retardation was required to touch her toes repeatedly for 30 seconds contingent on self-injury.

Water Mist

Contingent water mist has been used in a relatively small set of studies to decrease destructive behavior in individuals with developmental disabilities (e.g., Arntzen & Werner, 1999; Dorsey et al., 1980; Friman, Cook, & Finney, 1984; Singh, Watson, & Winton, 1986). The therapist generally implemented the procedure by standing in front of the individual with a squeeze-type bottle containing room-temperature water, holding the water bottle at a slant to avoid spraying directly into the individual's eyes, and delivering one mist of water for each instance of the target behavior.

Tastes and Smells

The contingent delivery of an aversive taste (e.g., vinegar, lemon juice) or smell (aromatic ammonia) also has been shown to treat problem behavior successfully. In several studies, for example, a small amount of unsweetened, concentrated lemon juice or vinegar was squirted into the mouth contingent on self-stimulatory behavior (Cipani et al., 1991; Friman et al., 1984), chronic rumination (Sajwaj, Libet, & Agras, 1974), public masturbation (Cook, Altman, Shaw, & Blaylock, 1978), and pica (Paisey & Whitney, 1989). To apply aromatic ammonia (i.e., smelling salts) contingent on problem behavior, the ammonia capsule was broken and held under the individual's nose for a specified period of time. This treatment has been used to treat SIB (Altman, Haavik, & Cook, 1978; Singh, Dawson, & Gregory, 1980a; Tanner & Zeiler, 1975), aggression (Doke, Wolery, & Sumberc, 1983), and breath holding and hyperventilation (Singh, 1979; Singh, Dawson, & Gregory, 1980b). The clinical use of other types of aromatics has not been reported in the literature.

Noise

The contingent presentation of noise has been used as a punisher for finger and thumb sucking (Stricker, Miltenberger, Garlinghouse, Deaver, & Anderson, 2001; Stricker, Miltenberger, Garlinghouse, & Tulloch, 2003), hair pulling (Rapp, Miltenberger, & Long, 1998), and auditory hallucinations (Fonagy & Slade, 1982). In Stricker and colleagues (2001), for example, participants wore a device consisting of two transmitters that automatically detected movement of the hand toward the mouth and then produced a 65-decibel tone. Thumb sucking was reduced to near-zero levels in the two children. Although the authors attributed the findings to an increase in the children's awareness of thumb sucking, the tone may have functioned as a punishing stimulus. Results of a subsequent study with the same device were consistent with a punishment interpretation because a 90-decibel tone was necessary to reduce the child's finger sucking (Stricker et al., 2003).

Shock

Considered the most intrusive and controversial of the punishment procedures, contingent electric shock has been shown to produce rapid and durable reductions in severe self-injury (Duker & Seys, 1996; Linscheid, Iwata, Ricketts, Williams, & Griffin, 1990; Salvy, Mulick, Butter, Bartlett, & Linscheid,

2004) and aggression (Ball, Sibbach, Jones, Steele, & Frazier, 1975; Foxx, 2003). In recent studies, brief electric shock of moderate intensity (e.g., 84 volts) was delivered to the individual's extremity (e.g., leg) via electrodes activated by a movement detection device (e.g., the Self-Injurious Behavior Inhibiting System; Linscheid et al., 1990) or remotely by a caregiver or therapist. Research findings indicate that shock does not increase the risk of undesirable side effects, and it can be a safe alternative to other punishment procedures (e.g., Linscheid, Pejeau, Cohen, & Footo-Lenz, 1994).

Negative (Type 2) Punishment Procedures

Time-Out from Positive Reinforcement

Time-out, one of the most common forms of punishment, refers to the contingent loss of access to positive reinforcers or withdrawal of the opportunity to earn positive reinforcers for a period of time. The removal of reinforcement typically has been accomplished by moving the individual to a less reinforcing environment, such as a barren room, partitioned area, or corner (*exclusionary* or *seclusionary time-out*) or by discontinuing reinforcement in the current environment (*nonexclusionary time-out*). In Toole, Bowman, Thomason, Hagopian, and Rush (2003), for example, exclusionary time-out was used to treat severe aggression in a 15-year-old girl with intellectual disabilities. The participant had access to a variety of highly preferred items and activities throughout the day. Following each instance of aggression, a therapist using the least amount of physical assistance necessary guided her to a padded treatment room. The participant was required to stay in the room for 5 minutes. Although a wide range of time-out durations has been examined (e.g., 15 seconds to 30 minutes), research on the relationship between this parameter and treatment efficacy has not produced consistent outcomes (see Matson & DiLorenzo, 1984, for a review).

Numerous procedural variations of nonexclusionary time-out have been developed to restrict access to reinforcement, without removing the individual from the immediate environment. These variations include the visual screen (a hand, mask, or cloth was placed over the individual's eyes; Rush, Crockett, & Hagopian, 2001; Singh et al., 1986), the "time-out ribbon" (a ribbon worn by the individual was removed contingent on problem behavior, during which time reinforcement was unavailable; Foxx & Shapiro, 1978; Salend & Gordon, 1987), "contingent observation" (the individual was required to remain in a location near the reinforcing environment; Poterfield, Herbert-Jackson, & Risely, 1976), and the removal of specific items (ongoing sources of stimulation [e.g., music, leisure materials] were terminated; Falcomata, Roane, Hovanetz, Kettering & Keeney; 2004; Keeney, Fisher, Adelinis, & Wilder, 2000; Ritschl, Mongrella, & Presbie, 1972). In Falcomata and colleagues (2004), for example, continuous access to a radio was removed for 5 seconds contingent on inappropriate vocalizations. This latter form of time-out has been referred to as *response cost* in some studies. However, procedures that result in the time-based loss of reinforcers are typically classified as time-out. In contrast, reinforcers lost as part of response cost (e.g., tokens; access to music) are not returned to the individual based on the passage of time, but they may be earned for appropriate behavior.

As noted previously, some type of physical restraint is frequently combined with exclusionary and nonexclusionary time-out. For example, an individual may be restrained via a basketthold or physically guided to remain in a prescribed stance while sitting or standing in the corner of a room (e.g., Fisher, Piazza, Bowman, Hagopian, et al., 1994; Matson & Keyes, 1990; Rolider & Van Houten, 1985). The contribution of potentially aversive aspects of physical contact to the efficacy of these procedures has not been examined.

Response Cost

Numerous studies have shown that the contingent removal of a specific amount of reinforcement (e.g., tokens) can function as an effective punisher. Typically, the reinforcers lost are those already in the individual's possession, having been obtained via appropriate behavior (e.g., differential reinforcement of alternative behavior) or independently of behavior (e.g., noncontingent reinforcement). Much of the research on response cost has

been conducted within the context of token economy systems (e.g., LeBlanc, Hagopian, & Maglieri, 2000; Truchlicka, McLaughlin, & Swain, 1998). However, various others forms of reinforcement have been lost via response cost, including books and audiotapes (Kahng, Tarbox, & Wilke, 2001), money (Epstein & Masek, 1978; Long, Miltenberger, Ellingson, & Ott, 1999), and participation in tournaments (e.g., Allen, 1998). In Kahng, Tarbox, and colleagues (2001), for example, a young boy who engaged in food refusal was given access to highly preferred items (e.g., books and videotapes). The items were removed if he refused to take a bite of food or engaged in problem behavior, and they were returned contingent on accepting a bite. Surprisingly little research has been conducted on methods for determining the most appropriate amount and type of reinforcers to remove as part of treatment with response cost.

Selecting Punishment Procedures

Although numerous punishers have been evaluated for clinical use, efficient approaches for prescribing specific punishment procedures have received less attention in the literature. Ethical guidelines mandate that priority should be given to the least restrictive procedure that is clinically effective (e.g., Behavior Analysis Certification Board, 2004; Van Houten et al., 1988). Inherent in this approach to treatment selection is the need to arrange punishment procedures hierarchically based on the degree of restrictiveness (i.e., how much the procedure limits individual's freedom or intrudes into an individual life in some manner) or aversiveness (i.e., how much the procedure produces discomfort, pain, or distress). Nonexclusionary time-out and response cost typically are considered the least restrictive of the procedures, followed by exclusionary time-out, overcorrection, and other physical punishers. This hierarchical arrangement, sometimes referred to as a *levels system*, is used to guide treatment selection and evaluation. Case illustrations and guidelines for identifying effective punishment procedures based on this approach can be found in a variety of articles and books (e.g., Alberto & Troutman, 2006; Barton, Brulle, & Repp, 1983; Cooper et al., 1987; Foxx, 1982; Gaylord-Ross, Weeks, & Lipner, 1980; Gross, Wright, & Drabman, 1981; Lovaas & Favell, 1987; Repp & Deitz, 1978). Some states also have adopted policies that explicitly categorize procedures based on level of restrictiveness (Spreat & Lipinski, 1986).

Nonetheless, an attempt to apply the least restrictive treatment model may itself raise ethical concerns. When using a hierarchical system to guide treatment, clinicians typically evaluate punishment procedures on a trial basis, starting with the least restrictive procedure that may be effective, and moving to more restrictive procedures, until an effective intervention is identified. To illustrate, caregivers may initially evaluate a 5-minute time-out procedure to reduce a child's disruption because the efficacy of this treatment approach has been reported in the literature (e.g., Clark, Rowbury, Baer, & Baer, 1973). If this intervention does not reduce the child's negative behavior, the duration of the time-out may be increased. Caregivers may then implement a more restrictive procedure, such as overcorrection, upon determining that the lengthier time-out is ineffective. Further evaluations with increasingly more restrictive procedures (e.g., restraint) may then ensue until caregivers obtain a clinically important decrease in negative behavior.

This process can be fairly time-consuming, delay the onset of treatment, and result in prolonged exposure to multiple intrusive interventions. The assumption that a more restrictive procedure has a greater likelihood of success than a less restrictive procedure also has no empirical support. With emphasis on the topography of an intervention rather than its function, the hierarchical approach ignores the possibility that a fairly intrusive procedure might function as punisher for some people but as a reinforcer for others (e.g., water mist; Fisher, Bowman, Kurtz, et al., 1994). In fact, the arrangement of procedures based on level of intrusiveness is fairly subjective. Of particular concern is the chance that exposure to progressively more intrusive interventions could promote habituation to putative punishers, decreasing the effectiveness of punishment (see further discussion below). Finally, a variety of additional factors should be considered when selecting a punishment procedure, including

the immediacy of effects, relevance to behavioral function, severity of the behavior, and caregivers' willingness to use the procedure (Iwata, Vollmer, & Zarcone, 1990; Van Houten et al., 1988; Vollmer & Iwata, 1993).

Assessment methodologies that reliably predict which treatments are likely to be effective would permit clinicians to select punishment procedures on the basis of other concerns (e.g., level of restrictiveness, severity of the behavior, caregiver's willingness to implement the procedure), while avoiding the commonly used trial-and-error approach to treatment selection. As discussed in the following sections, several potential assessments have begun to appear in the literature. When combined with a functional analysis, these strategies may provide clinicians with a more reliable, efficient approach for determining the least restrictive procedure that is effective.

Functional Analysis

Knowledge of function is especially important once a decision has been made to include punishment as part of treatment. A number of punishment procedures are uniquely indicated or contraindicated for particular behavioral functions. Punishment also is more effective if combined with extinction and differential reinforcement of alternative behavior (e.g., Azrin & Holz, 1966; Holz, Azrin, & Ayllon, 1963; Rawson & Leitenberg, 1973; Thompson et al., 1999). Thus, whenever possible, any identified functional reinforcers should be withheld for problem behavior and delivered for appropriate behavior.

The comprehensive functional analysis approach described by Iwata and colleagues (1994) has particular utility for identifying viable treatment options when punishment is being considered for clinical use. As described by Betz and Fisher (Chapter 13, this volume), the experimental analysis provides a great deal of precision in identifying multiple functions of problem behavior. Furthermore, although the assessment tests putative reinforcers for problem behavior, results reveal sensitivity (or lack thereof) to consequences that could function as punishers for the behavior. The effects of two commonly used procedural variations of punishment (verbal reprimands and time-out) are evaluated in the "attention" and "demand" conditions of the functional analysis. Thus, close examination of assessment outcomes may indicate whether a particular procedure is likely to be effective, unlikely to be effective, or specifically contraindicated for the target behavior.[1]

For example, three possible outcomes for the attention condition of the functional analysis are illustrated in Figure 21.1. Verbal reprimands and physical contact delivered during this condition may have no effect on behavior, thereby providing a basis for excluding them from consideration as punishment (see upper panel). Alternatively, levels of behavior in the attention condition may be lower than those in the control condition (see middle panel), providing some indication that this consequence would serve as an effective intervention. Finally, results may show that problem behavior is sensitive to attention as a reinforcer (see lower panel). Punishment procedures that typically require a contingent increase in verbal or physical attention, such as blocking, overcorrection, and physical restraint, may be contraindicated for the behavior. On the other hand, punishment procedures associated with a contingent decrease in attention (e.g., time-out) would be specifically indicated (Hagopian et al., 1998).

Similar outcomes for the demand condition are shown in Figure 21.2. The contingent removal of ongoing interaction and instructional materials is directly tested in this condition. If levels of problem behavior are similar to those in the control condition (see upper panel), loss of access to attention or materials (i.e., time-out) may not be particularly effective. On the other hand, treatment with time-out would be a viable option if levels of problem behavior are lower in the demand condition than in the control condition (see middle panel). Results indicating that behavior is sensitive to escape from demands as a reinforcer (bottom panel) also would provide important information about

[1]The punishing effects of these consequences can only be determined if the behavior occurs during the conditions under which they are tested—such that the behavior contacts the contingencies—and levels are lower than those in an appropriate control condition.

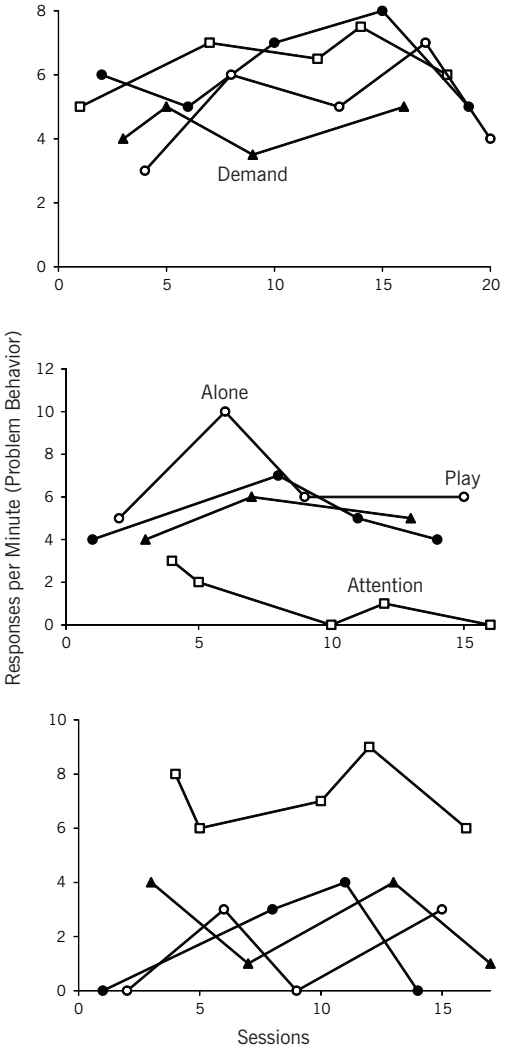


FIGURE 21.1. Three possible outcomes for the attention condition of the functional analysis that would provide important information about potential punishers (see text for further details).

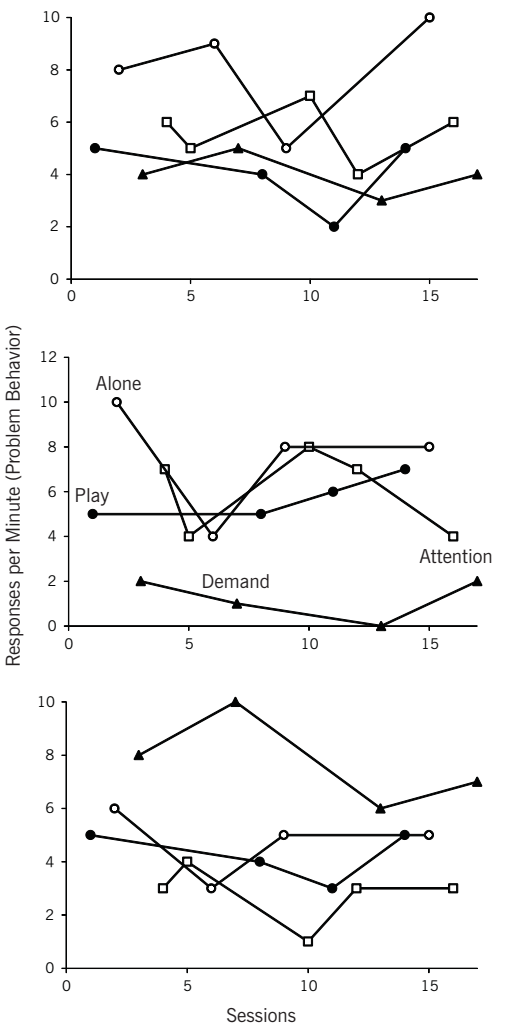


FIGURE 21.2. Three possible outcomes for the demand condition of the functional analysis that would provide important information about potential punishers (see text for further details).

treatment alternatives. Punishment procedures that require the removal or delay of demands, such as time-out, physical restraint, or protective equipment, would be contraindicated (Magee & Ellis, 2001). Procedures that involve a contingent increase in demands, such as additional work, exercise, and overcorrection, might be especially indicated for behavior maintained by escape (Hagopian et al., 1998).

The relationship between the various punishment procedures described in the previous section and each behavioral function is summarized in Table 21.1. However, further research is needed to test these predictions. For example, basic research findings suggest that using contingent demands for behavior maintained by escape from demands may be counterproductive (i.e., occasion the behavior being punished; see Iwata, 1987).

Although results of the functional analysis may help to narrow the list of viable treatment options, additional assessments typically are warranted to identify the most

TABLE 21.1. Predicted Effectiveness of Punishment Procedures in Relation to Behavioral Function

	Maintaining reinforcer			
Punisher	Attention	Tangibles	Escape	Automatic
Verbal reprimand	Contraindicated	—	—	—
Response blocking/ physical restraint	Contraindicated	Indicated	Contraindicated	Indicated
Overcorrection/ contingent effort	Contraindicated	—	Indicated	—
Water mist	—	—	—	—
Aversive taste/smell	—	—	—	—
Shock	—	—	—	—
Time-out	Indicated	Indicated	Contraindicated	Contraindicated
Response cost	—	Indicated	—	—

Note. Dashes indicate that the procedure is neither indicated nor contraindicated.

appropriate, effective intervention. Some approaches that have been examined in applied research are described in the following sections. However, further research is needed on the predictive validity and clinical utility of these assessments.

Stimulus Avoidance Assessment

An efficient approach for identifying potential punishers has been described by Fisher and colleagues (Fisher, Piazza, Bowman, Hagopian, et al., 1994; Fisher, Piazza, Bowman, Kurtz, et al., 1994). They evaluated participants' responses to various punishment procedures using a methodology similar to that developed by Pace, Ivancic, Edwards, Iwata, and Page (1985) for identifying potential reinforcers. In Fisher, Piazza, Bowman, Kurtz, and colleagues (1994), water mist and procedural variations of time-out, restraint, and contingent effort were included in the evaluation. Each punisher was presented independently of responding for 15–180 seconds across 10 trials, with a buzzer preceding the onset of each trial to decrease the likelihood of superstitious conditioning. Avoidance responses (e.g., dropping to the floor), negative vocalizations (e.g., crying), and positive vocalizations (e.g., laughing) were measured during these brief exposures. Procedures associated with the highest rates of avoidance responses and negative vocalizations were considered most likely to function as punishers. The clinical efficacy of procedures with low, medium, and high levels of these responses was subsequently compared in a multielement design for each participant. The assessment had good predictive validity. This methodology may be useful for assessing other types of procedures (e.g., withdrawal of preferred items), as well as certain parameters of punishment (e.g., magnitude).

An advantage of this approach is the ability to evaluate empirically multiple potential punishers in a short period of time. Information obtained from this assessment can be combined with other important considerations (level of restrictiveness, caregiver preference) to prescribe the most appropriate treatment. In Fisher, Piazza, Bowman, Hagopian, and Langdon (1994), for example, caregivers were asked to rate each of nine potential punishers as acceptable or unacceptable. Those rated as unacceptable were excluded from the stimulus avoidance assessment. Furthermore, ease of implementation was evaluated for each procedure by measuring escape responses during the avoidance assessment (i.e., the number of times the participant successfully prevented implementation). These data may indicate (1) whether a high level of treatment integrity would be possible if caregivers were to implement the punisher in the participant's natural environment, and (2) whether caregivers would find the procedure acceptable for clinical use. Both factors are important to consider when selecting treatments.

Brief Punisher Assessment

Brief punisher assessments in conjunction with or instead of avoidance assessments have been useful for identifying effective interventions. One or more potential punishers are evaluated during brief sessions to predict the effectiveness of the procedure(s) when implemented over lengthier time periods. For example, in the studies by Fisher and colleagues (Fisher, Piazza, Bowman, Hagopian, et al., 1994; Fisher, Piazza, Bowman, Kurtz, et al., 1994) described previously, the effects of three punishment procedures on problem behavior were compared by implementing each procedure during three to six 10-minute sessions, alternated in a multielement design. The assessment was shown to have good predictive validity when the punisher associated with the lowest levels of problem behavior was evaluated throughout the day as a part of a treatment package.

Thompson and colleagues (1999) briefly evaluated the effects of several procedures on self-injurious behavior (SIB) via AB designs. The least restrictive procedure that was associated with a 75% or greater reduction in SIB was selected for an extended treatment evaluation, during which punishment with and without reinforcement was compared. Punishment alone was effective in reducing self-injury below baseline levels for three of four participants, providing some support for the predictive validity of the brief assessment. However, because the brief assessment was not the focus of the investigation, the authors provided few procedural details (e.g., number and length of sessions; range of punishers evaluated).

Like the stimulus avoidance assessment, brief punisher assessments provide information about the potential efficacy of multiple punishment procedures in an efficient manner. Other measures relevant to treatment selection, such as the immediacy of effects, ease of implementation, and potential for side effects, also could be obtained while conducting the assessment.

Activity Assessment

Another potential strategy for identifying effective punishers, based on work described by Terhune and Premack (1970; 1974) and Allison and Timberlake (1974), has been examined in a few studies. Baseline observations were conducted to determine the relative amount of time an individual engaged in various, freely available activities. In some studies, an activity associated with a low probability of engagement was predicted to function as a punisher. A contingency then was arranged such that engagement with the low-probability activity was required following instances of the targeted (high probability) behavior. In Krivacek and Powell (1978), for example, three students with severe mental retardation were required to engage in low-probability activities (running, tracing letters, and playing with a ball) contingent on problem behavior. The low-probability activities were selected by teachers as those in which the participants rarely engaged spontaneously. Although problem behavior decreased during treatment, time spent in the low-probably activity was not removed from the total session time when reporting the results. As such, the findings are difficult to interpret because participants had less opportunity to engage in the target behavior during treatment than during baseline.

In other studies (Dougher, 1983; Holburn & Dougher, 1986; Realon & Konarski, 1993), any activity was predicted to function as a punisher if, as a result of the contingency arrangement, the individual was required to engage in the activity at higher than desired levels (i.e., above those occurring in the absence of the contingency). Called *response satiation,* this approach to treatment selection suggests that even activities with similar or high levels of engagement relative to the target behavior can function as punishers. In Realon and Konarski, for example, two participants with developmental disabilities were required to manipulate leisure materials for 5–15 seconds contingent on each occurrence of self-injury. The duration of punishment was selected by examining baseline levels of self-injury and item manipulation. During a control condition, 1 second of item manipulation was required for each occurrence of self-injury, a contingency that did not establish response satiation. Although treatment was only effective when the contingency produced response satiation, the physical contact needed to ensure that participants manipulated the items for the required amount of time may have functioned as punishment. Thus, the analy-

sis of response satiation was confounded by differences in the duration of physical contact. However, other studies suggest that response satiation may be a viable method for identifying and arranging punishment contingencies (e.g., Dougher, 1983; Holburn & Dougher, 1986).

Although further research is needed, activity assessments are appealing because they broaden the range of potential punishers available for clinical use. More specifically, this approach increases the likelihood of successful treatment with procedures based on contingent effort. Caregivers may find these procedures more acceptable than other types of punishers, especially if the contingent response is appropriate and functional.

Choice Assessments

Additional assessments of caregiver or client preference could be used to guide treatment selection when multiple effective punishers are available. Caregiver preference could be assessed by obtaining verbal report or ratings of acceptability (opinions about the appropriateness of each procedure, willingness to implement each procedure, etc.) or by asking caregivers to choose among the available treatments. Surprisingly few studies have evaluated the acceptability of treatments after they have been implemented by caregivers or staff in the natural environment (Armstrong, Ehrhardt, Cool, & Poling, 1997; see Mueller, Edwards, & Trahant, 2003, for a notable exception). Research findings suggest that acceptability ratings are influenced by a variety of factors, including knowledge of or prior experience with the treatment; intrusiveness of the procedure, procedural complexity or ease of use; number of previously unsuccessful attempts to treat the behavior; and client characteristics, such as age and problem severity (for reviews, see Foxx, McHenry, & Bremer, 1996; Lennox & Miltenberger, 1990; O'Brien & Karsh, 1990). Thus, it may be highly beneficial for caregivers to implement each procedure during brief punisher assessments before rating the acceptability of the punishers or choosing the treatment.

Preferences of the individual whose behavior is targeted for reduction also may be considered when selecting an intervention. A method for assessing treatment preferences of individuals with limited expressive communication skills has been evaluated in two studies (Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997; Hanley et al., 2005). Individuals with developmental disabilities were given opportunities to choose among three different treatments by activating one of three switches paired with each procedure. In Hanley and colleagues (2005), for example, two children chose between differential reinforcement alone, differential reinforcement plus punishment, and punishment alone. Interestingly, both children showed a clear preference for differential reinforcement plus punishment by allocating the majority of responding to the switch associated with this procedure.

Using Punishment Effectively

Research findings indicate that punishment can be highly effective for treating a variety of behavior disorders. Punishment also has been shown to be more effective than treatment with reinforcement or extinction (e.g., Barrett, Matson, Shapiro, & Ollendick, 1981; Grace, Kahng, & Fisher, 1994; Hagopian et al., 1998; Wacker et al., 1990). However, the relative efficacy of extinction, reinforcement, and punishment may be difficult to predict in application because various factors related to the use of these procedures can influence clinical outcomes.

In fact, results of basic research suggest that the manner in which punishment is commonly implemented in applied settings can undermine treatment effectiveness. Punishment may not produce immediate, substantial, or sustained reductions in problem behavior if the consequence is delayed, intermittent, relatively mild, paired with reinforcement for problem behavior or preceded by exposure to a less intense form or type of punisher, or if punishment results in an overall reduction in the amount of reinforcement received (see Lerman & Vorndran, 2002, for a review). Punishment also may be associated with a variety of undesirable side effects. A brief overview of factors related to the use of punishment is provided below, along with a discussion of current applied findings on strategies for using punishment effectively.

Contiguity of the Punisher

In most applied studies on punishment, the consequence was delivered immediately following instances of problem behavior. Such contiguity was probably critical to treatment effectiveness, although few applied studies have directly compared the effects of immediate to delayed punishment. In a notable exception, Abramowitz and O'Leary (1990) found that verbal reprimands were more effective in decreasing off-task behavior in schoolchildren when the reprimand was delivered immediately following the onset of the behavior rather than after the behavior had occurred continuously for 2 minutes. Basic studies with humans and nonhumans indicate that punishment procedures can fail to suppress responding when the consequence is delayed by just 10–30 seconds (e.g., Banks & Vogel-Sprott, 1965; Goodall, 1984; Trenholme & Baron, 1975). When a punisher is delayed, other responses or multiple occurrences of the targeted behavior are likely to intervene before the consequence is delivered, weakening the contingency between the response and its consequence.

Nonetheless, delayed punishment has been shown to be effective in some applied studies (e.g., Azrin & Powers, 1975; Maglieri et al., 2000; Van Houten & Rolider, 1988). Maglieri and colleagues (2000) used delayed verbal reprimands to reduce the consumption of prohibited food items by a girl with Prader–Willi syndrome. Consumption decreased to zero levels when the therapist weighed the food at the end of each 10-minute session and delivered a verbal reprimand for any food consumption. Procedural components that may have been responsible for the efficacy of the delayed punisher (e.g., therapist instructions; recent history with immediate punishment) were not examined further. Results of two studies (Rolider & Van Houten, 1985; Van Houten & Rolider, 1988) suggest that delayed punishment may be effective if the consequence is paired with stimuli associated with engaging in the behavior. Contingent on earlier instances of the target behavior, participants were required to engage in the response (aggression, theft) or listen to audiotape recordings of their behavior (disruption). A therapist or caregiver then immediately delivered the punisher (verbal reprimands, physical restraint). Both procedures were highly effective in treating problem behavior. Although the effect of the delayed punisher alone was not evaluated for most of the participants, this approach may have helped prevent the adventitious punishment of any untargeted responses that occurred prior to the consequence. Products of the behavior also may have acquired conditioned aversive properties as a result of this pairing procedure.

Other stimuli that might help to bridge the interval between a response and its consequence (e.g., instructions, conditioned punishers; Trenholme & Baron, 1975) should be evaluated further in applied research.

Schedule of Punishment

Results of basic and applied studies suggest that punishment is more likely to be effective if punisher delivery is contingent on each occurrence of the target behavior rather than intermittently (e.g., Azrin, Holz, & Hake, 1963; Calhoun & Matherne, 1975; Lerman et al., 1997; Thomas, 1968). Nonetheless, intermittent schedules of punishment have successfully treated problem behavior in a number of applied studies (e.g., Barton et al., 1987; Cipani et al., 1991; Clark et al., 1973; Romanczyk, 1977). A variety of schedules have been used, including variable-ratio (VR), fixed-interval (FI), and the differential punishment of high response rates (DPH). For example, a VR 4 schedule of time-out was just as effective in treating disruption as a continuous schedule in Clark and colleagues (1973). The generality of applied findings on intermittent punishment was unclear, however, because punishment appeared to be confounded with extinction or other potential punishers (e.g., verbal reprimands) in the majority of studies.

Punishing every instance of behavior may often be impractical, especially if the rate of responding is relatively high. However, it may be possible to thin the schedule of punishment gradually after obtaining clinically significant reductions in behavior under a continuous schedule (e.g., Barton et al., 1987; Lerman et al., 1997). In Lerman and colleagues (1997), for example, the schedule of punishment with time-out or restraint was successfully thinned from FR 1 to FI 300 seconds for two participants who engaged in self-injury maintained by automat-

ic reinforcement. Nevertheless, the schedule could not be increased beyond FR 1 for two other participants, limiting the generality of the findings. Further research is needed on strategies for improving the effectiveness of intermittent punishment.

Magnitude of the Punisher

Basic research conducted primarily with electric shock indicates that a greater amount or intensity of punishment produces larger reductions in behavior as long as the magnitude is not gradually increased over time (e.g., Cohen, 1968; Terris & Barnes, 1969). The intensity or duration of punishment has been shown to influence treatment efficacy in some applied studies (e.g., Hobbs, Forehand, Murray, 1978; Richman et al., 2001; Stricker et al., 2003; Williams, Kirkpatrick-Sanchez, & Iwata, 1993). Richman and colleagues (2001), for example, obtained a positive relationship between the volume of verbal reprimands and reductions in breath holding exhibited by a teenager with mental retardation. In Williams and colleagues (1993), a high-intensity shock (18.5 mA [milliamp]) was more effective in treating self-injurious behavior than a low-intensity shock (3.5 mA). Nonetheless, contrary to basic findings on magnitude, results of applied research have been markedly inconsistent. Lengthier durations of time-out, overcorrection, and restraint have not reliably produced greater reductions in problem behavior than shorter durations (e.g., Cole, Montgomery, Wilson, & Milan, 2000; Singh, Dawson, & Manning, 1981).

Thus, enlarging the magnitude of an ineffective punisher may have limited clinical utility, and may even promote resistance to punishment (e.g., Cohen, 1968; Terris & Barnes, 1969). Lengthier durations of punishment per se also may lead to habituation. For these reasons, preference should be given to punishers that are effective when presented briefly and to magnitude values within the range of those reported in applied studies.

Availability of Alternative Sources of Reinforcement

Basic and applied research also indicate that punishment is more effective if alternative sources of reinforcement are readily available for engaging in other responses (Holz et al., 1963; Rawson & Leitenberg, 1973; Thompson et al., 1999). Thompson and colleagues (1999), for example, found that levels of self-injury maintained by automatic reinforcement were much lower when punishment was combined with reinforcement of an alternative behavior (toy manipulation) than when either punishment or reinforcement was implemented alone. An increase in deprivation for the reinforcer maintaining the punished behavior has been shown to reduce the effectiveness of punishment in basic studies (e.g., Azrin et al., 1963). Basic findings further suggest that the total amount of reinforcement obtained from other sources should meet or exceed that obtained prior to punishment (i.e., when the individual could freely engage in the unpunished response; Fantino, 1973). As such, punishment may be most effective when the maintaining reinforcer(s) for problem behavior or reinforcers that are highly substitutable for the functional reinforcer(s) can be obtained through a variety of sources (e.g., both contingent on and independent of responding).

Reinforcement of the Punished Response

A number of applied studies have shown that punishment can be highly effective in the absence of extinction (e.g., Fisher, Piazza, Bowman, Hagopian, et al., 1994; Keeney et al., 2000; Lerman et al., 1997; Thompson et al., 1999). In fact, punishment is more likely to be used when the reinforcer maintaining behavior is unknown or cannot be controlled. Nonetheless, basic research indicates that punishment is more effective if reinforcement for the target behavior is withheld or delivered infrequently rather than following most instances of the behavior (Azrin & Holz, 1966). The punisher may even acquire discriminative or conditioned reinforcing properties if a behavior consistently produces both punishment and reinforcement under certain conditions (e.g., Holz & Azrin, 1961). Thus, whenever possible, punishment should be combined with extinction or other procedures designed to reduce the amount of reinforcement available for the punished response (see Vollmer & Athens, Chapter 19, this volume).

Antecedent Control of the Punished Response

Establishing discriminative control over the punished response by pairing the pres-

ence of a particular stimulus with punishment for engaging in the behavior has been shown to enhance treatment effectiveness in at least three applied studies (e.g., Maglieri et al., 2000; McKenzie, Smith, Simmons, & Soderlund, 2008; Piazza, Hanley, & Fisher, 1996). In these studies, the punisher was delayed or omitted while researchers evaluated the effects of the antecedent. As described previously, Maglieri and colleagues (2000) decreased the food stealing of an individual with Prader–Willi syndrome by delivering a verbal reprimand at the end of each 10-minute session during which consumption occurred. The experimenters then established as a discriminative stimulus an orange sticker placed on a container of the prohibited food by reprimanding the consumption of foods from this container and by providing no consequences for consumption of foods from the unlabeled container. As expected, food from the unlabeled container was consumed. However, food stealing immediately decreased to zero when the sticker was placed on both containers and on a refrigerator in the kitchen in a later phase. In Piazza and colleagues (1996), a man with developmental disabilities who engaged in cigarette pica was exposed to discrimination training with two different colored cards. Pica was punished with response interruption in the presence of a purple card but not in the presence of a yellow card. No pica occurred in the presence of the purple card when stimulus control was subsequently evaluated in the absence of the punishment contingency. Finally, McKenzie and colleagues (2008) delivered reprimands for eye poking when a participant with profound mental retardation wore wristbands and withheld punishment when the participant did not wear the wristbands. Subsequently, the participant did not engage in eye poking when she wore the wristbands in other settings, even though the experimenters provided no consequences for the behavior. Further research is needed to evaluate the long-term effectiveness of antecedent control techniques.

Use of Conditioned Punishers

The effectiveness of intermittent, mild, or delayed punishers may be enhanced by establishing and using conditioned aversive stimuli as part of treatment. Results of basic and applied studies indicate that stimuli that are neutral or ineffective as punishers may function as punishers themselves after being associated with punishing stimuli (e.g., Dixon, Helsel, Rojahn, Cipolone, & Lubetsky, 1989; Dorsey et al., 1980; Hake & Azrin, 1965; Salvy et al., 2004; Vorndran & Lerman, 2006). For example, in several applied studies, a verbal reprimand alone was effective in suppressing problem behavior after the word *no* was paired with an effective punisher (i.e., shock or water mist) contingent on responding (e.g., Dorsey et al., 1980; Lovaas & Simmons, 1969). Establishing and using conditioned punishers may be especially beneficial when the primary (unconditioned) punisher is periodically withheld or delayed. Furthermore, conditioning may permit caregivers to maintain treatment effects with less intrusive procedures as long as the conditioned punisher is occasionally paired with the original punisher (e.g., Vorndran & Lerman, 2006). However, further research is needed on the long-term maintenance of treatment with conditioned punishment.

Maintenance of Punishment Effects

The long-term efficacy of punishment with electric shock, overcorrection, water mist, verbal reprimands, and physical restraint, among others, has been reported in a number of applied studies (e.g., Altman et al., 1978; Arntzen & Werner, 1999; Kazdin, 1971; Richman et al., 2001; Rolider, Williams, Cummings, & Van Houten, 1991; Salvy et al., 2004; Zegiob, Jenkins, Becker, & Bristow, 1976). Typically, data were collected from 6 to 12 months after the initial application of punishment, during which time the original treatment was continued as is, faded, or withdrawn altogether. Successful clinical outcomes also have been reported across lengthier periods of time (i.e., from several years to 25 years after treatment; Duker & Seys, 1996; Foxx, Bittle, & Faw, 1989; Foxx & Livesay, 1984; McGlynn & Locke, 1997). However, the reliability and validity of longer-term outcomes are less clear due to a reliance on anecdotal information, archival records, indirect measures of treatment outcome, and circumscribed observations.

Despite numerous examples of long-term maintenance, the reemergence of problem behavior during and following the with-

drawal of treatment also has been reported (e.g., Arntzen & Werner, 1999; Duker & Seys, 1996; Williams et al., 1993). For example, Ricketts, Goza, and Matese (1993) and Williams and colleagues (1993) reported relapses in treatment with contingent electric shock 6 months and 31 months, respectively, after the initiation of treatment. In fact, the likelihood that treatment with punishment will produce long-term effects cannot be determined by examining the literature because treatment failures generally are not submitted or accepted for publication. More important, few studies have directly evaluated strategies that might promote successful maintenance.

Nonetheless, factors associated with specific cases of successful and unsuccessful maintenance may suggest some potential approaches for ensuring that punishment effects maintain over the long run. Relapses have been attributed to habituation or tolerance to the punisher, problems with treatment consistency or integrity, restricted opportunities to receive reinforcement for appropriate behavior, and continued reinforcement of the punished behavior (e.g., Duker & Seys, 1996; Foxx & Livesay, 1984; Ricketts et al., 1993). Habituation to the punisher may be less likely to occur with limited or infrequent exposure to the punishing stimulus. Using brief punishers that are highly effective in reducing problem behavior or randomly alternating among several effective punishers (e.g., Charlop, Burigo, Iwata, & Ivancic, 1988; Toole et al., 2004) restricts an individual's contact with the punishing stimulus. Ensuring that caregivers continue to implement the treatment correctly and consistently, combining punishment with dense schedules of alternative reinforcement, and removing or reducing reinforcement for problem behavior also should increase the likelihood of successful maintenance (e.g., Foxx, 2003; Foxx & Livesay, 1984; Linscheid, Hartel, & Cooley, 1993).

A fairly complex or labor-intensive intervention may be difficult for staff or caregivers to sustain over time, possibly leading to treatment relapse. Nevertheless, fading or modifying components of the original program to simplify implementation may decrease the effectiveness of the treatment. A systematic approach for successfully fading punishment has been demonstrated in several studies by Foxx and colleagues (see Foxx, 2003, for a review). In Foxx and colleagues (1989) for example, severe aggression exhibited by a man with a dual diagnosis was successfully treated across 52 months. The initial treatment consisted of punishment with contingent electric shock, escape extinction, and reinforcement of compliance. As part of the maintenance program, contingent electric shock was replaced with a nonexclusionary time-out procedure by first combining the two punishers, then discontinuing the shock after 12 months. Shock was only withdrawn after the participant had been responding regularly to positive reinforcers in his home and work settings. Over the next 30 months, the duration of time-out was gradually decreased from 3 hours to 15 minutes while aggression remained low. The authors noted that the time-out procedure had been ineffective prior to treatment with contingent electric shock. These results suggest that a gradual, highly systematic plan for fading treatment is a key component of long-term maintenance.

Stimulus Generalization of Punishment Effects

Unlike the research on maintenance, punishment effects have rarely been reported to generalize beyond the treatment setting or context (e.g., Doke & Epstein, 1975; Lovaas & Simmons, 1969; Marholin & Townsend, 1978; Rollings et al., 1977). Reductions in problem behavior typically failed to occur in contexts not associated with punishment, despite attempts to promote such transfer (e.g., Birnbrauer, 1968; Corte, Wolf, & Locke, 1971; Tate & Baroff, 1966). Generalization also has been difficult to obtain in basic studies with humans (e.g., O'Donnell & Crosbie, 1998; O'Donnell, Crosbie, Williams, & Saunders, 2000).

However, there have been surprisingly few studies in this area. Further research is needed on strategies to promote generalization because caregivers often are unable to monitor behavior closely or implement treatment across all relevant settings and situations. Problem behavior is likely to emerge whenever the punisher is withheld, especially if the behavior continues to produce reinforcement. Current knowledge about generalization suggests that punishment effects may be more likely to transfer to contexts

that closely resemble the treatment setting or situation (e.g., Guttman & Kalish, 1956; Hoffman & Fleshler, 1965; Honig & Slivka, 1964). In fact, the presence of stimuli that have acquired tight control over responding may help to ensure that problem behavior rarely occurs in the absence of the punishment contingency (see Rollings & Baumeister, 1981).

Results of three previously described studies suggest that discriminative control over the punished response can be established by pairing the presence of a stimulus with punishment for engaging in the behavior (Maglieri et al., 2000; McKenzie et al., 2008; Piazza et al., 1996). In these studies, problem behavior did not occur when the discriminative stimulus (a sticker, colored card, or wristbands) was introduced in settings that had never been associated with punishment. Although these findings are promising, further research on the durability of this strategy is needed because generalization was examined across a limited number of sessions.

Finally, generalization may be more likely to occur if the treatment conditions are systematically modified to resemble those in the generalization contexts. For example, the magnitude, schedule, immediacy, or type of punishment could be gradually faded (Foxx et al., 1989), and stimuli from the generalization setting (i.e., people, activities, materials) could be incorporated into the treatment setting prior to testing for generalization.

Indirect Effects of Punishment

The most commonly described disadvantages of punishment include the risk of elicited and operant aggression, other emotional responses (e.g., crying), decreases in appropriate behavior ("generalized response suppression"), escape from or avoidance of the punishing agent or situation, and caregivers' misuse of punishment (e.g., Kazdin, 2001). Although these indirect effects have been reported in the basic and applied literature, there have been few systematic analyses of these clinical problems. Nonetheless, research findings indicate that punishment can be associated with short-lived increases or decreases in unpunished behavior, including both appropriate and inappropriate responses. For example, although several studies have reported increases in aggression or crying during treatment with punishment (e.g., Duker & Seys, 1996; Hagopian & Adelinis, 2001), others studies have shown collateral increases in positive affect or appropriate behavior, such as compliance and toy play (e.g., Koegel, Firestone, Kramme, & Dunlap, 1974; Rolider et al., 1991; Toole et al., 2003). Interestingly, these same response forms also have been reported to decrease under punishment (i.e., aggression and crying: Bitgood et al., 1980; Linscheid et al., 1990; toy play: Lerman, Kelley, Vorndran, & Van Camp, 2003; Thompson et al., 1999). Thus, the likelihood of obtaining indirect effects and the forms they may take may be difficult to predict in application.

Basic findings suggest that aggression and emotional responses may be more likely to occur when the individual is exposed to unavoidable, intense aversive stimulation (e.g., Azrin, Hutchinson, & Hake, 1966; Hunt & Brady, 1995). Collateral changes also may occur among unpunished responses that (1) are functionally equivalent to the punished behavior (e.g., Baker, Woods, Tait, & Gardiner, 1986), (2) occur in the same context as the punished behavior (e.g., Bolles, Holtz, Dunn, & Hill, 1980), or (3) tend immediately to follow the punished behavior (e.g., Dunham, 1977, 1978). Together with some applied findings, this research suggests that increases in aggression and other undesirable indirect effects may be less likely with minimization of exposure to the punishing stimulus (i.e., using brief punishers that are highly effective in suppressing behavior), a combination of punishment with rich schedules of reinforcement for alternative behavior, and ensuring that reinforcement is withheld for functionally equivalent problem behavior.

Conclusion

Numerous procedural variations of punishment have been shown to produce durable reductions in problem behavior, even when the contingencies maintaining the behavior are unknown. Knowledge of behavioral function, however, should increase the likelihood of selecting an effective punisher, obtaining long-term reductions in behavior, and successfully fading treatment. Furthermore, basic and applied findings suggest

that the effectiveness of punishment can be improved by (1) selecting punishers via pretreatment avoidance, choice, or activity assessments; (2) delivering the consequence immediately following each instance of the behavior; (3) ensuring that alternative sources of reinforcement are readily available; (4) establishing discriminative control over the punished response; and (5) developing and using conditioned punishers. Nonetheless, further research is needed on strategies to promote the long-term and generalized effects of punishment in applied settings.

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CHAPTER 22

Token Economies

Kyle W. Boerke and David Reitman

In the late 1950s, Skinner's colleagues and students began to apply their experimental (Ferster & Skinner, 1957) and conceptual (Skinner, 1953) innovations to human behavior. These efforts resulted in a science of human behavior (applied behavior analysis) and the development of contingency management procedures that are still in use today (Ayllon & Azrin, 1968). The token economy is perhaps one of the earliest applications of this science to problems of social significance.

The first token economy systems were developed in the early 1960s. Their development was inspired by a general dissatisfaction with the quality of care provided to individuals in institutionalized settings and a desire to construct environments that would be more conducive to the development and maintenance of adaptive behavior in these individuals (i.e., a "total motivating environment"; Ayllon & Azrin, 1968, p. 24). Ayllon and Azrin (1965) were among the first to report positive results with the use of a token-based reward system. Initially implemented at Anna State Hospital in Illinois with persons with severe impairment (e.g., schizophrenia), Allyon and Azrin showed that the contingent delivery of token reinforcement increased work and self-care behavior, but that noncontingent delivery of tokens or program discontinuation resulted in drastic reductions in adaptive behavior. Ayllon and Azrin's (1968) extended findings were reported in *The Token Economy: A Motivational System for Therapy and Rehabilitation*.

Defining the Token Economy

Token economies are formal descriptions of *contingency relations* (defined here as antecedents, behaviors, and consequences) that are intended to modify or influence behavior through the delivery of conditioned reinforcers. *Antecedents* (i.e., discriminative stimuli or cues) are events preceding a behavior that, when specified as part of a token system, indicate a given behavior should be performed. *Behaviors* are the actions specified in the contingency relation. *Consequences* in the form of "backup" reinforcers should follow the performance of the behavior reliably. Often, the performance of the behavior signals the delivery of both immediate consequences and progress toward long-term, larger incentives.

A key feature of the token economy is the delivery of symbolic or token reinforcers

(e.g., poker chips, points) following the performance of prespecified behavior (Miltenberger, 2001). Most conditioned reinforcers lack inherent value and influence behavior by affording individuals opportunities to exchange them for "backup" reinforcers (e.g., special privileges, edibles, activities). Thus, tokens and conditioned reinforcers are generally considered to "bridge the delay" between delivery of the backup reinforcer and performance of the behavior (Clark, Lachowicz, & Wolf, 1968; Dickerson, Tenhula, & Green-Paden, 2005; Jones, Downing, Latkowski, Ferre, & McMahon, 1992; Kazdin & Bootzin, 1972).

The following elements seem to be common features of well-formulated contingency management programs. First, goals are set, and behaviors are specified in observable terms. Second, potential reinforcers and punishers (if applicable) are identified. Third, target behaviors are monitored frequently, and consequences are delivered consistently. Fourth, the need for flexibility and change is built into the contingency management system. Finally, collaboration between the parties, a written agreement, and formal monitoring processes are other program elements considered necessary to maximize effectiveness (Miltenberger, 2001). The ultimate goal of the token economy system is simultaneously to strengthen adaptive or desirable behavior and decrease maladaptive behavior (Miltenberger, 2001). Once successfully implemented, Stokes and Baer (1977) urged, token reinforcement systems should be faded as rapidly as possible.

Identify and Define Behavior

The first and arguably most important step in implementing a token economy program is identifying and defining behavior objectively. In fact, Ayllon and Azrin (1968) dedicated 28 pages of their groundbreaking text to the topic. It has long been suggested that ambiguous or poorly described behavior promotes misunderstanding and confusion regarding the achievement of program objectives and could fail to cue the consistent delivery of reinforcement for appropriate behavior. A recent paper by Moore, Tingstrom, Doggett, and Carlyon (2001) examined this issue. The authors first analyzed an ineffective token economy at the request of a unit psychiatrist. Their analysis revealed a number of ambiguous target behaviors, such as "following directions," "being nice," and "be where you are supposed to be." The authors also noted that lengthy delays between the delivery and redemption of tokens reduced the effectiveness of the program. The intervention recommended the development of operational definitions for each target behavior. For example, "following directions" was redefined as "making eye contact with the speaker and initiating compliance within 5–7 seconds of the request." In addition, instead of delivering backup reinforcers based on points earned the previous day, days were divided into four blocks, and behavior during any given block determined the level of privileges during the following block. Although this did not result in reductions in problem behavior directly, these relatively straightforward adjustments were sufficient to produce substantial reductions in seclusionary time-out and an increase in points earned for following directions and other target behaviors noted earlier.

Identify Conditioned Reinforcers

Tokens, imitation dollar bills, buttons, stickers, and poker chips have often been employed as conditioned reinforcers (Reynolds & Kelley, 1997). The selection of conditioned reinforcers should be sensitive to the context of implementation. In academic settings, handing a poker chip to a student who is working on an academic task such as writing an essay could disrupt the behavior of interest (Drabman & Tucker, 1974). To reduce potential disruptions associated with the delivery of tokens some researchers have delivered check marks, smiley faces, or stars on a chart when the behavior is observed (Anhalt, McNeil, & Bahl, 1998; Higgins, Williams, & McLaughlin, 2001; McGinnis, Friman, & Carlyon, 1999; Sullivan & O'Leary, 1990). For example, Higgins and colleagues (2001) developed a token economy for a third-grade student with learning disabilities and recorded a "check mark" contingent on appropriate behavior on a piece of paper taped to the top left-hand corner of the student's desk. Thus, the student was able to receive performance feedback without significant experimenter interruption. In another study intended to minimize

the intrusiveness of token delivery, Hupp, Reitman, Northup, O'Callaghan, and LeBlanc (2002) modified Pringles potato chip containers and attached them to clipboards. Tokens were subsequently delivered following the demonstration of the "ready position" during kickball games. A key feature of delivery of the tokens was that participants could hear the token as the token reached the bottom of the cylinder but did not need to divert attention from the game to receive or retain the token.

Choice of conditioned reinforcers may also be influenced by presence or absence of response cost, which is an important consideration, since many token programs appear to include such a contingency (see Musser, Bray, Kehle, & Jenson, 2001). In cases where response cost is employed, it may be wise to use conditioned reinforcers that can be removed with maximum efficiency because conflict may ensue when tokens are removed. Practically speaking, it may be easier to erase a point from a blackboard, flip a card, or take a chip out of a container than to remove a token from a client's hand or pocket. As one example of such a practice, Salend and Allen (1985) used 1-inch by 3-inch strips of paper taped to the top second graders' desks in a study evaluating the difference between externally managed and self-managed response cost systems. During the externally managed condition, the strips of paper were removed by the teacher contingent on the performance of inappropriate behavior.

Although the empirical merits of verbal praise and its role in facilitating the fading of the use of conditioned reinforcers is unknown, most authors recommend its use in conjunction with conditioned reinforcers (Alberto & Troutman, 2006; Drabman & Lahey, 1974; Drabman & Tucker, 1974; Kirby & Shields, 1972; Paul & Lentz, 1977). Finally, the selection of a conditioned reinforcer may be based on safety or health issues because small tokens may be swallowed, and tokens that circulate may potentially facilitate the spread of illness.

Identify Backup Reinforcers

Backup reinforcers are items, activities, or privileges that the individual can exchange for conditioned reinforcers (Kazdin, 2001). There are several considerations in their selection. First, backup reinforcers should have established reinforcing properties. One common method of identifying backup reinforcers is to ask the target individual about preferred consequences. However, some have questioned the validity of verbal assessment methods (Northup, 2000). Furthermore, verbal assessments are not always feasible for the population being served. For instance, when working with individuals with profound disabilities, the *single-stimulus preference procedure* (a reinforcer preference assessment that measures participant approach behavior to individually presented stimuli; Pace, Ivancic, Edwards, Iwata, & Page, 1985) or stimulus choice methods may be preferred over verbal methods (Fisher et al., 1992). Behavioral observations may also be used to identify backup reinforcers (Ayllon & Azrin, 1968). Specifically, Premack (1959, p. 227) noted that "any stimulus to which the species responds can be used as a reinforcer, provided only that the rate of the response governed by the stimulus is greater than that of some other response." The Premack principle became the basis for Allyon and Azrin's (1968) *probability of behavior rule*, which suggests that we ought to "observe what the individual does when the opportunity exists. Those activities that are probable at a given time will serve as reinforcers" (Ayllon & Azrin, 1968, p. 60).

Whether reinforcers are selected by interview or observation, *satiation* (i.e., a reduction in reinforcer efficacy following the repeated delivery of the reinforcer) can quickly lead to the failure of any token economy system. One method of preventing reinforcer satiation is to make conditioned reinforcers exchangeable for a variety of backup reinforcers (Ayllon & Azrin, 1968; Bowman, Piazza, Fisher, Hagopian, & Kogan, 1997; Egel, 1980, 1981; Reese, Sherman, & Sheldon, 1998). Nevertheless, in certain contexts, reevaluation of backup reinforcers may be necessary as often as once a week (Drabman & Tucker, 1974).

Establish a Schedule of Reinforcement and Exchange Rate

There are two methods of manipulating the delivery of backup reinforcers to maximize the effectiveness of a token system. The first

involves manipulation of the schedule of reinforcement to reduce the effects of reinforcer satiation. Specifically, it is usually recommended that token economies be initiated with continuous reinforcement (fixed-ratio 1 or FR 1) to establish a high rate of behavior, and that the therapist then introduce intermittent reinforcement based on either ratio or variable-time schedules (see Kazdin, 2001). Nevertheless, despite frequent exhortations to do so, our review of the literature suggests that it is exceedingly difficult to identify a body of research that clearly demonstrates the utility of fading reinforcement from continuous to intermittent schedules, at least where token economies are concerned. Another approach to avoiding satiation is to manipulate the amount of the conditioned reinforcer needed to obtain the backup reinforcer (i.e., the *exchange rate*). The initial exchange rate usually is determined by noting the "natural" rate of the appropriate behavior during the baseline period, which ensures that the individual will contact the reinforcement contingency (Ayllon & Azrin, 1968). Observing the baseline rate allows the professional to gauge the number of tokens the client will earn during a given period of time. For example, Salend and Allen (1985) reported that they gave participants "a set amount of tokens that represented the preestablished number of inappropriate behaviors that the subject could engage in before losing reinforcement" (p. 61). Thus, the number of tokens supplied to each participant was based on baseline levels of performance. After establishing the baseline rate of behaviors, the "price" of the backup reinforcers then may be assigned. This may be accomplished through the creation of a "menu of rewards" with a range of backup reinforcers—some inexpensive (easy to earn), others more costly (difficult to earn), and still others priced at the intermediate level.

Establishing the value of conditioned reinforcers may be especially challenging for younger clients or persons with developmental delay. A variety of procedures has been developed to address this problem. Having clients observe others during the exchange of tokens can sometimes establish tokens as conditioned reinforcers (Ayllon & Azrin, 1968). The noncontingent delivery of tokens, followed immediately by an opportunity to exchange the tokens for backup reinforcers, may be effective if difficulties arise (Kazdin, 2001).

Delays between "cash out" or redemption periods, delivery of conditioned reinforcers, and/or the performance of the behavior may reduce the effectiveness of a putative reinforcer for some clients. In these cases, reducing the delay between task performance and token delivery may be sufficient to improve performance (Field, Nash, Handwerk, & Friman, 2004). Field and colleagues (2004) showed that reducing by half the number of tokens needed to earn privileges and doubling exchange times resulted in a decrease in intense behavioral episodes and an increase in points earned compared to baseline.

In an extension of earlier work, Hupp and colleagues (2002) examined the separate and combined effects of medication and behavior management (token economy) on symptoms of attention-deficit/hyperactivity disorder (ADHD), as observed during a kickball game for young children. More importantly, in the context of this discussion, the study also compared the effects of "promised" delayed reward to actual delayed reward aided by the immediate delivery of tokens. Tokens were supplied contingent on sportsman-like behavior. Results indicated that delay of promised rewards did not increase sportsman-like behavior during the kickball games, although delayed rewards delivered via tokens increased sportsman-like behavior for all five children observed. Interestingly, stimulant medication had little to no positive effect on sportsman-like behavior in this sample of young children.

Keep Records

Creating a daily or weekly chart may have a variety of benefits, including provision of a visual record of client improvement that may enhance compliance with therapy-related tasks (Reitman & Drabman, 1996). Indeed, research suggests that persons implementing token systems (and other types of behavior management programs) may not recognize the improvements of their clients without such aids. For example, in a study of three boys with disruptive behavior problems, Reitman, Murphy, Hupp, and O'Callaghan (2004) found that although a token program significantly reduced classroom behavior problems, the classroom teacher's ratings of

the children's behavior generally remained unchanged. By contrast, the use of periodic reviews of graphs or similar behavioral data in the presence of the client may serve to facilitate more robust changes in behavior or perhaps more consistent changes in the perceptions of those who interact with persons in behavioral interventions. During the chart review, the professional or paraprofessional (in the case of parents, supervisors, or others) is able to provide the client with praise and feedback concerning progress and/or compliance with recommendations. Following such consultation, therapists and clients (including persons such as classroom teachers and administrators) may jointly decide to alter the treatment plan based on performance feedback (Hawkins & Mathews, 1999).

Decide If Response Cost Is Warranted

Response cost or behavior penalty (Clark, 1996) is a negative punishment procedure in which conditioned token reinforcers are removed in a response-contingent fashion (Azrin & Holz, 1966). Response cost has long been used in conjunction with token economies to reduce the frequency of problem behavior (Kazdin, 1971, 1972; Miltenberger, 2001; Reynolds & Kelley, 1997; Witt & Elliot, 1982). Unlike many other reductive techniques that may limit access to reinforcement (e.g., time-out), response cost systems do not directly restrict access to reinforcers (Reynolds & Kelley, 1997). Indeed, participants in a token economy system may continue to earn conditioned reinforcers for the performance of adaptive behaviors, despite losing tokens when maladaptive behaviors are performed.

An important step in implementing a token economy system is to determine whether the use of response cost procedures is necessary to effect behavior change. One should ask whether clients' maladaptive behavior is inhibiting the performance of adaptive behavior when deciding whether to use response cost. If the answer is yes, a response cost likely would be beneficial in reducing the performance of the maladaptive behavior. However, Miltenberger (2001) warns that token systems using a behavior penalty may fail if the token system is not established prior to the implementation of response cost. One further consideration is that the penalty must remove tokens (and thus access to backup reinforcers) without resulting in the complete loss of all of tokens. Complete loss of tokens earned in a given period and the loss of opportunities to exchange tokens for backup reinforcers may cause the system to fail (Kazdin, 1972; Miltenberger, 2001).

At least one early study suggests equivalence between response cost and nonresponse cost systems. Kaufman and O'Leary (1972) examined the differential effects of reward and response cost on academic and social behavior. Adolescents in a hospital were assigned randomly to a reward condition, in which they began each session with no tokens and were able to earn tokens throughout the period, or a response cost condition, in which they began the period with 10 tokens, which were taken away after rule infractions. The tokens could be exchanged for backup reinforcers from the school store. Interestingly, reward and response cost conditions were equally effective in reducing the maladaptive behavior.

Engage Participants and Train Staff

Implementation of token programs typically begins with a formal explanation of the rules of the token economy to participants. As noted previously, clients should be consulted at each stage of program development and well in advance of implementation. Nevertheless, a formal meeting ensures that all participants in the program understand how to earn tokens, when and where to redeem tokens, what tokens can be exchanged for, and how much backup reinforcers cost. Finally, if response cost is used, participants must be informed about how tokens may be lost if they engage in maladaptive behavior.

Although "consistent" delivery of tokens is generally regarded as a key component for eliciting behavior change, the precise level of consistency needed to achieve effectiveness has yet to be established empirically. On the other hand, research on treatment fidelity has revealed that some interventions can be implemented with less than 100% fidelity (Noell, Gresham, & Gansle, 2002; Northup, Fisher, Kahng, & Harrell, 1997) and retain effectiveness. Whatever the exact level of consistency needed, improvements in integrity could require extensive staff

training (e.g., hospital personnel, teachers, parents). Thus, ongoing supervision of staff and an additional level of contingency management may be necessary to maximize the likelihood of success. This may entail praise and other incentives for staff members who consistently deliver conditioned and backup reinforcers, constructive feedback for errors, and periodic staff retraining to eliminate drift (Miltenberger, 2001).

Given concerns about the effectiveness of empirically supported treatments outside of research-based settings, staff training looms as a unique opportunity to improve the generality of treatment effects for behavioral interventions, including response cost. However, only limited research attention has been devoted to this important topic. Suffice to say, token systems are likely to vary greatly in the fidelity of implementation and effectiveness (see Noell et al., 2005).

Phase Out the Program

After explaining the potential benefits of a token system in reducing classroom disruptions to a first-year teacher, we were recently asked how we could recommend that the teacher "bribe students to behave," and furthermore, "What message would that teach them when they enter the real world?" How could we, as professionals, recommend that students be taught to work only when they know they will be rewarded? Notwithstanding the observation that few, if any, adults work without compensation, we believe it is unlikely that persons strongly opposed to extrinsic reinforcement can be persuaded to accept such a behavior change program (see Reitman, 1998, for an extended discussion of this issue). Instead, we typically suggest that the "best" token systems are those that are deliberately phased out.

One of the best examples of such a phase-out was presented by Paul and Lentz (1977). In their now classic study, the authors worked with institutionalized psychotic patients drawn from four state hospitals in the central Illinois region. The residents were assigned to one of three treatment groups (each comprised 28 individuals): a milieu therapy group, a social learning therapy group (employing the token program), and a control group. The individuals were followed for over 10 years. Participants in the social learning group were offered a unique option that had the effect of reducing patient dependence on the token system. In a conventional "levels system" token program, clients earned opportunities to participate in more reinforcing environments but remained participants in the token economy. In a unique twist, Paul and Lentz offered patients at the highest level of the token program the opportunity to "buy" themselves off the token program. Specifically, residents on Level 1, the entrance level of the program, engaged in 6 hours of scheduled classes and activities each day and earned tokens for adaptive behavior, such as self-care, making their bed, and appropriate mealtime behavior. As the residents progressed to Level 2, they were only required to attend 3 hours of classes and activities, and the other 3 hours were supplemented with individual assignments. When on Level 3 or 4 the residents engaged in 4–6 hours of individual assignments and did not attend the scheduled classes and activities. With each level attained, the residents gradually had the opportunity to earn more tokens. However, in order to shape the appropriate behavior, the criterion for receiving tokens shifted upward as they progressed from level to level. Level 4 included the ability of residents to purchase a credit card that enabled them to have unlimited access to all reinforcers as long as they continued to meet Level 4 requirements. An additional component that led to the success of this token program was the inclusion of fading procedures throughout the level system. As the residents graduated from Level 1 to 2, the protocol called for delayed reinforcement through the use of a "payday" in which they received a lump sum of tokens. This practice helped teach the residents to plan ahead in much the same way they would be required to do outside of the hospital setting. Furthermore, Paul and Lentz supplied staff and residents with rules regarding the implementation and use of the token program.

In addition to the procedures employed by Paul and Lentz (1977), a number of effective techniques exist for reducing reliance on extrinsic or arbitrary contingencies, and promoting the generalization and maintenance of behavior change (O'Callaghan, Reitman, Northup, Hupp, & Murphy, 2003; Stokes & Baer, 1977). For example, one may employ

indiscriminable contingencies to facilitate generalization of token program contingencies. To make use of this technique, one must "make unclear the limits of training contingencies; in particular, conceal, when possible, the point at which those contingencies stop operating, if possible by delayed reinforcement" (Stokes & Baer, 1977, p. 287). The use of intermittent reinforcement in the form of variable-ratio or variable-time schedules also appears to facilitate generalization (Ferster & Skinner, 1957). Other approaches to fading token programs would gradually increase the "cost" of the backup reinforcers or delay the opportunity to redeem tokens. For a complete list of techniques for promoting generalization, readers are encouraged to consult Stokes and Baer (1977).

Finally, Sullivan and O'Leary (1990) used a reversal design to study the efficacy of fading procedures for both token and response cost programs. Results suggested that the token and the response cost programs were equally effective in eliciting increases in rates of on-task behavior. On the other hand, although children maintained high rates of appropriate behavior upon fading of the response cost procedure, only half of the children in the token program showed high levels of maintenance.

Additional Considerations

Treatment Acceptability

Theodore, Bray, and Kehle (2004) found that although teacher ratings did not reflect changes in behavior that were apparent through direct observation, teachers reported a favorable experience with the token system. Reitman and colleagues (2004) reported similar results. McGoey and DuPaul (2000) suggested that an "all positive" token reinforcement system and a response cost intervention were about equally effective in reducing disruptive classroom behavior. Interestingly, teacher ratings of the acceptability of the procedures favored the response cost procedure. When questioned, some commented that the response cost procedure was far less time-consuming than "catching the children being good." The relative merits of response cost-only programs are discussed at greater length toward the end of this chapter.

Individual versus Group Contingencies

Drabman, Spitalnik, and Spitalnik (1974) conducted one of the earliest studies exploring the relative efficacy of group and individual contingencies. Four experimental conditions were included: individual reinforcement, group reinforcement determined by the most disruptive child in the group, group reinforcement determined by the least disruptive child in the group, and group reinforcement determined by a randomly chosen member of the group. Although all four conditions proved to be equally effective at reducing disruptive behavior, the teacher was partial to the group reinforcement determined by a randomly selected member of the group, as it had been the least time consuming and easiest to use. Children, by contrast, ranked group reinforcement determined by the least disruptive member of the group as most preferred; however, it was disliked by the teacher. Neither the teacher nor the students preferred the individual reinforcement system.

Reitman and colleagues (2004) provided additional data on the effectiveness of individual versus group contingencies. Children earned opportunities to play the Rewards Target Game (see Anhalt et al., 1998), in which chances to throw a Velcro ball at a target permitted access to a variety of reinforcing activities, and tangibles were made contingent on the behavior of either randomly selected children (group contingency) or one of the three target or "star" children (individual contingency). During the baseline period, the teacher received training and explained the token system to her class. The token system also contained a response cost in which a marker could be moved down (negative consequence) contingent on disruptive behavior. Although initially the rates of disruptive behavior were somewhat low (M = 15% of intervals for each of the three participants), the results indicated that the token economy system reduced the rates of classroom rule violations for both individual and group contingencies.

Follow-Up, Maintenance, and Generalization

LePage and colleagues (2003) used a token economy on an acute inpatient psychiatric unit to reduce assaults on staff and patients.

Patients voluntarily enrolled in the program, and they earned stamps for performing behavior necessary for successful transition to the community. Examples of target behavior included taking medication, being on time for appointments, and showering. A response cost was implemented solely for major violations of safety rules requiring a police presence on the unit, such as hitting another person or destroying property. The tokens were redeemed for privileges such as off-ground passes, movies, rental of a stereo, or items from the token store (e.g., snacks, drinks, and phone cards). With a 2-year follow-up, this system has proven quite effective. Patient-to-patient injuries and employee injuries were reduced by 48% and 21%, respectively. Finally, a study by O'Callaghan and colleagues (2003) showed that training modifications based on the work of Stokes and Baer (1977) could be used to facilitate generalization of social skills to games in which direct contingencies (i.e., the token program) were not in effect.

Drabman and Tucker's (1974) critique and recommendations concerning "failures" of token systems provide an unusually comprehensive account of shortcomings and potential fixes for frequently encountered implementation problems in school settings. They identified three major classes of failures: program-based, teacher-based, and setting-based. *Program-based failures* concern elements such as poor definition and/or poor monitoring (tracking) of target behavior. *Teacher-* or *personnel-based problems* included failure to reward approximations of the behavior (shaping), altering programs without consulting the data, and ignoring disruptive behavior that produced social reinforcement from classmates. *Setting-based failures* concerned elements such as the size of the classroom and attendant problems in discriminating changes in behavior for large numbers of children. Most importantly, Drabman and Tucker offered helpful hints for choosing and distributing tokens, as well as managing day-to-day changes in the classroom-based token program.

Challenges: Problems of Application

There are a number of limitations of token systems, most of which are consistent with the limitations of behavior modification procedure more generally (see Reitman, Hupp, & O'Callaghan, 2005). One of the more durable but less devastating criticisms is the "no cure" criticism (Kendall, 1989), the notion that treatment effects typically do not persist after withdrawal of the intervention. Of course, this criticism can be leveled with equal measure to pharmaceutical remedies regarded to have a high degree of efficacy (e.g., stimulant medication). Another concern has to do with the ethical issues raised by the "imposition of contingencies" on vulnerable groups, such as children and adults with developmental disabilities. Fortunately, although there is the potential for children and adolescents to be taken advantage of or to have the terms of token systems unfairly altered or administered by parents or teachers, most behavior therapists seek to minimize this risk by fostering a collaborative process in which both parties contribute equally (or as equally as the individual's disability or status may permit). It is important to note that the right to effective treatment must also be weighed and may sometimes dictate the short-term use of more intrusive behavior change strategies to facilitate the long-term goal of greater freedom and independence (Reitman, 1998).

The implementation of a token system may present considerable training and resource challenges to potential users. For example, persons charged with the administration of a token economy must comply with the terms of the agreement or contract. Teachers or direct care staff must guard against reacting to noncompliance or aggression in ways that are inconsistent with the philosophy of the token system. Response cost systems also call for the dispassionate removal of points or tokens from a potentially volatile person. Emotional reactions from the program administrator may undermine the token program by supplying social or attention-based reinforcers for inappropriate behavior. Thus, because token programs may require parents and staff to endure significant antisocial behavior and/or commit material resources to aid in the fulfillment of the token program contingencies, administrators may become unable or unwilling to continue a token program once started. When a caregiver, staff person, or teacher appears overwhelmed,

it may be important to solicit support from relatives, counselors, or other staff.

Although somewhat beyond the scope of this chapter, some authors have argued that the effectiveness of contingency management procedures may be compromised by a failure to account systematically for *motivating operations* (events that influence the effectiveness of conditioned stimuli and reinforcers, see Laraway, Snycerski, Michael, & Poling, 2003). For example, imagine that a child receives $20 for cutting a neighbor's lawn. If the child is participating in a home-based contingency management system based primarily on monetary reinforcers, the likelihood of chore completion would almost certainly be reduced. As noted by earlier researchers, failure to consider deprivation and satiation adequately, as well as competing sources of reinforcement, has doomed many a token economy to failure (Allyon & Azrin, 1968; Drabman & Tucker, 1974).

As implied in all of the preceding, most token systems seem to require rather well developed repertoires of organizational, communication, and negotiation skills. Thus, persons charged with administration of token programs must either teach needed prerequisite skills or modify the token program to reduce demands on persons implementing the program. However, when such accommodations are made, the data suggest that token systems can be beneficial even in the most difficult of circumstances (see Ayllon & Azrin, 1968; Drabman & Tucker, 1974; Field et al., 2004).

Response Cost–Only Systems

Given these considerations, it is not surprising that researchers have pursued less resource-intensive approaches to behavior management, such as the use of response cost–only systems or group rather than individualized token programs. For example, a study by Conyers and colleagues (2004) suggests that the use of response cost–only systems may be favored over more complex and resource-intensive positive programs. Using an alternating treatments design, Conyers and colleagues supplied participants with tokens and subsequently removed tokens contingent on the performance of disruptive behaviors (e.g., crying or noncompliance). Disruptive behavior was reduced from 67% during baseline to 5% following response cost implementation. In the replication phase of the study, disruptive behavior increased to a mean of 52% and subsequently returned to nearly 5% upon reinstatement of the response cost.

One possible flaw in response cost–only systems stems from the often repeated maxim that punishment procedures "do not teach" appropriate responding (Reitman, 1998). In addition, in their extensive review of the punishment literature, Azrin and Holz (1966) noted that punishment often elicits an escape-related response on the part of the target individual. Nevertheless, researchers should continue to explore ways to simplify the delivery and improve the "real-world" effectiveness of behavior management programs such as the token economy. Several aspects of the response cost–only system are appealing from an effectiveness perspective. First among these is that the use of punishment (in this case, negative punishment) is commonplace in society. For example, late charges for not returning a library book on time, speeding or parking tickets, overdraft charges at the bank, or extra charges for going over on cell phone minutes are everyday examples of response cost (Kazdin, 2001; Miltenberger, 2001). So, although punishment-based procedures certainly have their detractors (see Sidman, 1989), one must consider acceptance and familiarity assets in the context of effectiveness and dissemination.

Summary and Directions for Future Research

Token programs have been used successfully in homes, prisons, recreational settings, educational settings, hospitals, businesses, and industry (Drabman et al., 1974; Hupp et al., 2002; Kahng, Boscoe, & Byrne, 2003; Kazdin, 2001; McNamara, 1971). Token programs employed in these settings can be distinguished on the basis of the types of consequences selected (reinforcers and punishers), the identity of the contractors (e.g., the helping professional, parent, teacher, peer, sibling), and the intervention setting (e.g., school, mental health clinic, hospital). Tokens systems have addressed a wide range of problems, such as schizophrenia, mental

retardation, ADHD, oppositional defiant disorder, and autistic disorder.

Token systems for children and adolescents also have been used to influence behaviors that would not ordinarily justify psychiatric diagnosis, such as social interaction, school attendance, academic productivity, and time on task (Miltenberger, 2001; Truchlicka, McLaughlin, & Swain, 1998). Kazdin (2001) notes that token systems have been employed with adults to reduce positive cocaine and marijuana tests (Budney, Higgins, Delany, Kent, & Bickel, 1991), decrease workplace injuries (Fox, Hopkins, & Anger, 1987), improve safe driving practices among pizza delivery drivers (Ludwig & Geller, 1991), and increase adherence to medical or rehabilitative regimens (Gottlieb, 2000).

Token economies have been particularly well-represented in academic settings. For example, Staats, Staats, Schutz, and Wolf (1962) increased reading proficiency with a system incorporating tokens that could be redeemed for small trinkets and edibles. This study established that both immediately delivered tangible reinforcers and token reinforcers could decrease escape-related behaviors in an academic context. O'Leary and Becker (1967) also explored the effectiveness of token economy programs in the academic area. O'Leary, Becker, Evans, and Saudargas (1969) examined how classroom context influences the effectiveness of token programs designed to reduce children's deviant behavior. Among the factors evaluated were the token reinforcement program itself, rules, lesson structure, and social reinforcement. The results indicated that the token reinforcement program decreased the disruptive behavior for nearly 86% of the participants, whereas no significant difference was found for the other experimental conditions.

Finally, although the efficacy of token economies is about as well established as any in the behavioral literature, implementation and dissemination challenges abound. Chief among the challenges are those relating to intervention integrity, training, and consultation—subjects of great relevance to the goal of bringing effective treatments to the public with greater regularity. A series of studies was undertaken by Reitman and colleagues to explore whether token systems may be employed to facilitate the display of appropriate social behavior in athletic settings (see Reitman et al., 2005). For example, Hupp and Reitman (1999) implemented a token economy during a basketball camp for children diagnosed with ADHD. Tokens consisted of "B-Ball Bucks" that were delivered contingent on sportsman-like behavior, such as cheering for peers, and could be exchanged for a variety of backup reinforcers. The token system improved sportsman-like behavior, whereas discussions about the value of good sportsmanship did not enhance social behavior. Perhaps more importantly, reinforcing appropriate behavior appeared to decrease unsportsman-like behavior, even though unsportsman-like behavior (e.g., verbal or physical aggression) was not directly targeted for change. Clearly, further studies are necessary to establish whether social skills learned and mastered in the context of a sports setting generalize and can be maintained in nonathletic settings. Readers interested in further consideration of some of these issues are urged to consult Conner-Smith and Weisz (2003) and/or Noell and colleagues (2005) for excellent introductions to these important topics.

Basic Research and Clinical Folklore

Although this review has revealed a substantial number of studies devoted to demonstrating the efficacy of token and contingency management procedures, and their application to a wide variety of human behaviors, a surprising amount of speculation and clinical folklore seems to guide much of the application of this popular procedure. For example, it is often extrapolated from basic research that conditioned reinforcers used in a token economy system may become powerful reinforcers in their own right (e.g., Jones et al., 1992), yet few, if any, rigorous experimental studies support these assertions. Additionally, although it is thought that token programs may heighten awareness of the target individual's appropriate behavior, possibly conferring conditioned reinforcing properties on the behavior manager (see Risley, 2005), there is precious little research on exactly how token economies exert their influence. The fact that many contingency management procedures also rely extensively on verbal stimuli

complicates this issue to a very significant degree (see Hayes, 1989).

Additional "bridge studies" are needed to inform issues such as the determination of which stimuli may be "reinforcing," as well as when stimuli begin to lose their reinforcing properties (i.e., satiation). As noted previously, many methods of determining what stimuli are likely to be reinforcing have become available, but little consensus has developed concerning which methods are best suited to which populations. Similarly, items that may in fact be reinforcing to participants may be fiscally impractical (e.g., a hospital setting in which patients may earn iPods as backup reinforcers) or require considerable staff resources to deliver consistently (e.g., rewarding a child with 15 minutes of a staff person's time during each school day). Even relatively straightforward issues of reinforcer satiation (e.g., how frequently reinforcers should be varied, how best to monitor satiation in applied settings) appear underresearched, thus leaving behavior therapists in the field with little practical guidance informed by research.

Paul and Lentz (1977) conducted a groundbreaking longitudinal study of the impact of a level-based token system, yet 30 years later, it remains one of the few studies to have a long-term, socially meaningful impact as a token-based instructional program. Moreover, the researchers' emphasis on the use of fading to promote maintenance and generalization of treatment has remained surprisingly novel. A cursory examination of the many classrooms that employ token systems is likely to reveal little attention to efforts to fade such programs over the course of the school year or to do so systematically across the school years. Thus, although this review has documented an extensive literature concerned with the token economy, its many variations and the many settings in which it is used suggest that there is an ongoing need for evaluation of this well-known intervention.

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PART VII

SUBSPECIALTIES

CHAPTER 23

Behavioral Approaches to Education

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The power and precision with which operant conditioning principles can be used to change behavior has resulted in almost immediate applications to education. For example, Skinner's (1954) model of programmed instruction used teaching machines to provide students with immediate feedback and reinforcement for correct responding across a large number of tightly sequenced tasks (e.g., arithmetic facts). Through the use of frequent reinforcement, self-paced practice, and prompting and fading (what Skinner called "vanishing"), learning was enjoyable, occurred quickly, and with few errors (Skinner, 1984). Keller (1968) showed how these same principles can be applied to create a personalized system of instruction (PSI) for college students. Curriculum materials for Keller's PSI courses consisted of a large number (30 or more) of small content units, each associated with its own set of study questions and exercises. Students were free to study and attend lectures whenever they wanted but were briefly examined over the material in each "unit." Performance on these unit tests was graphed, and mastery was required before moving forward in the curriculum.

As suggested by these examples, behavioral approaches to education are characterized by an emphasis on *doing* rather than *knowing*. By using rate of correct responding as the basic unit of analysis, the learner's task becomes one of emitting gradually more refined responses under gradually more demanding and diverse stimulus conditions. In order to promote high rates of correct responding by the student, the teacher functions more as a trainer or coach than as educator (Keller, 1968); that is, teachers facilitate learning by arranging brief, repeated opportunities to respond with prompting, feedback, and reinforcement across diverse curricular materials (Daly, Lentz, & Boyer, 1996). From the perspective of both student and teacher, this makes learning active, fast-paced, relatively error free, and more reinforcing than punishing (Wolery, Bailey, & Sugai, 1988).

The fundamentals of behavioral approaches to education have not changed since their inception and include (1) a well-sequenced set of tasks or curriculum materials that gradually increase in difficulty; (2) brief, repeated practice opportunities; (3) prompting, feedback, and reinforcement to establish and maintain correct responding; and (4) ongoing performance monitoring to inform changes in instructional methods (Chard, Vaughn, & Tyler, 2002: Martens & Witt, 2004). Behavioral approaches to instruction

are considered standard practice when teaching daily living, communication, and other adaptive behaviors to individuals with developmental disabilities (e.g., Lumley, Miltenberger, Long, Rapp, & Roberts, 1998) and when remediating deficits in children's basic academic skills (Daly, Chafouleas, & Skinner, 2005). Behavioral approaches to instruction have also been applied to athletic performance (Brobst & Ward, 2002), secondary and higher education (Cavanaugh, Heward, & Donelson, 1996; Crosbie & Kelly, 1994), and inservice teacher training (DiGennaro, Martens, & McIntyre, 2005). Although the effectiveness of these techniques has led to the development of comprehensive behavioral instruction and performance-monitoring programs (i.e., Direct Instruction, Precision Teaching), neither the programs nor their component techniques are widely used in the public schools (Lindsley, 1992).

The material in this chapter is organized loosely around a model for the dynamic and sequential development of proficient skills performance known as the *instructional hierarchy* (Daly, Lentz, et al., 1996; Haring, Lovitt, Eaton, & Hansen, 1978; Martens & Witt, 2004). Consistent with this model, we begin with a discussion of instructional strategies for skills acquisition, the components of discrete trial training, and the importance of stimulus control. We then discuss how both responding and stimulus control can be strengthened through fluency building, how to arrange curricular materials and reinforcement for productive practice, and the benefits of fluent responding for maintaining performance under more demanding conditions. In the next section we discuss challenges behavioral educators face when attempting to program for the generalization of skills, and how to refine further instruction and performance assessment to produce generative response repertoires. From a somewhat narrow perspective on the particulars of behavioral skills instruction, the focus of the chapter then broadens as we discuss the key features of three behavioral instruction programs (Direct Instruction, Precision Teaching, the Morningside Model of Generative Instruction) and research supporting their effectiveness. The extent to which teachers use or receive training in these empirically supported techniques is also addressed in this section. The last section of the chapter describes strategies for promoting systemwide adoption of behavioral instruction practices and presents data from a case study in system change.

Strategies of Effective Teaching

The Instructional Hierarchy as a Dynamic Teaching Model

The instructional hierarchy was proposed by Haring and colleagues (1978) to describe how children's performance of skills improved over time with training and how instructional procedures should be modified as children's skills improved. Although often referred to as a stage model, the instructional hierarchy is perhaps better characterized as a dynamic teaching model that involves closely monitoring the proficiency level with which a skill is performed, then tailoring instruction to promote further skills mastery at that and subsequent levels. With respect to measurement requirements of the instructional hierarchy, once a skill to be taught has been identified (e.g., oral reading of connected text), proficiency with that skill can be assessed along several dimensions, including accuracy of responding, rate of accurate responding, rate of accurate responding under more demanding or lengthier training sessions, rate of accurate responding under conditions different from training, and spontaneous modifications of the skill (Martens & Eckert, 2007). During the early stages of skill development, proficiency measures focus on *how* a skill is performed (i.e., accuracy and fluency). During later stages, proficiency is measured more by *when* a skill is exhibited or by the range of conditions under which the skill can be performed. Once a learner's emerging proficiency level has been identified, the instructional hierarchy can also be used to select training procedures that have been shown in previous research to promote learning best at that level. The instructional hierarchy provides the framework for Direct Instruction (Gersten, Carnine, & White, 1984) discussed later in the chapter, and has been used to design, implement, and evaluate interventions for a variety of children's academic performance problems (e.g., Daly & Martens, 1994).

Acquisition

Acquisition-level training focuses on providing learners with enough assistance to perform a skill correctly that was not previously in their repertoires. Acquisition trials may occur in the natural environment when opportunities to model and reinforce a target skill present themselves (i.e., incidental teaching) or in isolation under control of a trainer (i.e., discrete trial training; Wolery et al., 1988). The latter approach, discrete trial training, has been shown to be effective for teaching a wide variety of skills and involves presentation of (1) a command and target stimulus in the presence of which the behavior is to occur, (2) a prompt to increase the likelihood of a correct response, (3) an opportunity to respond, (4) corrective feedback for incorrect responses, and (5) reinforcement for correct responding.

Once a learner can perform a skill accurately with a certain amount of assistance, the assistance is withdrawn or gradually faded to transfer control to the target stimulus. Procedures for systematically fading prompts may involve intermittently withdrawing or reducing their intensity, increasing the latency to their presentation, or using progressively less intrusive prompts (Wolery et al., 1988). One strategic concern during acquisition is how rapidly prompts should be faded or withdrawn while still maintaining correct responding. This concern is typically addressed by measuring correct responses and errors at each prompt level and moving to either more or less intrusive prompts based on the resulting performance data. For example, if accuracy is high when assistance is provided, then it may be necessary either to fade assistance or to probe for independent responding. If accuracy is low, with no improvement over time, either more assistance may be needed or the skill should be taught using easier materials. If only errors occur, then prerequisite or component skills may need to be taught before continuing. Conversely, if accuracy is high and stable in the absence of assistance, then fluency building (described below) may be indicated.

Fundamental to skills acquisition is the development of *stimulus control*, or bringing the learner's response under the control of programmed instructional stimuli. Stimulus control accumulates gradually over time as learners are given multiple opportunities to practice skills with prompting, feedback, and reinforcement. As practice progresses, assistance is withdrawn, control by target stimuli increases, performance of the behavior becomes more efficient, and the conditions under which behavior is reinforced are better discriminated. For example, Chafouleaus, Martens, Dobson, Weinstein, and Gardner (2004) evaluated the effectiveness of three interventions involving practice, feedback, and reinforcement alone and in combination with children exhibiting different baseline levels of oral reading fluency. The two students whose oral reading was already under stimulus control of the printed words (i.e., those with the highest fluency and lowest error rates at baseline) benefited most from practice alone via repeated readings. The students with the highest baseline error rates benefited more from practice combined with either performance feedback or feedback plus reinforcement, presumably because the additional intervention components helped bring rapid and accurate reading under stimulus control of the text.

Fluency Building

Once the accuracy of responding is established, training shifts to fluency building. Binder (1996) defines *fluency* as "the fluid combination of accuracy plus speed that characterizes competent performance" (p. 164). By virtue of its emphasis on response rate, fluency building emphasizes free-operant rather than discrete trial training methods (Johnson & Layng, 1996); that is, during fluency building, learners are given enough stimulus materials (e.g., a 150-word passage, 30 addition problems) to allow for repeated performance of a skill or small set of skills. Research has suggested that in order for skills practice to be productive, it should include (1) tasks and/or materials to which the learner can respond with high accuracy and minimal assistance (i.e., instructionally matched materials); (2) brief, repeated practice opportunities with feedback and reinforcement; (3) monitoring and charting of performance; and (4) performance criteria for changing to more difficult material (Daly, Martens, Barnett, Witt, & Olson, 2007). Because it involves exposure to material that

increases in difficulty, a strategic concern with fluency building is exactly where in a curriculum sequence practice should begin. Depending on the skill, this determination may be made when the learner reaches a fluency criterion on material of either differing difficulty (e.g., passage reading) or differing ratios of known to unknown items (e.g., word list training; Daly, Martens, Kilmer, & Massie, 1996; MacQuarrie, Tucker, Burns, & Hartman, 2002). As an example, Martens and colleagues (2007) evaluated the effects of a fluency-based, afterschool reading program with 15 low-achieving second- and third-grade students. The curriculum comprised four passages at each of six grade levels, sequenced by difficulty both within and across grades. In order to advance to a more difficult passage in the curriculum, students were required to meet a retention criterion of 100 words correct per minute (WCPM) in the absence of practice 2 days after training. Training provided three times a week consisted of phrase drill error correction for words missed at pretest, listening passage preview, and three repeated readings of the passage. Additional components of the program included goal setting, charting, and token reinforcement. Results showed that after the equivalent of 5½ weeks of training, children advanced between two and three grade levels on average in the difficulty of passages they were able to read above the retention criterion. Significant pre- to postintervention gains were also observed for children at each grade level on untrained, generalization passages.

Maintenance and Generalization

Once a skill can be performed rapidly and accurately under controlled training conditions, latter stages of the instructional hierarchy involve modifying those conditions to approximate more closely the natural environment. The progression from fluency building to maintenance to generalization involves both the strengthening of stimulus control and the programming of stimulus diversity. Stimulus control is strengthened by the repeated reinforcement of correct responding to target discriminative stimuli (e.g., two-digit numbers and the sign for multiplication) over time and under a wide range of stimulus conditions (e.g., alone with the trainer, in class during a group exercise, at home for homework). On the other hand, stimulus diversity is programmed by systematically varying dimensions of the target discriminative stimuli themselves (e.g., vertical presentation in worksheets, horizontal presentation in story problems).

Three questions arise with respect to fluency building:

1. What rate of performance is required to promote maintenance and generalization of a skill?
2. How should fluency building activities be designed for more complex or composite skills?
3. How should reinforcement be arranged to support practice over time?

Three norm-referenced approaches to answering the first question that were adopted and subsequently abandoned by advocates of precision teaching included comparison to typical peers, competent peers, and competent adults (Johnson & Layng, 1996). These *norm-referenced* fluency aims were problematic because they did not always predict fluent performance over time, in different circumstances, with different materials, or on more complex tasks (i.e., generalization; Binder, 1996). As a result, *functional* fluency aims were developed to indicate performance levels above which fluency would likely be maintained under more demanding practice conditions. Summarized by the acronym RESAA, these functional fluency aims were used to predict *retention* in the absence of practice, *endurance* over longer work intervals, *stability* in the face of distraction, *application* to more complex tasks, and *adduction* (spontaneous emergence) of new forms of a skill (Johnson & Layng, 1996). For example, McDowell and Keenan (2001) trained a 9-year-old boy with attention-deficit/hyperactivity disorder (ADHD) to say phonemes displayed on flash cards at increasingly higher levels of fluency. Before performance reached a fluency aim of 60–80 sounds correct per minute, probes for endurance showed decreases in fluency and on-task behavior. Both on-task behavior and fluency were maintained at high levels once the fluency aim was achieved.

With respect to the second question, one implication of the instructional hierarchy is

that prerequisite or component skills should be practiced to high levels of fluency before learners are asked to combine them into more complex or composite skills (Binder, 1996). This may be relatively easy to accomplish when training students in simple or basic skills the first time they appear in a curriculum sequence, provided there is sufficient time for practice in the instructional day. When attempting to build fluency in more complex skills, however, the situation becomes more challenging. Consider oral reading fluency for example. Even after a starting point in the curriculum for fluency building has been identified (e.g., end-of-first-grade passages for a third grader with significant reading difficulties), deficits in one or more component skills (e.g., sight word vocabulary, decoding) may mitigate the effects of practice and reinforcement with connected text. In such cases it may be necessary to provide fluency- or even acquisition-level training in isolation on the deficient component skills concurrent with practice of the composite skill. Whereas cumulative dysfluency has been identified as "perhaps the single most important factor in long-term student failure (Binder, 1996, p. 184), cumulative fluency has been shown to accelerate the learning process and even lead to the spontaneous emergence of new skills, as discussed in the next section.

In terms of arranging reinforcement to support practice, previous research has shown that high rates of academic performance can be maintained on intermittent fixed-ratio schedules (McGinnis, Friman, & Carlyon, 1999); multiple-ratio schedules, where the magnitude of reinforcement progressively increases as completion rate increases (Lovitt & Esveldt, 1970); and even lottery schedules, where chances of reinforcement are as low as 50% (Martens et al., 2002). Preliminary evidence also suggests that students may prefer different reinforcement contingencies as their skills proficiency increases. Along these lines, Lannie and Martens (2004) gave students the opportunity to complete two sets of math problems, either both easy or both difficult. The completion of problems from each set, however, was associated with a different reinforcement contingency. Students could earn rewards for being on-task at specified intervals while working one set of problems, or for the number of problems completed correctly from the other set. Students in the study chose reinforcement for time on-task when working difficult problems but switched to reinforcement for the number of problems completed correctly when working easy problems.

The Role and Analysis of Generative Response Repertoires

As suggested in the previous section, student responding in a classroom should be highly predictable to anyone familiar with the curriculum. In a well-sequenced curriculum, response demands for many of the behavioral repertoires taught early in the curriculum (e.g., reading text, basic math calculations) are repetitive as they are incorporated into increasingly complex behavioral repertoires that are presumed to prepare students for life beyond the classroom (e.g., preparing reports). Although response demands may be largely predictable, academic stimuli that occasion them are continuously changing as time, exemplars, and settings change. Some of these stimulus changes occur naturally, but most should be programmed by the teacher.

One limitation that teachers face, however, is that they cannot teach all possible stimulus–response relationships as they prepare students for future academic behavior. Alessi's (1987) conceptualization of the teacher's task is most insightful for understanding how to promote and analyze generalization of academic responding. An economical and efficient approach to teaching is to train *generative response repertoires* that allow students to respond and even combine trained responses in novel ways in response to differing configurations of stimuli and task demands. These response repertoires are generative in the sense that the learner is now capable of applying previously learned responses in ways not previously instructed. These response repertoires may also be *recombinative*, in that the learner may combine responses in novel ways, thereby generating a new response repertoire. The result is new and more sophisticated behavioral repertoires for responding adaptively to varying stimulus conditions. The teacher should therefore strive to teach a generative set of responses as a subset of all pos-

sible responses (the universal set of all possible stimulus–response combinations for the response class). Trained responses are generative (and therefore functional) if they contribute to the learner's ability to respond appropriately in the presence of untaught stimuli. After the learner's responding has first been brought under stimulus control for the generative set, stimulus generalization proceeds, until the learner reaches a threshold of responding with the generative set that correlates with increases in correct responding for items from the universal set. Measurement is conducted with both the generative set of responses to assess mastery, and with samples from the universal set to assess generalization (Alessi, 1987).

Generative Repertoires in Oral Reading Fluency

This conceptualization of generalization is perhaps most appropriate for the basic academic skills that serve as the foundation for all other skills in a curriculum. Oral reading fluency and phoneme blending are examples of basic academic skills that have gained prominence in the wider educational community as their critical role in the development of reading has been established through authoritative documents such as the National Reading Panel (National Institute of Child Health and Human Development [NICHD], 2000) and the National Research Council (Snow, Burns, & Griffin, 1998) reports. In the case of oral reading fluency, a student's word reading should come under the stimulus control of the text, which comprises varying configurations of letters separated by spaces and punctuation marks. Those letters, of course, are organized into words that must be read or decoded rapidly if the student is to understand (i.e., provide a verbal report) the content of the text. Words appear in different orders in texts (with grammatical conventions constraining the order somewhat), and the student must be able to read words fluently across texts in order for word reading to be functional. The curriculum defines the generative set of response repertoires and the teacher applies a variety of strategies to bring student responding under the control of texts that become progressively more difficult throughout the curriculum. If the teacher simply measures student performance in the texts used for instruction, he or she does not know whether responding for instructed words will occur in other texts that contain the same words. If the student fails to generalize word reading to other texts, reading will not become a functional skill for other tasks required of the student (e.g., reading to prepare for a history exam).

One approach in the analysis of generalization of word reading is to measure student responding in passages whose word overlap with passages used for instruction is directly manipulated (Daly, Martens, et al., 1996). If many of the same words appear in two passages that are written as different stories (therefore, word order is different), then the two passages are said to have high word overlap (Daly, Martens, et al., 1996). The manipulation of word overlap between texts can serve to facilitate the measurement of generalized oral reading fluency. For example, Daly, Martens, and colleagues (1996) found greater generalization for instruction to high word overlap passages than to a set of equal difficulty level, low word overlap passages. Word overlap interacted with difficulty level, with greater gains observed in easier materials than in harder materials.

The analysis of generalized reading fluency based on word overlap has been incorporated into methods for identifying potentially effective reading interventions through brief experimental analysis (Daly, Bonfiglio, Mattson, Persampieri, & Forman-Yates, 2005; Daly, Martens, Hamler, Dool, & Eckert, 1999). For example, Daly, Persampieri, McCurdy, and Gortmaker (2005) used brief experimental analyses to identify individualized treatment packages based on the distinction of skills versus performance deficits for a fourth grader and a fifth grader. The effects of instructional strategies (repeated readings, listening passage preview, phrase drill error correction, and syllable segmentation error correction) and a reward contingency were examined together and separately (i.e., reward contingency vs. combined instructional strategies) to identify the most efficient intervention that produced either the highest level of responding or a level commensurate with a more complex treatment package for each participant. For one participant, the reward contingency was chosen. For the other, a treatment package that combined the instructional strategies with

the reward contingency was chosen. The interventions were then applied over time as self-managed reading interventions while student performance was continuously monitored as correctly read words per minute. Both participants demonstrated substantial improvements in oral reading fluency in an independent reading series. Treatment selection through brief experimental analysis is accomplished through the use of single-case experimental design elements. In this case, the full treatment package was initially alternated with a control condition. Then, the instructional condition was alternated repeatedly with a reward condition. Finally, the treatment package was compared to the condition (instructional or reward) that produced the highest level of responding during the second part of the analysis. In this type of brief experimental analysis, the behavior analyst compares performance in high word overlap passages to equal difficulty level low-word overlap passages, and evaluates the differences across treatments. Low word overlap passages serve as controls for difficulty level and other changes over sessions as a function of extraneous variables. The sensitivity of oral reading fluency allows for conditions to be alternated rapidly. Because the analysis is based on generalized responding, empirically derived interventions are more robust and therefore more likely to produce generalized improvements over time (Daly, Persampieri, et al., 2005).

Based on the prior conceptual analysis of generative responding, word reading should generalize not only to untaught configurations of instructed words (i.e., the same words appearing in novel texts), but also to untaught words. For a given level in the curriculum (e.g., first grade vs. second grade), the universal set would comprise all words that might appear in appropriate difficulty level texts. Many of these words might not share stimulus properties with the generative set. Nonetheless, students should be able to read them. This set can be sampled through the use of equal difficulty level but low word overlap passages. For example, in the study by Daly, Persampieri, and colleagues (2005), the reading series used for measurement over time was independent of the series used for instruction. Sampling to evaluate the effectiveness of empirically derived instructional interventions, therefore, was from the universal set and permitted subsequent conclusions regarding generalization of word reading fluency to untaught reading materials.

Gortmaker, Daly, McCurdy, Persampieri, and Hergenrader (2007) used a brief experimental analysis to identify potential parent tutoring interventions for three students with learning disabilities, and evaluated outcomes of the chosen interventions using both a multiple-probe design across tasks (passages) and a multiple-baseline design across participants. Measurement took three forms in this study. High and low word overlap passages (relative to passages in which treatments were applied) were used during the brief experimental analysis. Effects of parent tutoring were measured in high word overlap passages for each instructed passage as a part of a multiple-probe design. Effects of parent tutoring were also measured in an independent reading series across participants within a multiple-baseline design. Differential responding during the brief experimental analysis led to the identification of reading interventions that would be carried out by parents. Improvements as a function of parent tutoring in high word overlap passages, as well as low word overlap passages (the independent reading series), validated the effectiveness of the tutoring interventions at increasing students' generalized reading fluency to instructed words in novel order (high word overlap passages) and uninstructed words in novel texts (low word overlap passages).

Generative Repertoires in Phonological Awareness

An even more basic skill than word reading is the ability to manipulate sounds in words. Blending phonemes (the basic units of speech) to make up words is critical to a student's success in becoming a reader (NICHD, 2000). Experiential deficits with phoneme blending put students at significant risk for classification as learning disabled (Vellutino, Scanlon, & Tanzman, 1998). As a prerequisite skill to reading words, a student's ability to blend sounds to form words in response to textual stimuli is a highly generalizable skill itself when proficiency is attained. Combining responses allows a student to read a word he or she has previously been unable to read. Phoneme blending is an excellent example of a recombinative,

generative response repertoire because students are required to combine sounds based on textual stimuli as a basis for becoming good readers. Phonemic responding can be thought of as a *minimal response repertoire* (Alessi, 1987; Skinner, 1957) because (1) there is a point-to-point correspondence between the textual stimulus and the response, and (2) the verbal response is the smallest response under the stimulus control of the textual display. Daly, Chafouleas, Persampieri, Bonfiglio, and LaFleur (2004) demonstrated the superiority of bringing phonemes versus whole words under stimulus control for improving generalized word reading. In this study, they compared two conditions that were equated for response opportunities, differential reinforcement, and degree of overlap in phonemes between trained words and generalization words, while assessment and reinforcement opportunities across conditions were made indiscriminable (so participants could not associate words with a particular condition). The critical difference between the two conditions was the size of the response that was brought under stimulus control. In the phoneme-blending condition, phonemes were trained. In the sight word condition, words were trained. To measure generalization across both conditions, the letters corresponding to phonemes in unknown words were rearranged so that students were trained to read a nonsense variant of each unknown word that contained all the same phonemes. Participants mastered many more words in the phoneme-blending condition than in the sight word condition. This method of measuring generalization for phoneme blending represents a solid point of departure for working out future experimental analyses of how these minimal response repertoires may ultimately enable the learner to read and understand connected text.

Academic Instructional Programs Based on the Principles of Behavior Analysis

Behavioral approaches to instruction can be characterized by a philosophy that all students can learn concepts and principles related to explicit instructional antecedents and consequences (e.g., systematic prompts and reinforcement), ongoing progress monitoring, charting and performance feedback, and frequent opportunities for correct responding on instructionally matched materials (e.g., Alberto & Troutman, 2003). As such, the application of behavior analysis within effective academic instructional programs and interventions is far-reaching and it is beyond the scope of this chapter to identify and discuss each program or intervention that integrates elements of behavioral instruction. In fact, many instructional program designers, and educators in general, may not view a particular program or intervention as derived specifically from behavior analysis, even if it integrates behavioral principles. Instead, most educators and educational researchers commonly discuss effective academic instructional practices in terms of evidence-based, scientifically based, or research-based practices (e.g., NICHD, 2000; Stipek, 2005) rather than attributing those practices to a particular educational or psychological paradigm. It is clear, however, that many of the practices described as evidence-based incorporate several key elements from a behavior analytic paradigm, and could be considered to fall within a general framework of behavioral instruction.

To illustrate, recent evidence has called for systematic and explicit instruction in phonics at the early grade levels, particularly for children at risk for developing later reading difficulties (NICHD, 2000; Snow et al., 1998). Reading programs such as Open Court Reading (Adams et al., 2005) and Read Well (Sprick, Howard, & Fidanque, 2002) are two exemplars in providing such instruction, as highlighted by the Oregon Reading First Center (2004). Although these programs were not developed solely from behavior analytic principles, many key elements of these types of programs (e.g., explicit instruction, systematic prompts, frequent opportunities to respond) undoubtedly map onto the characteristics of behavioral skills instruction. Similarly, reading intervention programs such as peer tutoring (see Mathes & Fuchs, 1994) may not be considered *specifically* behavioral, though many elements of this intervention share behavioral instruction principles (e.g., promoting frequent opportunities for student responding).

Described below are three examples of how behavioral techniques can be combined into comprehensive instructional and/or

monitoring programs for academic skills: Direct Instruction, Precision Teaching, and the Morningside Model of Generative Instruction. The effectiveness of each of these programs is discussed, as well as the extent to which each is implemented by teachers in the schools.

Direct Instruction

Similar to the Open Court Reading and Read Well programs mentioned previously, DI was not developed by specifically drawing on principles of behavior analysis, though this approach to instruction clearly falls within a behavioral framework (Becker, 1992; Fredrick, Deitz, Bryceland, & Hummel, 2000). According to Becker (1992), DI is "a systematic approach to the design and delivery of a range of procedures for building and maintaining basic cognitive skills" (p. 71). More specifically, DI is a skills-based instructional package in which teachers promote the sequential development of student competencies by following scripted instructional routines (Becker, 1992; Gersten et al., 1984). In doing so, teachers generally use small-group instruction and instructional strategies such as modeling and positive reinforcement (e.g., praise for accurate responding). Furthermore, DI lessons ensure that teachers allow students to obtain sufficient practice with targeted material and receive frequent opportunities to respond with corrective feedback.

In Project Follow Through, the largest educational experiment ever conducted, DI was one of several instructional programs independently used with thousands of students representing various socioeconomic levels and ethnicities throughout the United States. This large-scale project aimed to assess each program by comparing pre- and posttest scores on various measures to a similar control group (see Watkins, 1997, for a detailed review of the study). Although Project Follow Through had some limitations (e.g., inconsistent use of experimental design elements), careful analyses of the data suggested that students receiving DI performed better than those receiving any other instructional program on basic skills measures, comprehension measures, and affective measures, such as self-esteem (Becker, 1992; Watkins, 1997). Since Project Follow Through, the DI model has continued to demonstrate its effectiveness. In a meta-analytic review of 37 studies that examined the effectiveness of DI, Adams and Engelmann (1996) noted that "DI interventions have been shown to produce superior performance with preschool, elementary, and secondary regular and special education students and adults. [DI has also] produced superior results with various minority populations, including non-English speakers" (p. 3).

Precision Teaching

Derived more directly from the principles of behavior analysis, Precision Teaching (PT) is a measurement and decision-making process that can help facilitate other instructional strategies and interventions. PT was designed to help teachers determine the effectiveness of their teaching, and it is based on the following key principles: (1) Measure observable and repeatable behaviors directly and daily; (2) measure learning as a change in response rate, with the goal of evaluating and promoting fluent responding; and (3) record performance on a semilogarithmic chart and analyze data visually (e.g., Fredrick et al., 2000). Accordingly, students are typically taught to record their response rate on a semilogarithmic chart for various academic behaviors (e.g., the number of words read correctly per minute), then teachers visually evaluate whether a student's progress in that area has decreased, is stable, or has increased. If the teacher finds that progress has decreased over at least 2 or more days, an instructional change is made and, as always, students continue to chart subsequent performance and teachers observe the trends in performance.

Relative to the evidence supporting DI, there has been less research examining the effectiveness of PT. Nevertheless, previous studies have demonstrated its utility in both regular and special education classrooms (e.g., Beck & Clement, 1991; White, 1986), as well as in a university setting (McDade & Goggans, 1993). Perhaps most notably, however, each of the primary goals and principles behind PT, with the exception of using a semilogarithmic chart, are the same goals and principles guiding the process of curriculum-based measurement (CBM), a

widely used assessment tool with substantial evidence supporting its reliability and validity (e.g., Shinn, 1989), as well as its utility for instructional decision making, particularly in the area of reading (Fuchs & Fuchs, 1986). In addition, PT is one of the essential assessment components used at the Morningside Academy (described below).

The Morningside Model of Generative Instruction

The Morningside Model of Generative Instruction (Johnson & Street, 2004) is an instructional model developed out of work by Johnson and colleagues at the Morningside Academy School in Seattle, Washington. Founded by Dr. Kent Johnson in 1980, the Morningside Academy (MA) offers schooling at the elementary and middle school levels, primarily for students who have been academically unsuccessful at their previous schools. Core instructional components at the MA include (1) student groupings according to instructional ability; (2) a focus on the foundation academic skills (reading, writing, and mathematics) for students coming to the MA without basic skills in these areas; and (3) a carefully sequenced curriculum, daily measurement of performance, and a focus on building fluency in each of the skills outlined in the instructional sequence. Within these components, the MA model of generative instruction "hinges on the belief that complex behavioral repertoires emerge without explicit instruction when well selected component repertoires are appropriately sequenced, carefully instructed, and well-rehearsed" (Johnson & Street, 2004, p. 26). In other words, the MA model of instruction explicitly seeks to build generative response repertoires through appropriate instructional sequencing, effective instructional practices, and student mastery of skills.

Although it is not a major goal of the MA to conduct tightly controlled research on its educational programs, pre- and postoutcome data on the instructional package that the MA implements are routinely gathered, including implementation of its model into outside schools and school districts. Data collection ranges from daily, criterion-referenced measures to yearly norm-referenced tests. Overall, the data collected over 25 years at the MA demonstrate that its educational model is effective, especially compared to typical educational achievements. For instance, in one rural public school in British Columbia, in which the MA program was implemented, the percentage of students performing at grade level in writing rose from 39 to 80% in 9 months. In a separate school in British Columbia, the number of students reading in the "below average" range decreased by 24% in one school year, and the number of students reading in the "above average" range increased by 35%. Johnson and Street (2004) describe similar results across each of the major academic areas, and across a range of grade levels and school types (e.g., rural, urban).

Teachers' Use of Behavioral Instruction Practices

Unfortunately, there are no known data concerning how many or how often teachers implement behavioral instruction practices. However, several authors have observed that most teachers are not using such practices, particularly those in regular education classrooms (e.g., Axelrod, 1996; Binder, 1991; Fredrick et al., 2000; Hall, 1991). Explanations for this relative lack of implementation have included poor dissemination and poor marketing of effective practices, little involvement by behavior analysts in preservice and/or inservice teacher training, attempts to promote procedures that do not fit into typical classroom ecologies, and educators' generally poor perceptions of behavior analysis (Axelrod, 1996; Binder, 1991; Hall, 1991; Lovitt, 1994). Lindsley (1992) also cited philosophical differences between behavior analysts and educators about the value of teacher-directed learning, fluency building through practice, competition in the workplace, and the dissemination of achievement test scores.

In a recent study, Begeny and Martens (2006) asked master's-level elementary, secondary, and special education teachers in training to estimate how much coursework and applied training they received in various behavioral instruction and measurement practices over the course of their undergraduate and graduate training. Results indicated that students in each type of degree program received little to no coursework or applied training in a majority of the instructional practices listed on the survey (e.g., peer tutoring, prompting, shaping, fading).

Moreover, teachers' training in behavioral assessment practices (e.g., CBM, using bar graphs to make instructional decisions) and instructional programs (e.g., DI) was particularly low, even for special educators.

Despite these findings, it seems possible that more widespread use and training of behavioral instruction practices will occur in the near future. Two primary reasons for this optimism are U.S. legislation calling for schools to use evidence-based practices (i.e., the No Child Left Behind Act), and the subsequent momentum for federal agencies to disseminate and obtain information about research-based practices (e.g., NICHD, 2000; Stipek, 2005). Because many evidence-based instructional practices are also behavioral, the opportunity to promote their use may be greater now than ever before. The last section of this chapter describes how behavior analysts can be involved in effecting systemwide adoption of behavioral instruction practices and presents a case example in system change.

Promoting Systemwide Adoption of Behavioral Instruction Practices

Principles of Effective Systemwide Change

Applying effective behavior change strategies at the systems level is a logical endeavor because of the potential to affect positively many children at one time. Selecting and implementing a behavior change process for use at a systems level has many similarities to selecting and implementing an effective intervention at the individual-student level. Contingencies in the system can either support or not support a behavior change effort. The system can either be well prepared or not to engage in the behaviors necessary to carry out the behavior change effort. The practice itself can produce either large returns for the effort or smaller effects. Because systemwide behavior change efforts occur at a cost (e.g., lost instructional time in a school system), the commitment to implement a behavior change process should be made following a cost–benefit analysis. Practices that have sufficient empirical support are the pool from which strategies and programs should be selected. The goal is to identify instructional strategies that are effective under typical classroom conditions and likely to be adopted by those asked to use them. To be effective, system change agents must remember that choice behavior is governed by the same principles of behavior for all individuals, both those adopting the program and those the program is intended to effect (Mace & Roberts, 1986). In the following section, we describe what we consider to be the basic tenets of successful systemwide application of behavior change processes.

- *Incremental gains must occur and be tied to contingencies for those responsible for implementing procedures.* Consultants must consider baseline status relative to desired outcome and should arrange for "reinforcement" contingent on adequate progress. Fidelity of implementation can be an indicator of whether hypothesized reinforcers are actually reinforcing. Frequent, specific feedback to key decision makers should be a cornerstone of systems change efforts (e.g., McDougal, Clonan, & Martens, 2000).
- *The cost of implementation should be relatively low.* Where costs in terms of effort or resources can be minimized, accurate implementation is likely to be enhanced. A fading in procedure can also be used, so that initially the system has to engage in very minimal effort or behavior change to experience reinforcement (Lentz & Daly, 1996). The key is to require the smallest amount of performance initially to establish stimulus control over successful adoption. Stakeholders in the system must have enough responsibility to make the correct discrimination for an initial change to occur.
- *Direct measures of desired outcomes must be obtained routinely.* Direct measures of desired outcomes are pivotal because this places the contingency on the "right" response. Maintaining a "results" focus as opposed to a "process" focus produces better outcomes (Reschly, 2004).
- *The system should be continuously refined, based on child performance measures.* The role of the consultant is to problem-solve implementation to ensure that the desired outcome is obtained. Achieving the desired outcome may require slight or periodic alteration of the program (Neef, 1995).
- *Implementation should be monitored for integrity.* Arranging antecedent conditions is a necessary but not sufficient condition to promote integrity of implementation.

Treatment integrity as an independent variable in school-based programs has often been ignored (Gresham, 1991). Yet understanding how (and how well) an intended application was carried out is critical to internal, external, and consequential validity (Baer, Wolf, & Risley, 1987). Research is clear in suggesting that implementation integrity cannot be assumed (e.g., Noell et al., 2005). Rather, high levels of integrity must be strategically programmed by providing teachers with needed materials; *in vivo* training that uses a combination of instruction, written prompts detailing intervention steps, modeling, and coaching; and ongoing performance feedback about the accuracy of implementation and changes in student behavior.

- *Decision making should be monitored for accuracy/integrity.* Decision rules should be operationalized, linked to data collection procedures, and monitored for accuracy. Macmillan and colleagues found that school-based teams rarely reached decisions about child evaluation that matched with (1) their own assessment data, (2) others assessment data, (3) or even local criteria for identification (Macmillan, 1998; Macmillan, Gresham, & Bocian, 1998; Macmillan & Speece, 1999).
- *The program should produce benefits for general and special education students.* Problem-solving models of assessment using direct measures of student performance have increasingly been used as vehicles for systems change (Fuchs & Fuchs, 1998; Shinn, 1995). Problem-solving models of assessment provide a system for utilizing intervention resources, so that children who need assistance receive it early and in a more effective manner. Children who fail to respond to intervention are referred for special education services. Hence, benefits result for both general and special education.

Problems are identified when the child's performance is discrepant with the expectations for performance in that setting. Characterizing problems as a lack of child–environment fit provides a logical basis for intervention. Most problem-solving models of assessment obtain universal screening data and apply particular decision rules to characterize whether performance problems are evident for many children exposed to similar stimulus conditions. If many children are experiencing learning problems in a classroom, then the problem is characterized as classwide, and classwide intervention is utilized prior to identifying individual children for assessment or intervention (Fuchs & Fuchs, 1998). Assessment of the learning environment relative to performance expectations identifies intervention targets (classroom management strategies, instructional programming, task difficulty level). When few students experience performance problems, individual student intervention is planned for the lowest-performing students. When multiple classwide problems are identified in a single school, schoolwide intervention may be indicated.

Case Example of a Schoolwide Math Intervention

Vail School District just outside of Tucson, Arizona, was using a problem-solving model of assessment (Screening to Enhance Equitable Placement [STEEP]; Witt, Daly, & Noell, 2000) to track student growth and to serve as the basis for special education eligibility assessment. STEEP comprised a series of scripted assessment procedures and associated decision rules that ultimately relied upon a child's response to a series of controlled intervention trials to determine whether a referral should be made. Children who did not respond successfully to intervention iterations were eligible to receive more resource-intensive intervention through special education. This type of approach to eligibility determination has been occurring successfully in the United States during the last two decades (Ikeda, Tilly, Stumme, Volmer, & Allison, 1996; Marston, Muyskens, Lau, & Canter, 2003).

The STEEP model specifically begins with universal screening. Each class is screened with two types of measures, one designed to reflect expected grade-level performance at that point in the school year (i.e., curriculum-based assessment [CBA]) and the other designed to reflect expected grade-level performance by year's end (i.e., CBM). For our purposes, CBM and CBA are distinguished by the range of stimuli to which students are asked to respond. CBA uses a more narrow stimulus set to sample a skill that is currently being taught and yields scores

that are useful for screening, whereas CBM samples key skills that will be taught during some specified time period and yields scores that are useful for tracking progress toward the end-of-instruction goal (Fuchs & Deno, 1991; VanDerHeyden, 2005). Teachers use scripted, standardized instructions to administer probes in math, writing, and reading. The math and writing probes are group-administered and require about 10 minutes. The reading probes are administered individually and require about 1 minute per student. Hence, within 1 hour, data are obtained that reflect the performance of all children in the class in each subject area relative to each other and to benchmarks related to functional fluency aims (e.g., reading fluency rates associated with successful performance on more comprehensive measures of reading performance). A trained consultant is present in each classroom to ensure 100% integrity with administration procedures (standardized instructions delivered as scripted, correctly timed, papers collected with student names). Content-controlled materials external to the curriculum are used and held constant within grade levels across schools to facilitate district-level and grade-level comparisons. Following screening, teachers are provided graphs showing the performance of children in their classroom relative to each other and to benchmarks for frustrational, instructional, and independent levels of performance. These criteria taken from Deno and Mirkin (1977) depend on the topic and grade level. For example, a second grader scoring fewer than 20 digits correct in 2 minutes on a grade-level skill is considered to perform in the frustrational range. These criteria are useful because they can be used to guide instruction. Certain instructional strategies are differentially effective depending on student skills fluency. So, for example, a child performing in the frustrational range is likely to make multiple errors and experience a lack of success in applying knowledge to solve new or more complex problems. The task may be too difficult for the child, and/or the child may require guided practice with immediate corrective feedback to facilitate making the correct discrimination. In our case, performance in the frustrational range for an expected grade-level skill is an indicator that intervention is needed, and that without intervention, children are likely to struggle with the general education program of instruction. If the class median is in the instructional range, then children below the 16th percentile for their class who also perform in the frustrational range are targeted for individual assessment and intervention. If the class median is in the frustrational range, then classwide intervention is indicated and conducted prior to further individual assessment and intervention.

In the Vail School District, classwide problems in math were detected in multiple classes at multiple grade levels in each of the schools. These findings were consistent with high-stakes test scores indicating that many children were failing to meet minimal math standards. Hence, for math, administrative leaders agreed to pursue schoolwide math intervention in grades 1 through 8 in all schools. The math intervention was designed to (1) supplement general instruction occurring through the core curriculum; (2) build fluency (accuracy plus speed; Binder, 1996) in a series of computational tasks upon which conceptual understanding could be instructed and evolve; and (3) identify children who continued to exhibit performance problems as the rest of their classmates progressed.

First, an identified and developed series of computational skills consistent with skills specified in the state standards were ordered logically within a hierarchy for intervention (e.g., sums to 5 was targeted before sums to 10). Second, an intervention protocol for fluency building was developed. This protocol followed a classwide peer-tutoring or peer-assisted learning format and contained the following components: modeling of correct skills performance, guided practice of correct skills performance, and timed independent practice of correct skills performance with delayed feedback/error correction and a group contingency for fluent performance. When class performance reached the mastery range (Deno & Mirkin, 1977), the next logical skill (e.g., sums to 15) was introduced.

Intervention occurred for 20 minutes daily, 4 days per week. Assessment data were collected every fifth day on the same day of the week. Assessment occurred each day of intervention, and students could track their scores daily, but a weekly probe was

collected to track performance schoolwide, to use in decision making, and for research purposes/program refinement. Two types of probes were collected each week, and every fourth week, a third probe was added. Each week, a probe of the skill on which students were being instructed was obtained to track within-skill growth in response to standard intervention. These data indicated not only when task difficulty should be increased but also growth in trained skills, reflecting the degree of stimulus control achieved through intervention. The second probe was a mixed probe of previously mastered skills to track the degree to which previously mastered key computational skills were being retained over time. Third, once per month, a probe reflecting key computational skills that students were expected to master by year's end monitored growth toward year-end mathematical computation objectives.

Each week, five randomly selected teachers at each school were observed to estimate integrity of intervention implementation. A trained, school-based consultant held a copy of the intervention script and observed implementation, noting correctly and incorrectly completed steps. Each week, the consultant met with teachers at their grade-level planning times, provided feedback on the accuracy of implementation, and graphed data of students' performance in their classes. New materials were provided if difficulty level was increased.

Use of this process across multiple sites has been associated with gains in math skills, as reflected by CBM data and year-end high-stakes test performance (VanDerHeyden & Burns, 2005). Use of this process has also facilitated identification of decision-making criteria to guide future math assessment. For example, Burns, VanDerHeyden, and Jiban (2006) identified fluency levels in math associated with the greatest performance increases in response to a standard intervention (i.e., functional fluency aims). Their findings indicated that about 46 digits correct per 2 minutes for second and third graders, and 74 digits correct per 2 minutes for fourth and fifth graders were associated with the greatest performance increases. These findings were consistent with the instructional ranges estimated by Deno and Mirkin (1977) and could be used to establish benchmarks for performance.

Conclusion

Large numbers of U.S. children continue to have significant difficulties with basic academic skills. The National Center for Education Statistics (2004) reported that 37% of fourth graders read below the basic level, whereas the number of children classified as learning disabled increased 351% from 1976–1977 to 1998–1999 (U.S. Department of Education, 2000). Many have cited the failure to adopt evidence-based practices for the relative ineffectiveness of the American public education system with low-achieving students (e.g., Lindsley, 1992). As noted by Carnine (1992), dogma rather than science has often dictated educational reform over the years, enabling fads to cycle through the schools with no demonstrable improvements in instruction. As shown in this chapter, effective teaching methods based on the principles of behavior analysis are available to educators and have been for some time. Recent legislation has created an opportunity for behavior analysts to become more active in promoting adoption of these evidence-based practices, and we hope the material in this chapter will be of some use in these efforts.

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CHAPTER 24

Behavioral Treatment of Autism

Tiffany Kodak and Laura L. Grow

Autism spectrum disorders (ASDs) are pervasive developmental disorders that are evident in early childhood. The diagnosis of an ASD is based on specific diagnostic criteria established by the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR; American Psychiatric Association, 2000), and encompasses a number of disorders, including autism, Asperger's syndrome, Rett's disorder, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified.

ASDs are characterized by three core impairments (American Psychiatric Association, 2000). Individuals with an ASD display marked impairment in communication that may result in odd and repetitive speech patterns, markedly delayed speech and language skills, and even a complete lack of spoken language. In addition, individuals with ASDs have difficulties with social interactions in the areas of eye contact, relationships with peers, play skills, and social or emotional reciprocity. A final area of impairment involves marked abnormalities in patterns of behavior characterized by restricted, repetitive, or stereotyped interests or activities. Children with ASDs may engage in repetitive behavior, such as repeatedly placing items in lines and/or stereotyped body movements (e.g., rocking, hand flapping). They may display restricted activities, such as consuming only certain foods (e.g., chicken nuggets and chips); engaging in problem behavior, if activities do not occur in a particular order; or resisting changes in the environment (e.g., placing stuffed animals in specific locations on the bed each night).

Over the past 20 years, the prevalence of ASDs has increased. Recent prevalence estimates indicate that ASDs occur in 1 in 91 to 1 in 150 children (Centers for Disease Control and Prevention, 2009; Kogan et al., 2009). These prevalence estimates are approximately 20 times higher than those obtained in the 1980s (Burd, Fisher, & Kerbeshian, 1987). A number of factors may influence the apparent increasing trends in the diagnosis of ASDs, including heightened awareness of the characteristics of the disorder, better assessment tools, early diagnosis, confusion regarding measures of prevalence versus incidence, and issues related to the design of studies evaluating the prevalence of ASDs (Volkmar, Lord, Bailey, Schultz, & Klin, 2004). Because of these problems, it is unclear whether the apparent growth in ASD prevalence reflects an actual increase in the proportion of children affected by these disorders.

Associated Features of ASDs

Several medical conditions and behavioral excesses or deficits have been associated with a diagnosis of ASD (American Psychiatric Association, 2000). Although certain characteristics or conditions may be more common in individuals with ASDs, the associated features are not part of ASD diagnostic criteria. The related features include sleeping and feeding disorders, delays in toilet training, severe problem behavior, genetic and medical conditions, and mental retardation.

Sleep Disorders

Individuals with ASDs display a higher incidence of sleep disturbances, including increased daytime sleep (Piazza, Fisher, Kieswetter, Bowman, & Moser, 1990), decreased total sleep, bedtime tantrums, and frequent night wakings (Kodak & Piazza, 2008). Sleep disorders can result in decreased cognitive functioning, increased levels of self-injurious behavior (SIB), and other severe problem behavior and increased levels of parental stress (Kodak & Piazza, 2008). As a result, many individuals with ASDs would benefit from treatment for sleep disorders given the negative impact these disorders can have on both the child and caregivers. A description of behaviorally based treatments for sleep disorders is outside the scope of this chapter. Refer to Kodak and Piazza for a detailed description of empirically derived treatment procedures that have been utilized for individuals with ASDs and other developmental disabilities.

Feeding Disorders

Approximately 25–35% of typically developing children exhibit feeding disorders. The prevalence of feeding disorders is substantially higher in individuals diagnosed with an ASD than in typically developing children, and it is estimated that 90% of children with an ASD display at least some inappropriate mealtime behavior (DeMeyer, 1979). Food selectivity is one type of feeding disorder that appears to be more common in individuals with ASDs, perhaps due to the rigid and restricted interests characteristic of this population (Schreck, Williams, & Smith, 2004). Children who display food selectivity may consume enough food to meet their overall caloric requirements, but they may not meet their daily nutritional needs because of restricted consumption of foods high in essential vitamins and minerals (Piazza, 2008). Treatments based on the principles of applied behavior analysis (ABA) have been highly effective in increasing the variety of foods consumed and in decreasing inappropriate mealtime behavior in individuals with food selectivity. For a description of effective behavioral interventions for children with feeding disorders, refer to Kodak and Piazza (2008).

Delayed Toilet Training

A large portion of individuals with developmental disabilities are not successfully toilet trained prior to the age of 6. In fact, over half of parents of children with an ASD report concerns regarding toilet training and incontinence (Williams, Oliver, Allard, & Sears, 2003). Azrin and Foxx (1971) developed an intensive behavioral treatment package for toilet training adults with developmental disabilities that includes reinforcement for voids on the toilet, fluid loading, scheduled toilet trips, and overcorrection. Numerous studies have evaluated variations of this treatment package with individuals with ASDs and other developmental disabilities (e.g., LeBlanc, Carr, Crossett, Bennett, & Detweiler, 2005).

Despite the effectiveness of the procedures developed by Azrin and Foxx over 30 years ago, several concerns have been raised regarding the appropriateness of using punishment procedures in toileting interventions (Cicero & Pfadt, 2002). As a result, novel treatments comprising antecedent manipulations and reinforcement-based procedures have been developed to increase the frequency of continent voids (e.g., Hagopian, Fisher, Piazza, & Wierzbicki, 1993). Hagopian and colleagues examined the utility of a water-prompting procedure to increase urinary continence in a young male with mental retardation. Results indicated that the water-prompting procedure was effective in increasing continent voids, while maintaining low levels of SIB that had previously been associated with other toileting interventions. Future research might focus on comparing the relative effectiveness of different approaches to

toilet training and measuring potential side effects or issues that arise as a result of each type of intervention. For example, whereas overcorrection might evoke problem behavior, a water prompt may be difficult to fade over time to promote independent voids on the toilet.

Severe Problem Behavior

Individuals with ASDs are more likely to engage in severe problem behavior, including self-injurious, aggressive, or disruptive behavior; noncompliance; elopement and pica, among others (American Psychiatric Association, 2000). Functional analysis methodology has been applied to the assessment of many topographies of problem behavior in individuals with developmental disabilities to identify the environmental variables maintaining problem behavior (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). The information obtained from the functional analysis is used to develop function-based treatment procedures. Although the assessment and treatment of severe problem behavior is critical to intervention programs for many individuals diagnosed with an ASD, a thorough description of this topic is covered elsewhere; functional analysis is covered by Betz and Fisher in Chapter 13 (this volume), and function-based treatments are covered by Fisher and Bouxsein in Chapter 20 and Lerman and Toole in Chapter 21 (this volume).

Associated Conditions and Genetic Disorders

Some level of cognitive impairment may occur in approximately 75% of individuals with autism (American Psychiatric Association, 1994). In addition, several medical conditions and genetic syndromes are more common in individuals with an ASD diagnosis. Approximately 25% of individuals with autism are diagnosed with epilepsy (American Psychiatric Association, 1994), with the onset of seizures occurring during childhood or adolescence (Rutter, 1970). Genetic disorders, including tuberous sclerosis and fragile X syndrome, are also associated with an ASD diagnosis. For more information on the relationship between these genetic disorders and ASDs, refer to Volkmar and colleagues (2004).

Early and Intensive Behavioral Intervention

Early and intensive behavioral intervention (EIBI) is an approach to educational programming for children with ASDs. Intensive behavior intervention is characterized by a comprehensive, hierarchically arranged curriculum implemented for several years, with the goal of improving the overall functioning level of the child (Smith, 1999). The procedures utilized to increase adaptive behavior and reduce problem behavior are based on principles of operant conditioning (e.g., reinforcement, stimulus control, generalization). Numerous learning opportunities are presented with carefully programmed instructional and reinforcement procedures. Multiple areas of functioning are targeted in a developmental sequence to improve several broad skill areas. Educational targets for EIBI programming often include preacademic and academic skills, language, social skills, and independent play skills, among others.

The University of California Los Angeles (UCLA) Young Autism Project is a landmark outcome study that documented substantial improvements in a large portion of children (approximately 47%) receiving EIBI (Lovaas, 1987), and those gains in functioning maintained through adolescence (McEachin, Smith, & Lovaas, 1993). The success of early studies examining EIBI led to additional research and widespread dissemination. To date, research has compared (1) different intensities of EIBI (e.g., Smith, Eikeseth, Klevstrand, & Lovaas, 1997), (2) EIBI and other treatments (e.g., Eikeseth, Smith, Jahr, & Eldevik, 2002), and (3) clinic- versus parent-managed models (e.g., Sallows & Graupner, 2005).

In recent years, researchers have focused on reviewing the empirical support for EIBI by evaluating experimental studies based on established criteria (e.g., Reichow & Wolery, 2009). Several research groups have developed criteria to evaluate empirical support for EIBI (e.g., Horner et al., 2005; Reichow, Volkmar, & Cicchetti, 2008). Although there are differences in specific criteria across these studies, there is considerable overlap related to experimental rigor, verification of diagnosis, and measures of procedural integrity, among others.

There is general consensus that EIBI is an effective treatment for remediating many of

the behavioral deficits and excesses associated with an ASD (Reichow & Wolery, 2009). Results of some (but not all) studies on EIBI suggest that effectiveness of the intervention may be related to the child's IQ prior to receiving intervention. In addition, at least one child in the studies reviewed by Reichow and Wolery either experienced no change or regressed on at least one outcome measure. Overall, recent reviews of the literature highlight the need for additional research on the learner variables associated with "best" outcomes.

Early Intervention Models

A number of early intervention models based on the principles of ABA were developed to provide an educational curriculum for teaching individuals with ASDs. The models described below have demonstrated effectiveness in studies published in peer-reviewed journals, and have since been published as commercially available treatment manuals. Each model is reviewed in detail, followed by a description of key differences. Finally, recommendations are provided for integrating the models to maximize learning.

Natural Environmental Training

The essential features of natural environmental training (NET) are the emphasis on child-directed interactions, techniques that increase motivation to respond, and generalization of skills. NET, which has also been referred to as *natural language approaches* (LeBlanc, Esch, Sidener, & Firth, 2006), is typically conducted in natural settings (e.g., home) with an emphasis on training caregivers to promote learning opportunities during playtime. This model capitalizes on naturally occurring establishing operations (EOs) to teach functional language skills, although motivation to respond is not necessarily described in the NET literature in terms of EOs. NET incorporates choice-making opportunities into treatment, frequent preference assessments, and variation in reinforcers across trials to increase the likelihood of occasioning vocalizations. Interspersal of mastered tasks is also utilized to maintain the individual's motivation to respond. Training is programmed into settings that closely approximate free play to decrease similarity to those of academic or work settings.

The goal of training is to establish a functional relationship between emitting vocalizations and gaining access to reinforcers. Requests for items are typically targeted in the initial portion of treatment to establish a functional relationship between the vocal response (e.g., "dinosaur") and the reinforcer (e.g., brief access to the dinosaur). Although an emphasis is placed on teaching children to request items, other topographies of vocalizations (e.g., answering "wh" questions) are targeted during treatment, and the same reinforcing stimuli as those provided following requests are delivered contingent on other vocal responses.

The NET approach was developed to incorporate research described by Stokes and Baer (1977) into training. Thus, NET emphasizes training multiple exemplars, training across settings and therapists, and use of intermittent contingencies to promote generalization of language (LeBlanc et al., 2006). Intermittent contingencies are programmed into treatment once a verbal repertoire is established to more closely approximate the contingencies that occur in naturalistic settings (e.g., school). By emphasizing the generalization of language skills across settings and therapists, the individual's newly acquired language is more likely to occur under the stimulus conditions present in a variety of settings. NET encompasses several teaching strategies for individuals with ASDs including incidental teaching, the Natural Language Paradigm (NLP), and the mand-model procedure.

Incidental Teaching

Hart and Risley (1968) developed incidental teaching strategies from their experiences teaching language to preschool children in natural settings. Incidental teaching strategies are conducted in unstructured settings such as free-play time in a classroom. Incidental teaching is child-directed, and the trainer uses the child's initiation as a learning opportunity. Trials are initiated when the child shows interest in an item by pointing or gesturing toward it. The goal of incidental teaching is to train the child to emit language spontaneously in response to multiple cues in the natural environment.

Children learn to attend to discriminative stimuli that signal the availability of adult attention for language attempts during incidental teaching (Hart & Risley, 1975). This discrimination is important to language occurring in the natural environment because attempts to communicate are unlikely to produce a reinforcer unless an adult is attending to the child's vocalizations. Discrimination training begins after the child shows interest in an item, and the therapist physically approaches the child, engages in eye contact, and exhibits a questioning look (Hart & Risley, 1975). If the child does not emit a spontaneous vocalization at the initiation of a teaching trial, the therapist provides a prompt that is relevant to the learning opportunity. Prompts are faded across trials as the child responds accurately following less intrusive prompts. Hart and Risley recommend rotating between a select number of prompts to ensure that children are able to emit a relevant response. Thus, the limited variation in prompting is one variable that distinguishes incidental teaching from other NET procedures (e.g., NLP).

Previous research on incidental teaching with disadvantaged preschool children showed that the procedure was effective in producing variability in verbal responses and generalization to novel therapists (Hart & Risley, 1975), and preference for play activities in which incidental teaching was incorporated into free play (Hart & Risley, 1968). Incidental teaching was extended to children with ASDs, and the results indicated that training produced generalization of language (e.g., McGee, Krantz, Mason, & McClannahan, 1983).

Incidental teaching procedures were compared to traditional teaching strategies (e.g., teaching at a desk in a private room with minimal distractions) in a study by McGee, Krantz, and McClannahan (1985). Prepositions were taught using both strategies, and results indicated that acquisition of target prepositions did not vary across teaching procedures. However, incidental teaching sessions were somewhat lengthier than the traditional teaching procedure. Data collected during generalization probes indicated a higher frequency of correct use of prepositions taught during the incidental teaching condition. This study highlights the need for additional research on comparisons of various teaching strategies to identify the procedures that result in (1) rapid acquisition, (2) higher levels of attending, (3) generalization of skills across settings and therapists, and (4) the least amount of instructional time necessary to produce mastery of target skills. Another area of future research involves identifying children's preference for intervention procedures by examining choice between language training strategies, as has been done with other behavioral interventions (Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997; Schmidt, Hanley, & Layer, 2009).

A major limitation of incidental teaching is the inclusion of only one trial of learning per teaching episode. Prolonged intertrial intervals may occur during incidental teaching, depending on the length of time to the child's initiation of the next trial. In an attempt to resolve this limitation, Charlop-Christy and Carpenter (2000) developed a retain teaching procedure called multiple incidental teaching sessions (MITS), which is similar to incidental teaching, with the addition of multiple learning or practice trials once the child initiates an interaction; that is, the therapist presents two practice trials following the first trial to provide additional opportunities for learning. In this regard, MITS combines the procedures of incidental teaching and discrete trial training by conducting multiple trials in succession. Due to limited evaluations of MITS, additional research on the effectiveness and efficiency of this procedure in comparison to other intervention strategies is warranted.

Natural Language Paradigm

Koegel, O'Dell, and Koegel (1987) developed NLP to combine language training and play skills. Teaching strategies are integrated into play opportunities to increase the extent to which learning is fun for the child and therapist. NLP includes the provision of choices between high-preference stimuli to prevent a loss of interest in items and to increase the child's motivation to respond during structured learning opportunities. Frequent selection of highly preferred items also allows for variation throughout training.

A learning opportunity begins when the child selects a preferred item. The therapist restricts access to the preferred item and

models a short phrase (e.g., "Lion roars") while concomitantly modeling an appropriate motor activity (e.g., opening the lion's mouth). Shaping is incorporated into treatment, and the therapist reinforces closer approximations to the target vocalization across trials. Thus, reinforcement is initially provided for attempts to echo the therapist's model (e.g., the child says "rar"). Following a correct response, the therapist provides brief access to the preferred item (3–5 seconds) and pairs social reinforcement (e.g., praise) with opportunities to play. The target vocalization is typically repeated multiple times during the reinforcement interval. For example, the therapist says "Lion roars" several times while the child plays with the lion. After the brief reinforcement interval, the therapist restricts access to the item and models a different phrase (e.g., "Yellow lion"). If the child does not emit a vocalization following two models of the target response, the therapist removes the item and provides another opportunity to select from several highly preferred items (Charlop-Christy & Kelso, 1997).

A graduated time-delay procedure often is used during treatment to promote spontaneous language (Walker, 2008). When the child develops a verbal repertoire, spontaneous language should emerge as the child emits an appropriate vocalization prior to the therapist's delayed model. The graduated time-delay procedure aids in the transfer of stimulus control from the therapist's model to the appropriate antecedent stimuli (Walker, 2008).

Training involves repeated opportunities for the therapist and child to take turns interacting with toys in a setting that approximates play conditions in the natural environment. Training also facilitates generalization by targeting multiple responses across different stimulus exemplars in novel play settings. For example, the therapist may model "Lion roars" with the lion and "Bear roars" with a bear. Furthermore, a variety of descriptors is provided for each stimulus, so that the child learns multiple vocal responses for one toy. Variations in modeled responses may decrease the likelihood that the child engages in repetitive vocalizations with items (e.g., always saying "Yellow lion" when the child sees a toy lion).

Research on NLP shows rapid acquisition of targeted language skills, as well as generalization of language across settings (Koegel et al., 1987; Laski, Charlop, & Schreibman, 1988). However, several procedural variables warrant additional consideration. Shaping of target responses may be extremely difficult when multiple therapists implement NLP at different points in time because the criteria for determining which targets to reinforce and which ones to extinguish in the shaping process are not well delineated in NLP. This limitation is exacerbated by the fact that data collection measures are not well defined in NLP; that is, it may be challenging to collect data on the frequency of each therapist-modeled and child response without significantly disrupting the natural flow of treatment. The procedures were developed to simulate play in the natural environment, and data collection during trials could substantially impact the extent to which the training trials appear similar to play.

Despite the potential limitations of NLP, Laski and colleagues (1988) trained parents to implement NLP with their children, and the results indicated that the participants acquired language skills. Thus, the aforementioned limitations may not critically affect the extent to which children benefit from the treatment procedures. However, more research is needed on the efficacy of NLP with children who require extensive shaping to acquire vocal verbal behavior.

Mand Model

This NET strategy was developed by Rogers-Warren and Warren (1980) as an extension of the incidental teaching procedures described by Hart and Risley (1968). Despite the name of the procedure, the word *mand* does not represent the functional verbal operant associated with the verbal behavior approach. Rather, the procedure teaches children to expand upon their current repertoires by increasing the complexity of their vocalizations or the mean length of utterance. The mand-model procedure was developed to teach children turn-taking skills, joint attention, and responses to therapist prompts, and to provide information when verbally requested to do so (Halle, Alpert, & Anderson, 1984).

Similar to other NET strategies, multiple highly preferred items are present during training trials. When the child indicates

interest in an item, the therapist initiates prompting in an attempt to obtain language that meets a predetermined criterion; that is, the therapist determines a criterion for responding prior to the initiation of the session (e.g., three-word utterances). If the child does not respond at or above this criterion, the therapist provides prompts to occasion the target response. However, unlike other NET strategies, if the child does not emit a response at the criterion level following two prompts, access to the restricted item is provided to maintain the child's motivation to continue responding during the session. Thus, the child obtains the preferred item following correct or incorrect prompted responses (Halle et al., 1984).

Applied Verbal Behavior

The applied verbal behavior (AVB) approach to teaching communication skills is based on Skinner's (1957) theory of verbal behavior. This approach emphasizes the functional units of language. With this "functional" approach, a verbal operant is defined in terms of not only its topographical characteristics (e.g., a child saying "red") but also antecedent events that occasion or evoke the response (e.g., a parent pointing to a picture of a red ball), and the consequent events that reinforce the response (e.g., a parent saying, "Good job; the ball is red").

Skinner's (1957) taxonomy of verbal behavior includes seven elementary verbal operants, and early intervention programs typically focus on four of these: mand, tact, echoic, and intraverbal. Treatment typically begins with mand training because this verbal operant has the most direct benefit to the speaker (Skinner, 1957). A *mand* is a verbal operant (e.g., "Drink, please") that is evoked by a relevant EO (e.g., walking outside on a hot day) and reinforced by delivery of the requested consequence (e.g., giving the child a drink). Mand training should be conducted under the appropriate antecedent and consequent events; that is, mand training tends to be most effective when the relevant EOs are present (or presumed present), and the reinforcer related to the child's mand is available following an appropriate response.

Therapists using an AVB approach to language training are also concerned with stimulus control. Mands should occur in the presence of the relevant EOs and discriminative stimuli. However, early on in training, AVB therapists often include antecedent prompts that are components of other verbal operants. For example, an AVB therapist may include an intraverbal prompt (e.g., "What do you want?) or an echoic prompt (e.g., "Drink") to increase the likelihood that the child will emit the target response (e.g., the child saying "Drink"), and that the target response will contact the relevant reinforcer (e.g., delivery of the drink). Over time, these prompts are quickly faded to establish a "pure" verbal operant.

Once mands are acquired, the antecedents controlling trained verbal operants are combined with other antecedents to teach additional functions of language (e.g., combined mand–tact training). These antecedents are programmed into learning opportunities to produce the target response and are faded out during training, so that control over responding is transferred from one set of stimulus conditions to another. Numerous studies have shown that stimulus control can be successfully transferred from one verbal operant (e.g., a tact) to another (e.g., intraverbal) during training (e.g., Miguel, Petursdottir, & Carr, 2005).

Skinner's theory (1957) has improved the manner in which communication training is conducted during early intervention (EI) by placing an emphasis on initial mand training and highlighting the need for intraverbal training (Sundberg & Michael, 2001). Prior approaches to EI neglected training of intraverbal behavior and primarily emphasized tact training. Thus, individuals with ASDs were taught to tact most items in their environment but were unable to carry on conversations with others. By limiting training in this manner, individuals with ASDs were not provided the necessary skills to function fully in typical settings or to establish peer relationships. As such, Skinner's theory, and the inclusion of mand and intraverbal training, has advanced the quality of treatment provided to children in EI programs (Sundberg & Michael, 2001).

Discrete Trial Training

Discrete trial training (DTT) was developed in the early 1970s as a type of behavioral intervention for children diagnosed with

autism (Lovaas, Koegel, Simmons, & Long, 1973). This model emphasized a highly structured approach to teaching, in which the child and therapist sit at a table, various skills are taught during discrete learning trials, skills are broken down into smaller units of behavior and taught to mastery, and a brief intertrial interval is programmed between trials. Highly preferred items (usually small edible items) and praise are delivered following correct responses. Sessions, sometimes referred to as *drills*, consist of a specific number of trials that may involve presenting the same discriminative stimulus in a massed-trial format (e.g., repeatedly presenting trials of "Touch dog" throughout a session).

Early studies evaluating DTT for young children with autism reported substantial increases in IQ scores, decreases in inappropriate behavior (e.g., self-stimulatory and problem behavior), and increases in spontaneous social interactions (Lovaas, 1987; Lovaas et al., 1973). The rapid acquisition of skills may be attributed to the manner in which DTT is conducted. The procedure allows for fast-paced instruction to maximize the number of learning opportunities in a brief period of time. There are several additional, potential advantages of using DTT over other EI models. Treatment procedures may be easier to teach inexperienced staff members to implement. DTT is more similar to the format of instruction in classrooms settings (e.g., sitting at a desk and answering questions) than other intervention models, and it may be particularly well suited to the acquisition of certain verbal operants (e.g., tacts, echoics). Finally, DTT may increase the ease of data collection during learning trials (Sundberg & Partington, 1999).

Unique Feature of EI Models

Many of the behaviorally based EI models (NET, AVB, and DTT) are unique in terms of their approach to language-based training, the manner in which specific skills are taught, and the terminology used in each. NET and AVB are similar, in that both models place an emphasis on naturalistic training procedures that focus on teaching mands (AVB) or requests (NET) for items at times and under condition in which the child is motivated to obtain the requested item (e.g., maximizing the effects of the relevant EOs by conducting frequent preference assessments and/or restricting access to the items). Skills taught in DTT vary from those of NET and AVB because DTT trials incorporate specific, verbal discriminative stimuli (e.g., "What is it?") instead of programming trials in a manner that would allow responding to come under control of the antecedents described by Skinner (1957). While these procedures may occasion correct responding on each trial in DTT, extensive training may be necessary to ensure that skills taught during DTT generalize to other, less structured settings. Thus, proponents of AVB and NET have stated that DTT may not promote generalization of skills in a manner similar to other EI models (Sundberg & Michael, 2001).

The terminology used varies across DTT, NET, and AVB models. NET and DTT make a distinction between receptive and expressive language training. *Receptive language* typically refers to training auditory–visual conditional discriminations (e.g., teaching a child to touch or point to a picture following the presentation of an auditory stimulus). Proponents of AVB refer to this type of training as *teaching listener behavior. Expressive language* typically refers to teaching children to tact an item in the presence of a nonverbal stimulus (e.g., a picture) and a verbal stimulus (e.g., "What is it?"). The distinction between receptive and expressive language is consistent with a structural approach to language development (Leaf & McEachin, 1999; Maurice, Green, & Luce, 1996). Alternatively, AVB approaches communication training from a functional perspective and considers the antecedent and consequent events surrounding verbal behavior during training (Sundberg & Partington, 1998). Due to differences in the approach to language-based training, the setting of intervention varies substantially in the initial portions of treatment. DTT models do not typically incorporate training into the natural environment until a number of prerequisite skills are targeted during one-on-one seatwork (e.g., attending, compliance). Thus, language skills (typically, tacts and echoics) are taught during one-on-one activities at a desk for the first year or two of treatment and subsequently are practiced in other, less structured settings later in treatment (e.g., the second year

of EI). In contrast, NET and AVB language training occurs in natural settings from the onset of treatment and focuses early training on establishing mand repertoires. This training occurs during free-play time, similar to the loosely structured activities encountered in preschool classrooms.

Differences in the setting of language training substantially alter the way each approach addresses motivational issues. The AVB approach refers to motivation in terms of EOs that momentarily increase the effectiveness of a reinforcing stimulus and increase the likelihood of behavior that has produced access to the stimulus in the past. Thus, mand training occurs under conditions in which naturally occurring EOs are programmed into training (e.g., the child has not had access to several highly preferred items for a period of time; Kelley, Shillingsburg, Castro, Addison, & LaRue, 2007). NET describes motivation in terms of the child's willingness to respond for preferred items. The therapist provides frequent choices between highly preferred items to encourage the child to participate in treatment. Finally, DTT addresses motivation by providing highly preferred items (e.g., food) following correct responses during each trial. DTT therapists place less emphasis on motivational variables, and they typically do not conduct frequent preference assessments during trials. Instead, several highly preferred food items are alternated across trials to decrease the likelihood of satiation during DTT.

Combining Intervention Models

Each approach to EI has unique strengths that may be utilized in an eclectic approach that includes a variety of empirically validated, ABA-based interventions. For example, the functions of verbal operants can be taught using the AVB approach in the natural environment while children acquire other skills, such as attending behavior and following instructions within the context of DTT. Therapists can program the learning environment to capitalize on naturally occurring EOs by restricting access to certain highly preferred items for use during language training. NET may be used to teach social skills, such as turn taking and sharing toys. The mand-model strategy can be utilized to increase the individual's mean length of utterance, while taking into account the function of the vocalization (AVB). For example, training might focus on teaching different carrier phrases for mands and tacts.

Skinner's taxonomy may be incorporated into teaching a variety of skills in either NET or DTT. For example, if the therapist is teaching the concepts yes and no, an AVB approach to teaching may involve initially training "yes" and "no" as a mand-intraverbal operant by asking children whether they would like to watch highly preferred or nonpreferred video clips. This training can occur within a DTT format as long as the relevant antecedents and consequences are programmed into training. Combining DTT with other EI models capitalizes on the strengths of several models by incorporating naturally occurring MOs into treatment, and the learning trials are more child-driven because the child is offered a selection of video clips prior to each trial.

Clinical Considerations and Future Research

Establishing a Reinforcing Environment

In many cases, the identification of reinforcing stimuli is a critical factor in the success of behavioral acquisition programs. Systematic preference assessments are commonly conducted to identify a hierarchy of potentially reinforcing items or activities. A large body of research has focused on developing effective and efficient methods for assessing preference for stimuli among individuals with developmental disabilities (see Piazza, Roane, & Karsten, Chapter 9, this volume).

Within the context of an EI program, a preference assessment can provide opportunities for individuals to select the reinforcers included in upcoming teaching sessions. Although frequent, systematic preference assessments are recommended to control for potential fluctuations in preference for reinforcers over a period of time, there is substantial variability among EI programs regarding how often preferences are assessed. A recent study by Love, Carr, Almason, and Petursdottir (2009) found that most EI programs (i.e., 65%) assessed preference multiple times per day, while some programs (i.e., 19%) conducted preference assessments on a quarterly or annual basis. Research indicates that frequent, brief preference assessments

are more effective for identifying potential reinforcers than less frequent, comprehensive assessments (DeLeon et al., 2001). Despite research supporting the use of frequent preference assessments, it is possible that some EI programs may conduct preference assessments less often because of time or resource constraints. Researchers have responded to this clinical issue by developing brief preference assessments that are more reasonable to implement in naturalistic settings (e.g., Carr, Nicolson, & Higbee, 2000).

In conjunction with frequent preference assessments, choice-making opportunities can be interspersed throughout educational programming to increase the reinforcing properties of instruction in general (Kodak, Lerman, Volkert, & Trosclair, 2007; Laski et al., 1988). Moreover, current research suggests that individuals may prefer instructional contexts that incorporate opportunities to make choices among reinforcers over environments that provide identical reinforcers selected by a therapist (Tiger, Hanley, & Hernandez, 2006). There are multiple opportunities to integrate choices into a typical teaching session during EI (e.g., task selection). Previous research has demonstrated that choices between tasks may result in increases in task engagement (Dunlap et al., 1994), as well as decreases in problem behavior (Romaniuk et al., 2002). Several reinforcement parameters may influence an individual's choice (e.g., reinforcement rate, quality, immediacy, and magnitude) and alter the efficacy of the reinforcing stimuli included in EI learning trials. Additional research is needed to determine the extent to which choice variables influence the acquisition of new skills.

Assessing and Identifying Target Skills

In order to select appropriate targets for intervention, an assessment of the current skill level of the individual in several domains is typically conducted. Information from a formal assessment of skills allows clinicians to (1) measure a number of important behavioral repertoires, (2) identify areas that would benefit from intervention, and (3) track educational progress over a period of time. Several types of formal assessment programs are commercially available to clinicians and researchers.

Assessment of Basic Learning and Language Skills—Revised

The Assessment of Basic Learning and Language Skills—Revised (ABLLS-R) is a tool for identifying areas that require intervention for children with autism and other developmental disabilities (Partington, 2006). The ABLLS-R includes educational skills that are grouped into 25 skill areas (e.g., social skills, motor skills). The language components of the ABLLS-R are based on Skinner's (1957) account of verbal behavior. One useful component of the ABLLS-R is guidelines to develop goals for individualized education plans (IEPs). *Teaching Language to Children with Autism or Other Developmental Disabilities* (Sundberg & Partington, 1998) is intended to be used as a companion treatment manual for many of the skills assessed in the ABLLS-R. Information is collected in interviews of caregivers and other individuals who are familiar with the child (e.g., teachers), during naturalistic observations, and in tests of specific skills.

Verbal Behavior Milestones Assessment and Placement Program

The Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) is designed to assess the current level of a variety of language and related behaviors to identify educational target skills in individuals with ASDs and other developmental disabilities (Sundberg, 2008). The VB-MAPP includes three main sections: the Milestones Assessment, the Barriers Assessment, and the Transition Assessment. Information is gathered by interviewing caregivers and others who are familiar with the child, collecting data during naturalistic observations, and conducting tests of specific skills.

The Milestones Assessment evaluates the child's current behavioral repertoire along 16 dimensions of behavior (e.g., listener responding) arranged in a developmental sequence across three levels, and measures skills that are typical for children between the ages of 0 and 18 months, 18 and 30 months, and 30 and 48 months. The Barriers Assessment is designed to assess 24 language and learning barriers (e.g., prompt dependency) that may interfere with progress during educational programming. The information obtained

from the assessment may identify areas of intervention that should be addressed prior to other objectives. The Transition Assessment gathers information on specific skills needed to make educational gains in less restrictive environments. The assessment is divided into three main categories. Category 1 contains measures of academic independence (e.g., group skills) that are most critical in determining a specific child's appropriate level of support. Category 2 generates information about specific learning patterns (e.g., rate of skill acquisition) that are related to a child's readiness for acquiring skills outside of one-on-one instruction. Category 3 evaluates repertoires in the areas of self-help (e.g., toileting skills), spontaneity (e.g., adaptability to change), and self-direction (e.g., independent play skills).

Early Intervention Curricular Manuals

Several EI curricular manuals based on the principles of ABA are commercially available (e.g., Leaf & McEachin, 1999; Lovaas, 2003). Many of the recommendations and strategies in published curricula are rooted in the original treatment manual associated with UCLA Young Autism Project, *Teaching Developmentally Disabled Children: The ME Book* (Lovaas, 1981), which used DTT as a primary instructional strategy (e.g., Leaf & McEachin, 1999). In contrast, the Sundberg and Partington (1998) manual references Skinner's (1957) analysis of verbal behavior as the conceptual framework for language training. Despite some differences in methods for training skills across EI manuals, most EI supervisors reference more than one published manual when designing the curriculum for a given client (Love et al., 2009).

Instructional Procedures

Identifying Effective Prompting Strategies

Developing the most effective, efficient teaching procedures for individuals with ASDs is an important, growing area of research. Effective teaching should result in rapid skill acquisition, high levels of correct responses, and a high probability of reinforcement. Response or stimulus prompts are used to increase the likelihood of a correct response, thereby increasing access to reinforcers. Evaluating and selecting effective prompts are considered best practices and require careful consideration of learner and task variables (Wolery & Gast, 1984). Assessment of any relevant prerequisite skills needed for particular prompts to occasion correct responses should be conducted prior to intervention. For example, model prompts are most appropriate for learners who display an imitation repertoire. It is possible that prompts may be differentially effective depending on the type of task (McComas et al., 1996). For instance, a picture schedule might be more effective for activities such as making a snack, whereas a gestural prompt might better facilitate social initiations. Future research might focus on identifying specific learner skills or difficulties that are predictive of the relative effectiveness of a variety of stimulus and response prompts. Although researchers are beginning to address this topic (Bourret, Vollmer, & Rapp, 2004; Fisher, Kodak, & Moore, 2007), more research is needed on empirical methods for matching prompting strategies to learner characteristics.

Identifying Prompt Fading Strategies

Response and stimulus prompts are typically incorporated into instructional procedures during initial teaching sessions and faded as quickly as possible (i.e., *prompt fading*). The purpose of prompt fading is to transfer stimulus control from therapist-delivered prompts to stimuli in the natural environment that should evoke appropriate responses (Walker, 2008). Multiple prompt fading procedures have been developed and evaluated in the extant literature (e.g., least-to-most prompting; Horner & Keilitz, 1975). Numerous studies have compared the relative effectiveness and efficiency of various prompt fading techniques. In general, research indicates that most prompt fading procedures are effective for teaching a variety of new skills (Ault, Wolery, Doyle, & Gast, 1989). However, procedures vary in terms of their efficiency; that is, the number of sessions required to teach new skills varies considerably across different prompting procedures. It is possible that the efficiency of prompting procedures relates to the specific skills of the learner or the task (Wolery & Gast, 1984). For example, within-

stimulus fading may be ideal for learners who attend to irrelevant features of stimuli (i.e., faulty stimulus control), whereas an identity-matching prompt may be well-suited for learners who have poor attending skills (Fisher et al., 2007). Another consideration is the training and effort required to implement various types of prompt fading techniques. For example, within-stimulus fading requires extensive preparation and materials. Future research might evaluate how the efficiency of prompt fading strategies is influenced by the learner's skill level, features of the task, and practical considerations (e.g., time and effort).

Maintenance and Generalization

A primary goal of EI is for the child to continue to exhibit previously learned skills during direct instruction (i.e., maintenance of the skills over time) and engage in these skills across a number of settings and in novel situations (i.e., generalization of skills). Unfortunately, many EI programs fail to program adequately for maintenance and generalization of skills (Smith, 1999). Furthermore, the educational gains achieved during intervention often do not generalize to other response topographies (e.g., learning to add the *-ing* ending to a novel word) nor to response variations required in other settings (Charlop, Schreibman, & Thibodeau, 1985), and more research and attention are needed in these areas.

Maintenance

Maurice and colleagues (1996) recommend assessing maintenance once per week for 3–6 weeks to measure whether the child continues to exhibit the recently mastered skill. When data demonstrate that the child has maintained a target skill (e.g., correct responses during weekly maintenance probes), the child may continue to practice the skill at relevant times, but no data are collected on the mastered skill.

Numerous EI manuals recommend modifications to ongoing teaching procedures to increase the likelihood that skills will be retained following training. For example, Lovaas (2003) recommended modifying (1) the schedule of reinforcement and (2) the type of reinforcement provided for correct responses, procedures that can also promote generalization (as discussed below). In addition, when arbitrary reinforcers (e.g., food) are used to train a new task, it is important to program naturally occurring reinforcers (e.g., praise, high fives) into treatment and maintenance to ensure that behavior does not extinguish in the natural environment.

Generalization

Generalization occurs when skills acquired in one setting (or with one person) are exhibited without training in other settings (or with other people). Stokes and Baer (1977) described seven techniques to evaluate and/or promote generalization. The specific techniques most relevant to EI are training sufficient exemplars and using indiscriminable contingencies. Training sufficient exemplars involves (1) teaching multiple responses to the same stimulus (e.g., teaching multiple ways to deliver a complement), or (2) teaching the child to engage in the correct response across a number of different, relevant stimuli (e.g., tacting "dog" in the presence of different examples of dogs that share some common features). Sometimes generalization can occur when as few as two response exemplars, therapists, or settings are included in generalization training (e.g., Stokes, Baer, & Jackson, 1974), but at other times, more exemplars are required (e.g., Miller & Sloane, 1976). Thus, more research is needed to determine the optimal conditions to achieve stimulus generalization.

Another behavioral technique that is highly relevant to EI in training for generalization is the use of indiscriminable contingencies. When using indiscriminable contingencies, reinforcement for appropriate behavior is typically provided on an intermittent schedule (e.g., variable-interval 5). For example, Freeland and Noell (2002) evaluated whether completion of math problems was maintained when correct responding no longer produced reinforcement following a phase in which (1) each correct response was reinforced, or (2) correct responding produced intermittent reinforcement. Results indicated that responding was only maintained following a phase of intermittent reinforcement. Although the schedule of reinforcement for skills acquired in EI programs is commonly transitioned to variable schedules, few stud-

ies have evaluated the schedule of reinforcement necessary to maintain skills in settings other than the training setting.

Conclusion

Early intervention based on the principles of ABA is a critical component of any comprehensive treatment for individuals diagnosed with ASDs. Although several behavioral EI strategies have produced impressive results with small groups of children with ASDs, outcome studies evaluating the large-scale implementation of EI procedures have focused on the UCLA-based model (i.e., DTT). Thus, randomized controlled trials of other behavioral EI models (e.g., AVB, NET) are needed to identify additional effective strategies. In addition, many of the behaviorally based EI models can be used in conjunction with each other. Future research might examine the utility of combining the behavioral EI approaches to take advantage of unique features of each model.

Despite an increase in EI research in the past 30 years, considerably more research is needed to delineate optimal teaching strategies for children with ASDs. For example, additional research is needed to evaluate the impact of learner and task variables on the effectiveness of particular intervention strategies. Future research might focus on developing systematic evaluations of potential variables that interact with the effectiveness of acquisition procedures. Information from an assessment of this type might lead to better identification of procedures that result in rapid skill acquisition. Improving our existing teaching technologies and developing new ones are likely to improve further the outcomes for children with ASDs treated with EI.

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CHAPTER 25

Teaching Safety Skills to Children

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There are numerous threats to personal safety that children may encounter in their lives. These child safety threats can be divided into two categories: (1) frequently occurring situations in which the child has repeated opportunities to practice safe behaviors and (2) low incidence but life-threatening situations in which the child may have but one opportunity to use the safety skills successfully (Miltenberger, 2005). Frequently occurring situations that require repeated preventive behaviors include, among others, the use of seat belts or child safety seats in an automobile, the use of bike helmets when riding a bike, and the use of safe street-crossing skills. Low-incidence but life-threatening situations that occur infrequently or not at all in a child's life include events such as attempted abduction, home fires, or finding an unattended firearm. The child's use of safety skills in such situations could save his or her life.

Although the child's use of safety skills in situations involving both types of safety threats is important for preventing accidental injury or death, the focus of this chapter is on child safety skills appropriate for low-incidence but life-threatening safety threats. In particular, this chapter focuses on skills necessary to ensure child safety when a child finds an unattended firearm. In this chapter we review the nature of the problem of unintentional firearm injuries to children, describe risk factors associated with unintentional firearm injuries, and discuss two approaches to intervention: modifying parent behavior to promote safe storage of firearms, and teaching safety skills to children to prevent gun play, with an emphasis on behavioral skills training procedures for teaching safety skills.

The Nature of the Problem

Hundreds of children in the United States are injured or killed each year by firearms. An average of 2,833 children (ages 0–14) were injured and 693 were killed by firearms each year between 1993 and 2000 (Eber, Annest, Mercy, & Ryan, 2004). Childhood firearm deaths and injuries often are not deliberate. Unintentional shootings accounted for 43% of firearm injuries (1,222 per year) and 21% of deaths (143 per year) (Eber et al., 2004). The American Academy of Pediatrics (AAP; 2000) reported that 24% of deaths caused by firearms in children under age 5 were unintentional, as were 26% for children ages 5–9, 21% for children ages 10–14, and 5%

for 15- to 19-year-olds. Over 1,500 children alone were killed accidentally with a firearm between 1996 and 2001 ("Common Sense," n.d.). The only cause of unintentional death greater than that of firearms was vehicular accidents (Kellerman, 1993; Zavoski, Lapidus, Lerer, & Banco, 1995).

Most unintentional firearm injuries and deaths are caused by handguns (AAP, 2000; Brady Center, n.d.; Grossman, Reay, & Baker, 1999; Knight-Bohnhoff & Harris, 1998; Zavoski et al., 1995). Easy access to guns is associated with an increased risk of accidental firearm injuries and fatalities (Miller, Azrael, & Hemenway, 2001; Miller, Azrael, Hemenway, & Vriniotis, 2005; Ordog et al., 1988). In fact, most incidents occur in the home of the victim or that of a friend or family member of the victim (Brady Campaign, n.d.; "Common Sense," n.d.; DiScala & Sege, 2004; Eber et al., 2004; Grossman et al., 1999; Kellerman & Reay, 1986; Wintemute, Teret, Kraus, Wright, & Bradfield, 1987).

Risk Factors for Firearm Injuries

Two important risk factors associated with unintentional firearm injuries in children are unsafe storage practices (i.e., the gun is stored unlocked, loaded, and without a safety device) and children's tendencies to play with guns they find (Himle & Miltenberger, 2004). A number of researchers have documented that many gun owners fail to store their guns properly (e.g., Azrael, Miller, & Hemenway, 2000; Johnson, Coyne-Beasley, & Runyon, 2004), and that when children find guns they often play with them (Hardy, 2002; Hardy, Armstrong, Martin, & Strawn, 1996; Jackman, Farah, Kellerman, & Simon, 2001).

Gun ownership rates vary, with 20–40% of households owning at least one firearm (Brady Center, n.d.; "Common Sense," n.d.; Haught, Grossman, & Connell, 1995; Schuster, Franke, Bastian, Sor, & Halfon, 2000; Senturia, Christoffel, & Donovan, 1994). Owning one gun increases the likelihood of owning another gun fivefold (Senturia et al., 1994), and households containing a male member are more likely to have a gun than those without a male (Knight-Bohnhoff & Harris, 1998; Schuster et al., 2000). Handguns are owned by more than half of gun-owning households. Parents are more likely to have a rifle, followed by a shotgun, and a handgun, respectively (Schuster et al., 2000). Protection is cited most often by handgun owners as the reason for keeping the gun in the home (AAP, 2000; Dresang, 2001; Haught et al., 1995; Wiley & Casey, 1993). However, a gun in the home is far more likely to kill a family member or friend than to be used for protection from a stranger (AAP, 2000; Brady Center, n.d.; Dresang, 2001; Kellerman, 1993; Kellerman & Reay, 1986).

Parents' Behavior and Beliefs

Many parents do not store their firearms safely even though access to guns is associated with childhood firearm injuries and fatalities. Less than half of parents report storing their guns in the safest manner, which is locked, unloaded, and separate from ammunition (Farah & Simon, 1999; Stennies, Ikeda, Leadbetter, Houston, & Sacks, 1999; Wiley & Casey, 1993). More importantly, some parents (13–30%) store their guns both unlocked and loaded, which is the most unsafe storage practice ("Common Sense," n.d.; Farah & Simon, 1999; Hemenway, Solnick, & Azrael, 1995; Miller et al., 2005; Schuster et al., 2000; Senturia et al., 1994; Stennies et al., 1999). Many families with firearms reported storing their firearms in a manner between these two extremes (Stennies et al., 1999). Ammunition was stored separate from firearms in nearly half of the homes with firearms (Haught et al., 1995; Hendricks & Reichert, 1996).

Trigger locks and other safety devices for firearms have been shown to be an effective preventive measure. Kellerman (1993) found that trigger locks could prevent about 30% of unintentional shootings. Vernick and colleagues (2003) determined that 45% of past unintentional deaths could have been prevented with the use of one or more of three safety devices: personalized guns, loaded chamber indicators, and magazine safeties. In light of this knowledge, unfortunately, less than half of gun-owning parents use such safety devices ("Common Sense," n.d.; Haught et al., 1995; Schuster et al., 2000).

Gun-owning and non-gun-owning parents differ in their firearm safety beliefs. More non-gun-owning than gun-owning parents

believe that keeping guns out of the house is the best way to avoid accidental shootings (Farah & Simon, 1999), whereas gun-owning parents believe that education-based safety training is a sufficient strategy for prevention (Knight-Bohnhoff & Harris, 1998). Gun owners prefer to obtain safety information from a gun organization, whereas non-gun-owning parents would rather learn from the police. Parents who own guns state that they (1) would be willing to talk to their pediatrician about firearms, and that they (2) believe statistics regarding the greater risks than benefits of owning firearms. Nevertheless, these parents do not remove guns from their household; however, most reported that they would follow advice to keep guns locked and unloaded. Non-gun-owning parents stated that information from pediatricians would make them less likely to buy a gun in the future (Webster, Wilson, Duggan, & Pakula, 1992).

Webster and colleagues (1992) surveyed parents in a pediatrician's office and found that gun owners were more willing than non-gun-owners to trust children with firearms at a much younger age. Some gun owners (14%) were willing to trust a child younger than 12 years old, while 39% trusted 12- to 15-year-olds, and 26% said they would never trust a child with a firearm. These rates differed for non-gun-owners, who rarely (3%) believed a child under 12 years old should be trusted with a gun. Although 9% of non-gun-owners were willing to trust a 12- to 15-year-old with a gun, 42% of this group stated that they would never trust a child with a firearm (Webster et al., 1992). Combined, gun owners and non-gun-owners trust their own child with a gun at, on average, age 9 years old but they do not trust other children until age 21 (Farah & Simon, 1999). Gun owners also were more likely to believe that children can discriminate between a real gun and a toy gun at an earlier age than were non-gun-owning parents, and more likely to think their own child could make this judgment reliably (Farah & Simon, 1999; Webster et al., 1992).

Many parents, regardless of gun ownership status, are confident that their child would not touch or play with a gun if the opportunity arose (Brady Campaign, n.d.; "Common Sense," n.d.; Farah & Simon, 1999). Parents report talking to their children about gun safety (Farah & Simon, 1999; Knight-Bohnhoff & Harris, 1998), but most report not discussing guns ownership with parents of their child's friends (Brady Campaign, n.d.). Of those who have not discussed the issue with other parents, most say they have not thought about it, and others assume that there are no guns in the household, or that the firearms are safely stored (Brady Campaign, n.d.).

Children's Behavior

Although parents tend to trust their children not to touch or play with a gun, this is often not the case. Hardy and colleagues (1996) found that 19% of children whose parents owned a gun reported playing with it without their parent's knowledge. In addition, 24% more children than parents verified that the child was aware of a gun in the household, and 67% of children stated that they knew where the gun was located and had access to it (Hardy et al., 1996).

More recently, Hardy (2002) asked parents and children similar questions. When parents were asked if they thought their child would play with a gun 41% said yes, 32% said no, and 27% were unsure. Interestingly, 40% of children of the parents who answered "no" did play with the gun, as did 59% of children of the unsure parents.

Children placed in a room with various toys, toy guns, and real but disabled firearms often touched and played with the real gun (Hardy, 2002; Jackman et al., 2001). In a study by Jackman and colleagues (2001), pairs or trios of 8- to 12-year-old boys were sent into a room in which a gun was placed in a drawer. Jackman and colleagues found that in 76% of the groups, at least one child handled the gun, and in 48% of the groups, at least one child pulled the trigger. Only once (5%) did a child leave the room and report finding the gun to an adult. Nearly all of the children who touched the gun (93%) and pulled the trigger (94%) had received gun safety information at some point. Hardy (2002) found similar results, with 53% of children playing with a gun found in the room, and only 1 child out of 70 reported finding the gun to an adult. Furthermore, children are not able to discriminate between fake and real guns as well as parents believe. In fact, about half of the children who found

the gun were not sure whether it was a real gun or a toy (Hardy, 2002; Jackman et al., 2001). Children are more likely to identify a gun incorrectly as fake when it is real than to identify it as real when it is fake (Hardy, 2002).

Two Approaches to Preventing Childhood Firearm Injuries

Two approaches to preventing firearm injuries to children are to promote safe storage of firearms by parents and to teach safety skills to children to prevent gun play because the two major risk factors for childhood firearm injuries are accessible firearms and children's tendencies to play with firearms they find.

Promoting Safe Storage Practices

Various strategies have been carried out to get parents to store their guns more safely. These strategies have included legislation that makes it a felony to store firearms so that they are accessible to children, efforts by pediatricians and other physicians to counsel parents about the dangers of firearms and the need for safe storage, and media or other campaigns to educate parents about the dangers of firearms and the need for safe storage (e.g., Himle & Miltenberger, 2004; Jostad & Miltenberger, 2004).

Florida was the first state to implement a law that punished those who stored or left a loaded firearm where a child could find it (Brady Campaign, n.d.). The Child Access Prevention Law had positive results in Florida during its first year of implementation, with a 50% drop in unintentional shootings. Since then, 19 other states have adopted similar laws (Brady Campaign, n.d.).

Cummings, Grossman, Rivara, and Koepsell (1997) evaluated whether these laws were effective in decreasing the death rates of children under 15 years old. Overall, the death rate was 23% lower than expected in states that adopted safe storage laws. The study also found that the decrease in deaths was greater for children under 10 years of age than for those between the ages of 10 and 14.

Webster and Starnes (2000) also evaluated the effectiveness of the Child Access Prevention Law. They found no change in death rates in states where the penalty was a misdemeanor, but a decrease in unintentional deaths in states where the penalty was a felony. However, further analysis showed that when data from Florida were excluded from the analysis, the decrease in death rates following the implementation of Child Access Prevention Law was not statistically significant. Florida may have been so successful because it was the first state to implement the law; therefore, the law received much publicity. They also have the most severe penalty, and the death rate prior to implementation was quite high, so there was more room for greater change. Researchers are continuing to contemplate possible reasons for success in Florida but not other states (Webster & Starnes, 2000).

A number of researchers have evaluated the effects of pediatrician counseling about firearm safety and safe storage practices (e.g., Grossman et al., 2000; Grossman, Mang, & Rivara, 1995). Grossman and colleagues (1995) evaluated pediatricians' beliefs and practices regarding this issue. They found that many family physicians and pediatricians agreed that they should be responsible for counseling families about firearms, yet they stated that it was low on their list of priorities. About one-third stated that they did not know what to tell parents, and one-half admitted that they have never counseled a family on firearm safety. Pediatricians were more likely than family physicians to agree that firearms should not be kept in homes with children, and family physicians were more likely to promote teaching safe practices on how to use a gun when old enough. Pediatricians were more willing to suggest removal of firearms to parents, yet both groups doubted that the families would listen to this advice. Both pediatricians and family physicians said they would tell parents to store ammunition and guns separately and thought that parents would be receptive to this suggestion (Grossman et al., 1995).

Grossman and colleagues (2000) evaluated the effectiveness of physicians educating parents on firearm safety, providing written materials about safe storage, and providing a discount coupon for purchasing safe storage devices. This counseling and economic incentive program did not produce any sig-

nificant changes in parents' storage or ownership compared to controls.

In another investigation, Sidman and colleagues (2005) evaluated the effects of a media campaign that included television and radio announcements, educational materials, billboards, and discount coupons for lock boxes on the safe storage practices of gun owners in King County, Washington. The authors conducted telephone surveys to assess storage practices in the intervention county and nine control counties in different states, and found that the intervention did not produce statistically significant changes in safe storage practice.

Coyne-Beasley, Schoenbach, and Johnson (2001) evaluated the effectiveness of the Love Our Kids, Lock Your Guns program on participants' safe storage practices. As part of this program, persons in the parking lot of a mall took a survey, received individualized counseling, obtained safety information, and were given a gun lock with instructions at no expense. The effectiveness of the program was evaluated after 6 months. Almost all of the participants thought the program was helpful. At follow-up, 77% of the participants said they locked their guns (compared to 48% at baseline), and 72% said they used the gun lock (compared to none at baseline). Only 7% continued to store their guns loaded and unlocked at follow-up compared to 18% at baseline. Following the program, participants who had children were more likely than those without children to lock their guns (Coyne-Beasley et al., 2001).

Although the research by Coyne-Beasley and colleagues (2001) illustrates a program that was successful in promoting safe storage of firearms, the researchers made personal contact with individual gun owners and gave away gun locks, a time- and resource-intensive practice that is not likely to be applied on a wide scale. In general, research on changing parents' gun storage practices has produced mixed results, with many programs producing no changes in safe storage practices. Furthermore, this research uses self-report of safe storage practices, so the results need to be interpreted cautiously. As pointed out by McGee, Coyne-Beasley, and Johnson (2003), it is not clear what types of interventions or intervention components make gun owners more likely to store their guns safely. Clearly, more research is needed to evaluate strategies for promoting safe storage practices by parents and other gun owners. If gun owners stored their guns safely, the threat to child safety would be greatly diminished, as would the need for teaching safety skills to children to prevent gun play.

Teaching Safety Skills to Children

Researchers have attempted to teach safety skills to children to prevent gun play because efforts to promote safe storage of firearms have not been largely successful. Efforts to teach safety skills to children comprise two general approaches: One is an informational approach, and the other is an active learning approach. In an informational approach, the teacher talks about the safety threat posed by guns and describes the safe response to the threat, often with the children verbally rehearsing the correct response. In the case of finding a gun, the safe response is not to touch the gun, to get away from it, and to report its presence to an adult (e.g., Gatheridge et al., 2004; Himle, Miltenberger, Gatheridge, & Flessner, 2004; Poche, Yoder, & Miltenberger, 1988). In an active learning approach, the teacher has the student actually practice the safety skills in simulated situations, praising correct performance and giving corrective feedback for incorrect performance of the skills (Gatheridge et al., 2004; Himle, Miltenberger, Flessner, & Gatheridge, 2004; Miltenberger et al., 2004; Poche et al., 1988).

Informational Approach

Hardy (Hardy et al., 1996) was the first researcher to evaluate informational training programs to prevent gun play by surreptitiously videotaping children as they found a gun in a playroom before and after receiving firearm safety information. During assessments, two children played in a room together. The room contained a disabled firearm, a toy gun, and various other toys. The intervention consisted of a 30-minute session in which a police officer told children and parents that a child should never touch a gun without permission from parents, that a child should tell an adult if he or she finds a gun or if another child is playing with a

gun, and that all guns are dangerous unless an adult says otherwise. Children were given time to ask questions and color pictures. Hardy et al. found that the trained group was just as likely to touch and play with the gun as the control group after training. Similar results were reported by Hardy (2002).

One commonly used training program for children, called the Eddie Eagle GunSafe Program, is distributed by the National Rifle Association (Himle, Miltenberger, Gatheridge, et al., 2004). This program uses training materials and activities designed to be age appropriate (e.g., an informational poster, coloring book, video, cutting material, sequencing cards with the safety motto, and certificates and stickers to use as rewards). The Eddie Eagle GunSafe Program is designed to teach children to stop, not to touch, to leave the area, and to tell an adult if they ever find a gun. Children receive information, rehearse the safety message, and verbally respond with the safety message to "what if" scenarios during the five 15-minute training sessions. However, the Eddie Eagle GunSafe Program is an informational rather than an active learning approach to training because children do not engage in behavioral rehearsal of the safety skills. The Eddie Eagle GunSafe Program has trained well over 15 million children, yet there are few studies evaluating its effectiveness.

Himle, Miltenberger, Gatheridge, and colleagues (2004) evaluated the effectiveness of the Eddie Eagle GunSafe Program, Level 1, and found that 4- and 5-year-old children trained with this program were able to score well on self-report assessments (i.e., they could tell the researcher what they were supposed to do when they found a gun). However, they were no better than untrained children when asked to role-play what they would do in a situation involving a gun. In addition, they were unable to perform the skills when assessed in a naturalistic setting in which they found a gun and were unaware that they were being tested. Gatheridge and colleagues (2004) also evaluated the Eddie Eagle GunSafe Program's effectiveness with 6- and 7-year-old children. These children were able to perform well on the self-report assessment and also to do slightly better on role plays than controls. Yet, again, children trained with the program did not perform the safety skills in the naturalistic setting (when they did not know they were being tested) any better than controls.

Research evaluating informational programs for teaching children safety skills to prevent gun play has shown that such programs are not successful. This finding is consistent with research showing that an informational approach is not successful in teaching other safety skills as well (e.g., Beck & Miltenberger, 2009; Poche et al., 1988).

Behavioral Skills Training

It should not be surprising that informational programs to teach safety skills do not work because such programs do not require children to rehearse the safety skills with feedback until they demonstrate successful performance (Gatheridge et al., 2004; Hardy, 2000; Hardy et al., 1996; Himle, Miltenberger, Gatheridge, et al., 2004). On the other hand, behavioral skills training (BST) is an approach that requires active participant involvement, with rehearsal of the skills to mastery across a range of simulated situations. Research has shown that BST is effective in training various safety skills, including abduction prevention skills (Carroll-Rowan & Miltenberger, 1994; Johnson et al., 2005, 2006; Marchand-Martella & Huber, 1996; Olsen-Woods, Miltenberger, & Forman, 1998; Poche, Brouwer, & Swearingen, 1981; Poche et al., 1988), sexual abuse prevention skills (Lumley, Miltenberger, Long, Rapp, & Roberts, 1998; Miltenberger, & Thiesse-Duffy, 1988; Miltenberger, Thiesse-Duffy, Suda, Kozak, & Bruellman, 1990; Miltenberger et al., 1999), pedestrian safety skills (Yeaton & Bailey, 1978), and fire safety skills (Jones, Kazdin, & Haney, 1981; Jones, Ollendick, McLaughlin, & Williams, 1989).

BST involves the use of instructions, modeling, rehearsal, and feedback. Instructions are given first by the trainer describing the safety threat and the safety skills to use in response to the threat. Next, the trainer models the safety skills in simulated situations involving the safety threat. Then, the participant rehearses the safety skills in the context of a role play. The trainer provides praise for correct performance and corrective feedback for incorrect performance. Rehearsal is continued, with feedback, until the safety skills are executed correctly and

automatically when the child is presented with a range of simulated safety threats (e.g., Himle & Miltenberger, 2004). As a result, the safety skills should come naturally when the child is faced with a real-life situation involving a similar safety threat.

Research evaluating BST for teaching safety skills to children (and adults with mental retardation) has produced a number of findings. First, BST is effective in producing skills acquisition, although the skills do not always generalize or maintain over time (Marchand-Martella & Huber, 1996; Poche et al., 1981). Second, BST appears to be more effective with individuals than with groups of children (Carroll-Rowan & Miltenberger, 1994; Johnson et al., 2005; Miltenberger & Olson, 1996). Third, in some instances BST is not effective until *in situ* training is added; that is, individuals learn the skills with BST but fail to use them until training occurs in the naturalistic setting (Johnson et al., 2005; Miltenberger et al., 1999). Fourth, BST is more effective than informational approaches that do not involve active learning (Gatheridge et al., 2004; Himle, Miltenberger, Gatheridge, et al., 2004). Finally, BST can be time-intensive, sometimes requiring numerous sessions before the skills are acquired and generalized (Johnson et al., 2005; Miltenberger et al., 1999).

BST to Prevent Gun Play

Miltenberger and colleagues have evaluated BST procedures for training safety skills to prevent gun play given their success in training other safety skills (Gatheridge et al., 2004; Himle, Miltenberger, Flessner, et al., 2004; Himle, Miltenberger, Gatheridge, et al., 2004; Miltenberger et al., 2004, 2005). In their initial study, Himle, Miltenberger, Gatheridge,and colleagues (2004) compared BST to the Eddie Eagle GunSafe Program and a control group to assess the effectiveness of the two training programs. The authors conducted training with 4- and 5-year-olds during five brief sessions of each program to keep training times consistent across programs. Children in the Eddie Eagle group were trained in small groups, in a manner consistent with the instructions in the Eddie Eagle training materials manual. Small groups of children in the BST program received instructions and modeling, then rehearsed the skills across a variety of scenarios in which they found a gun in each of the five 15-minute sessions. The researchers used a real (but disabled) gun in training, and created simulations in which the child found a gun in different situations in the home to promote generalization.

Self-report, role-play, and *in situ* assessments followed training. Safety skills were assessed according to a 4-point scale (0 = *touched the gun*, 1 = *did not touch the gun*, 2 = *did not touch the gun and immediately left the room*, and 3 = *did not touch the gun, immediately left the room, and told an adult about the finding the gun*). In the self-report assessment, the researchers described a scenario in which the child found a gun and asked the child what he or she would do in the situation. In the role-play assessment, the researcher described a scenario in which the child found a gun, then simulated the situation with a real but disabled gun (e.g., the researcher placed the gun on a table and told the child to pretend to find the gun on the kitchen table in his or her home). The researcher told the child, "Show me what you would do if you found the gun." In the *in situ* assessment, the researcher placed a gun in a room in the home or day care setting without the child's knowledge, and the parent or teacher asked the child to go to the room for some reason (e.g., "I have a snack waiting for you on the kitchen table"). The researchers videotaped, via a hidden camera, the child's behavior upon finding the gun.

Children in both training programs scored significantly higher than controls on the self-report measure (they could say what to do upon finding a gun). BST children scored significantly higher than both the Eddie Eagle group and controls on the role-play assessment, with all BST children receiving a score of 3. Finally, *in situ* assessment scores were equivalent for all three groups, showing that the skills did not generalize to naturalistic assessments. The results of this study are shown in Figure 25.1. This study highlights the importance of multiple assessment procedures to examine the full breadth of skills acquisition and generalization (Himle, Miltenberger, Gatheridge, et al., 2004). The results also highlight the distinction between a skills deficit and a performance deficit that may account for failure to exhibit the safety

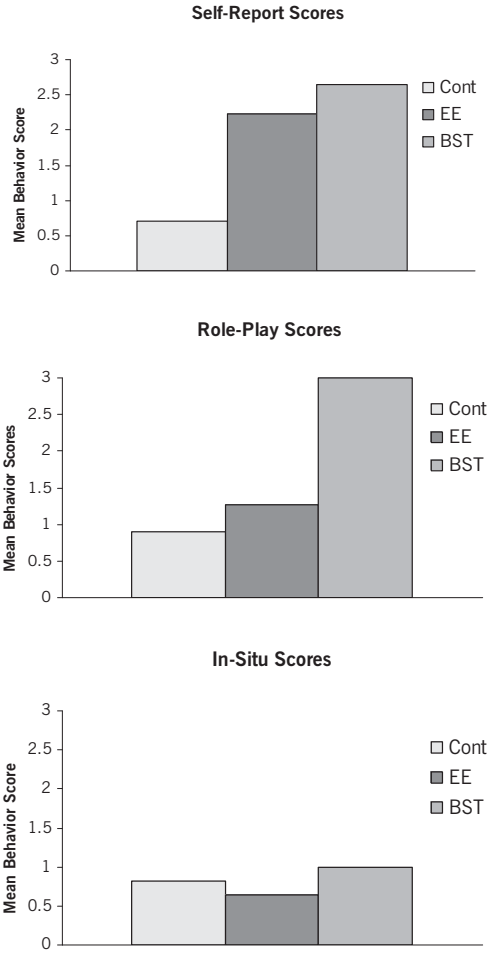


FIGURE 25.1. Mean scores for the control, Eddie Eagle GunSafe Program, and behavioral skills training groups on the self-report, role-play, and *in situ* assessments appear in the top, middle, and bottom panels, respectively.

skills following training. The BST children had acquired the safety skills, as measured in the role-play assessment, but then failed to perform the skills during the *in situ* assessment. Similar findings have been reported in other safety skills training studies (Lumley et al., 1998; Miltenberger et al., 1999).

Himle, Miltenberger, Flessner, and colleagues (2004) conducted another study with 4- and 5-year-olds, evaluating procedures to promote generalization of firearm safety skills from training sessions to *in situ* assessments. Eight children were trained individually in two 30-minute BST sessions. In each session, upon finding a gun in a variety of scenarios, the child rehearsed the safety skills, receiving praise and feedback, until he or she performed the skills correctly five times in a row. Children were then assessed (with *in situ* assessments) and given up to three booster sessions if they did not perform correctly. Booster sessions included instructions, modeling, rehearsal, and feedback, similar to the initial training sessions. *In situ* training was implemented if the child still did not perform correctly during the assessment that followed the third booster session. During *in situ* training, the trainer entered the assessment situation, observed the child failing to exhibit the safety skills correctly, and provided a short training session in which the child was required to rehearse the safety skills correctly five consecutive times.

During baseline, no participants exhibited the safety skills. All children scored 0 or 1 on the 0- to 3-point scale. Three children performed to criterion (three consecutive scores of 3) following training and booster sessions. The other five children achieved criterion scores with the addition of *in situ* training (see Figure 25.2). Follow-up assessments occurred in the home between 2 weeks and 2 months following training. All children received a score of 3, with the exception of one child who received a score of 2 (failed to report the gun to an adult). This child exhibited the safety skills on a subsequent assessment (Himle, Miltenberger, Flessner, et al., 2004).

In a similar study, Miltenberger and colleagues (2004) evaluated individual BST with *in situ* training as needed for teaching safety skills to six 6- and 7-year-old children. Three of the children achieved criterion performance following two to four BST sessions, but the other three children required *in situ* training before they exhibited the skills consistently during *in situ* assessments. The skills generalized to the home setting and were maintained 5 months following training for all of the children.

The results of Himle, Miltenberger, Flessner, and colleagues (2004) and Miltenberger and colleagues (2004) demonstrated the importance of *in situ* training for teaching safety skills to children. *In situ* training resulted in successful performance for all children when children did not perform the safety

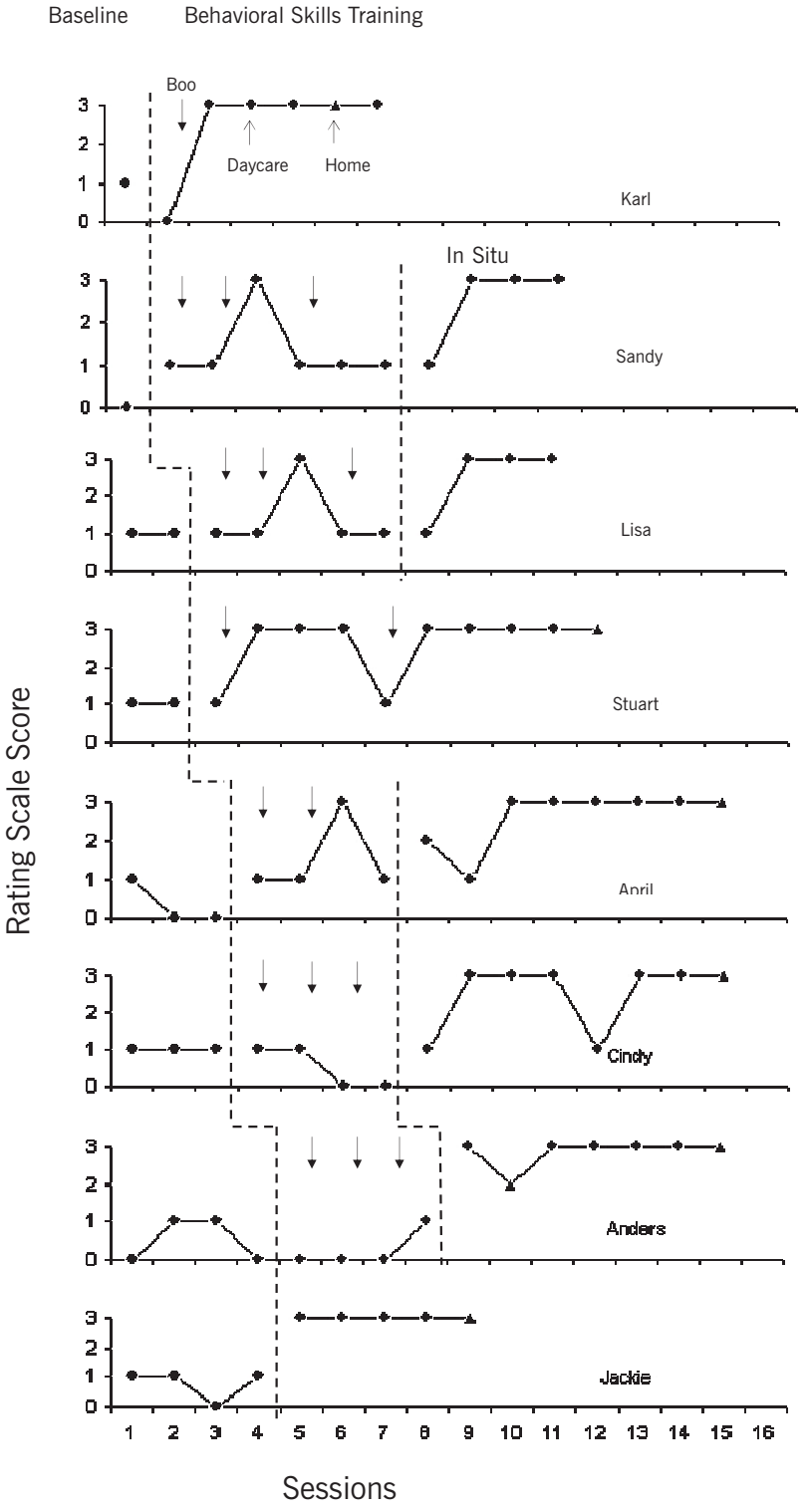


FIGURE 25.2. Rating scale scores for each child during assessments conducted in baseline, behavioral skills training, and *in situ* training (if required).

skills during *in situ* assessments following BST.

In a replication of the Himle, Miltenberger, Gatheridge, and colleagues (2004) study, Gatheridge and colleagues (2004) compared the effectiveness of the Eddie Eagle GunSafe Program and BST implemented in small groups with 6- and 7-year-olds. In addition, they evaluated the use of *in situ* training with participants who did not exhibit the skills following initial training with BST or the Eddie Eagle GunSafe Program. The results showed that children in Eddie Eagle and BST groups again had higher safety skills scores than controls on the self-report assessment; that is, children in both training groups could tell the researcher what to do upon finding a gun. Role-play assessments revealed that children in the Eddie Eagle and BST groups scored significantly better than controls, but that BST children also scored significantly better than Eddie Eagle children. In fact, all children in the BST group scored a 3 during the role-play assessment, showing that they had acquired the safety skills (consistent with the results for the 4- and 5-year-olds in the study by Himle, Miltenberger, Gatheridge, et al., 2004). Finally, *in situ* assessments revealed that BST children scored significantly higher than Eddie Eagle and control children. Unlike the 4- and 5-year-olds who did not exhibit the safety skills during *in situ* assessments following BST in the Himle, Miltenberger, Gatheridge et al. study, most of the 6- and 7-year-olds who received BST in this study did exhibit the safety skills during posttraining in *in situ* assessments. Almost all of the Eddie Eagle children needed additional *in situ* training before performing the safety skills, but only a few BST children required *in situ* training (Gatheridge et al., 2004).

Research by Himle, Miltenberger, Flessner, and colleagues (2004) and Miltenberger and colleagues (2004) suggested that *in situ* training was needed following BST to promote generalization of the skills for half of the participants; therefore, Miltenberger and colleagues (2005) evaluated BST, incorporating *in situ* training early on. In this study, 10 4- and 5-year-olds received two 30-minute BST sessions and an *in situ* assessment and *in situ* training session 30 minutes after the second session. A novel trainer entered the assessment situation and conducted *in situ* training if the child did not exhibit the safety skills. The child received praise from the adult to whom the gun was reported if the child engaged in the safety skills correctly during the *in situ* assessment. Further *in situ* training sessions were conducted, if needed, for the children to use the safety skills in subsequent assessments. Miltenberger and colleagues found that all 10 children learned the skills in just a few training sessions, and that the skills generalized and maintained over a 3-month follow-up. Furthermore, five of the participants participated in a dyad assessment in which they found the gun while with a peer, and all five engaged in the safety skills successfully (see Figures 25.3 and 25.4). These results suggest that the inclusion of *in situ* training may make BST more effective and efficient (Miltenberger et al., 2005). It is also possible that *in situ* training alone would have been effective. Further research should investigate this possibility.

Conclusion

A number of conclusions can be drawn, based on the results of the studies evaluating BST for teaching safety skills to children to prevent gun play. First, BST is superior to the Eddie Eagle GunSafe Program, an informational approach without an active learning component. This finding is consistent with other research demonstrating that rehearsal of the skills with feedback is a necessary component of training programs (e.g., Beck & Miltenberger, 2009; Poche et al., 1988). Table 25.1 shows the sequence of steps in BST for teaching safety skills to children to prevent gun play.

Second, the number of BST sessions required for children to exhibit the safety skills varies across children. In some cases, children exhibited the skills after two training sessions; in other cases, children did not exhibit the skills after five training sessions. This finding was consistent across 4- to 7-year-old children and suggests that assessments of safety skills must be repeated to determine how many training sessions are required for the generalized use of the skills.

Third, some children do not exhibit the safety skills until they undergo *in situ* training. All children who received *in situ* training exhibited the safety skills after one to three

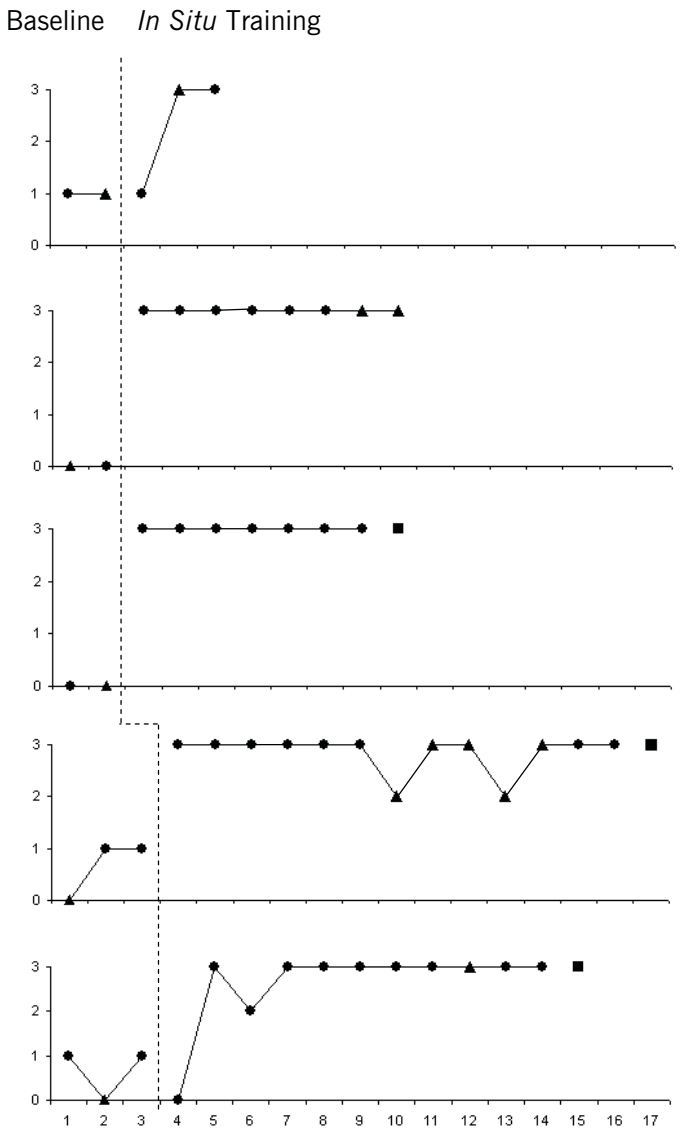


FIGURE 25.3. Rating scale scores for participants during baseline and *in situ* training phases.

training sessions (most after just one session) regardless of how many BST sessions preceded *in situ* training. It is not entirely clear what behavioral mechanism underlies the effectiveness of *in situ* training. One possibility is that it simply involves reinforcing instances of generalization, a known strategy for promoting generalization (Stokes & Baer, 1977). Another possibility is that getting caught exhibiting the incorrect behavior (and having to rehearse the safety skills a number of times) serves to punish the incorrect behavior, and avoidance of getting caught negatively reinforces the use of the safety skills in subsequent assessments.

Fourth, children's responses to different types of assessment were not consistent, showing that different repertoires are involved in describing the appropriate safety skills, demonstrating the skills, and using the skills during *in situ* assessments. This research shows that children can acquire the safety skills, as demonstrated in role plays, yet still fail to perform the safety skills when

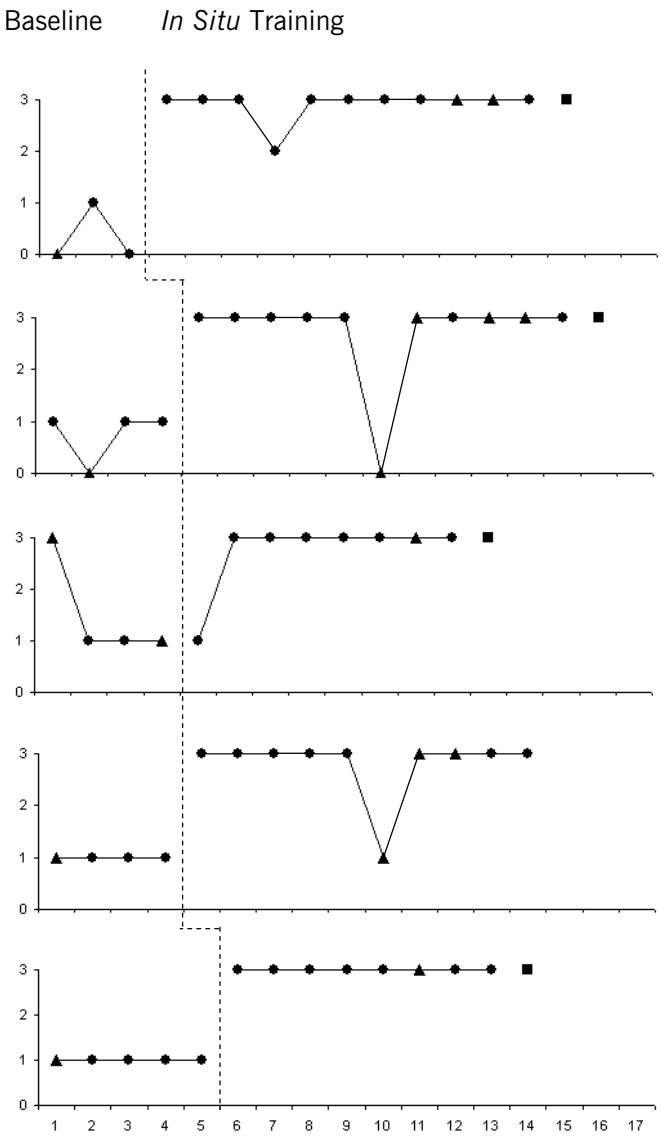


FIGURE 25.4. Rating scale scores during baseline and *in situ* training phases.

assessed without their knowledge. As such, the failure to perform the skills during *in situ* assessments can be viewed as a performance deficit, not a skills deficit. This finding suggests that *in situ* training may function more as a contingency management procedure than as a skills training procedure. Therefore, BST may be most appropriate for teaching the skills, whereas *in situ* training may be most appropriate for reinforcing use of the skills.

Future Directions

A number of areas of research may be pursued to further our knowledge of how best to teach safety skills to children. One topic for future research is investigation of factors that may influence the effectiveness of BST procedures. At this point, research suggests that BST is superior to informational approaches, and that individual BST is superior to BST conducted with groups. However, future research should investigate (1) whether

TABLE 25.1. Steps in BST for Teaching Safety Skills

- Provide instructions: Describe the dangers of playing with firearms and the safety skills to use when finding an unattended gun ("Don't touch it, get away, and tell an adult about the gun"). Give examples to illustrate the safety skills in different situations.
- Model the safety skills: Simulate a situation in which you find a gun (using a disabled firearm or a replica of a real gun) and demonstrate the safety skills—"Don't touch it, get away, and tell an adult about the gun." Describe the importance of the skills after modeling them.
- Provide the opportunity for rehearsal: Set up a scenario in which the child could find a gun (e.g., on a shelf in the parents' bedroom) and place a gun (a disabled gun or a replica of a real gun) in the simulated situation. Ask the child to show you the safety skills. During the rehearsal, set up the situation so the child has to run out of the room and tell an adult in another room about finding the gun.
- Provide praise and feedback: Provide descriptive praise for correct rehearsal of the safety skills or for any aspect of the skills that was executed correctly. Provide further instruction for improvement (feedback) if any aspect of the safety skills was executed incorrectly.
- Repeat, with a variety of scenarios: Have the child rehearse the safety skills with praise and feedback in a variety of different scenarios, each representing a situation in which a gun could be found in his or her home or the home of a friend.

there are age differences in the effectiveness of BST, and how BST may need to be modified for different ages of children; (2) the optimal number of training sessions for maximum effectiveness in the minimum amount of training time; and (3) whether features of *in situ* training can be integrated efficiently into BST to increase its effectiveness.

Another topic for future research is the distinction between a skills deficit and a performance deficit that appears to underlie the failure to use the safety skills during *in situ* assessments. If researchers analyze factors that contribute to failure to use the safety skills once they have been acquired and demonstrated in training sessions, then these factors may be addressed in training programs. For example, perhaps children fail to use the safety skills because of the competing reinforcement contingency for playing with a gun (e.g., automatic positive reinforcement for gun play), or because of peer contingencies in which they might be ridiculed for not picking up the gun or for reporting finding a gun, or because of rule-governed behavior (they believe they would get in trouble themselves for reporting the gun). These possible explanations are all speculative, but they point to the need to analyze why children fail to use the safety skills they have already demonstrated in role-play assessments.

Another area for future research is to incorporate dyad assessments and peer challenges into training and assessment. The research to date has focused on assessment of skills when the child finds the gun while alone. Only two BST studies have assessed children's skills while finding a gun with a peer (Miltenberger et al., 2005, 2009). It is important to include these situations in assessment and training because children may find a gun while with siblings or peers, and the siblings or peers may play with the gun or challenge the child to play with the gun. For example, training could include scenarios in which a peer challenges the child to play with the gun. Assessments could then be conducted with a confederate who finds the gun with the participant and challenges him or her to touch or pick up the gun (Miltenberger et al., 2009).

One other topic for future research is to evaluate strategies to make BST more efficient to promote widescale use. Safety skills training programs described in the literature are implemented by trainers (i.e., graduate students in behavior analysis) to individual children or small groups of children, typically in a handful of training sessions. Although this training generally is effective, it is time-intensive and requires the presence of trained individuals to implement. Therefore, such training programs are not likely to be adopted widely until they can be delivered more efficiently. One potential strategy to make safety skills training programs more efficient is peer training. More children would benefit because training could be delivered by their peers and not require as much trainer involvement, if peer training were found to be effective. Recent research by Jostad, Miltenberger, Kelso, and Knudson (2008) has shown that 6- and 7-year-olds can learn to provide BST for 4- and 5-year-olds. In this investigation, researchers used BST to train older children to conduct BST with the

younger children. The four 6- and 7-year-olds then trained six 4- and 5-year-olds in two to five BST sessions and delivered *in situ* training, if needed. Jostad and colleagues (2008) showed that all six children learned the safety skills, and that the 6- and 7-year-old trainers also exhibited the safety skills themselves when assessed following training. Results of this study, along with similar results by Tarasenko, Miltenberger, Brower-Breitwieser, and Bosch (2010), suggest that peer training may be a fruitful approach to teaching safety skills. More research is needed to demonstrate the use of peer training in this area.

Another strategy to make safety skills training programs more efficient is to create training programs designed to teach parents or teachers to train their students or children. More children would receive training if teachers or parents used an instructional program (e.g., instructional manual, video, CD) to learn how to conduct BST, then taught their students or their own children. For example, the Eddie Eagle GunSafe Program is designed to teach parents or teachers to conduct training. Unfortunately, it is an informational program that has not been shown to be effective in the research conducted to date (Gatheridge et al., 2004; Himle, Miltenberger, Gatheridge, et al., 2004). Future programs that teach parents or teachers to be trainers of safety skills need to be developed and evaluated in order to be as effective as possible. Promising results from Gross, Miltenberger, Knudson, Bosch, and Brower-Breitwieser (2007) provide preliminary support for the effectiveness of an instructional program to teach parents to use BST to teach safety skills to their children. More research is needed to develop and evaluate the effectiveness of such programs, with the ultimate goal of promoting widescale dissemination.

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CHAPTER 26

Behavioral Pediatrics

Integrating Applied Behavior Analysis with Pediatric Medicine

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Pediatric primary health care providers are the professionals contacted first by parents concerned about their children's behavior problems. About 25% of the children seen in primary care have symptoms that meet criteria for a behavioral or emotional disorder (Costello, Edelbrock, et al., 1988; Horowitz, Leaf, Leventhal, Forsyth, & Speechley, 1992), and another 40% or more may exhibit subclinical behaviors or emotions that cause their parents concern (Costello & Shugart, 1992). As a result, these pediatricians have been referred to as *gatekeepers* for child mental health services (Costello, Burns, et al., 1988; Dulcan et al., 1990) and the locus of their practices as de facto mental health settings (Regier, Goldberg, & Taube, 1978). *Applied behavior analysis* (ABA) is a powerful science that specializes in behavior, its analysis, and the development of methods for influencing it in socially adaptive ways. *Behavioral pediatrics* (BP) is the branch of pediatrics that focuses on the relationship between behavior and pediatric health care (Blum & Friman, 2000; Christophersen, 1982; Friman, 2005a; Friman & Blum, 2003; Russo & Varni, 1982). Our overarching position in this chapter is that integrating ABA and BP extends the scope of ABA, expands effective practice of BP, and improves pediatric health care for children.

BP is a broad field that includes four primary domains of research and practice: (1) the evaluation and treatment of high-frequency, low-intensity (common) child behavior problems presenting in primary health care settings; (2) the influence of physiological variables on child behavior problems; (3) the influence of behavioral variables on child medical problems; and (4) the interaction between physiological and behavioral variables in the evaluation and treatment of medical and behavior problems. The high prevalence of behavior problems presenting in pediatric settings, in conjunction with the increasing recognition of the reciprocal relationship between physiology and child behavior, has led to dramatic growth in BP over the past 30 years (e.g., the *Journal of Developmental and Behavioral Pediatrics* is in its 26th year; the Society of Behavioral Pediatrics is large and growing). ABA has made significant contributions over that time span and these, coupled with the continuing growth of BP, provide multiple opportunities for applied behavior analysts who wish to work in child health care settings.

Relationship between Pediatrics and ABA

As indicated earlier, primary care providers (several subspecialties provide primary

care for children, but the most common by far is pediatrics; hereafter, we use the term *pediatrician* to refer to the providers and *pediatrics*, to the settings) are the professionals most likely to provide initial interventions for behavioral or emotional problems exhibited by children (Christophersen, 1982; Costello, Burns, et al., 1988; Costello, Edelbrock, et al., 1988; Dulcan et al., 1990). The types of interventions most likely to be used are supportive counseling, prescriptive behavioral treatment, or referral (Blum & Friman, 2000; Friman, 2005a; Friman & Blum, 2003). ABA has contributed substantially to the development, implementation, and evaluation of pediatric interventions, especially prescriptive behavioral treatment, for many of the behavior problems initially presenting in primary care (Cataldo, 1982; Christophersen, 1994; Christophersen & Rapoff, 1979; Friman, 2005a; Friman & Blum, 2003). The cardinal principle informing these interventions—that behavior is influenced by its current and historical circumstances—is familiar to and accepted by most pediatricians. Thus, many of these interventions have been incorporated into the practice of primary care pediatrics, including interventions for child discipline, incontinence, sleep disorders, habit disorders, and symptoms of attention-deficit/hyperactivity disorder (ADHD) (e.g., Blum & Friman, 2000; Blum, Williams, Friman, & Christophersen, 1995; Christophersen & Friman, 2004; Dalton & Forman, 1996; Friman & Blum, 2003; Friman & Jones, 1998; Friman & Schmitt, 1989).

In this chapter we discuss in depth four problems that ABA therapists often treat, one representing each of the four primary domains of BP: (1) bedtime struggles, representing common behavior problems; (2) constipation and retentive encopresis, representing physiological influences on behavior; (3) nocturnal enuresis, representing behavioral influences on physiology; and (4) feeding problems, representing the interaction between behavior and physiology.

Bedtime Problems

Teaching children to go to bed, to go to sleep, and to stay asleep throughout the night is difficult for many families in this culture, in that at least 30% of families contend with sleep problems three or more nights a week (Lozoff, Wolf, & Davis, 1985). The difficulties reported by parents include bedtime struggles, such as resistance to going to bed; fussing and crying while in bed; and night waking with fussing, crying, and unauthorized departures from the bedroom. Pediatricians often address these problems by prescribing soporific drugs, but all such medications produce side effects, and treatment gains are often lost when the medication is withdrawn (for a review, see Edwards & Christophersen, 1994).

Behavioral Treatment for Bedtime Problems

The cardinal component of the most effective behavioral interventions for bedtime problems involves one of the first documented and most frequently used ABA-informed procedures, extinction. As children develop sleep habits, they often learn to associate specific environmental factors with self-quieting and the induction of sleep. Misinformed parental efforts to help children sleep (e.g., soothe, cuddle, or lie down with the child until sleep onset occurs) often result in problematic sleep associations that mitigate the process of falling asleep. Unfortunately, when the parent is absent at bedtime, the child is left without the stimulus that is most powerfully associated with sleep. The child's response to parental absence typically involves prolonged and intensive crying that resembles an "extinction burst" (Blampied & France, 1993; Edwards & Christophersen, 1994; Ferber, 1985; Friman, 2005b). This response motivates most parents to intervene either by further soothing or disciplining their child, which, unfortunately, usually worsens the problem. Soothing responses can reinforce crying, disciplinary responses to crying often provoke more crying, and both parental responses limit the child's learning of self-quieting skills (Blampied & France, 1993; Edwards & Christophersen, 1993; Ferber, 1985; Friman, 2005b; Lozoff et al., 1985). Not surprisingly, after failed attempts to solve the problem themselves, parents whose children exhibit bedtime problems often ask their pediatrician for advice. The four procedures most likely to be prescribed are described below; all are derived from ABA.

Extinction

This approach to bedtime problems involves no visits by the parent to the child's bedroom after the child has gone to bed. In effect, the child is left to "cry it out." Generally, extinction works more rapidly than other approaches, but it presents problems that mitigate its overall effectiveness, including the following: (1) Crying can be highly aversive, especially during the first nights of treatment; (2) crying and screaming can draw attention from the neighbors, with predictably problematic consequences; and (3) extended crying and screaming differentially affects parents, which can cause marital discord (Adams & Rickert, 1989; Edwards & Christophersen, 1994; Rickert & Johnson, 1988). Thus, extinction is a straightforward behavioral approach to bedtime problems in children, but it has limited social validity. In an attempt to improve social validity, sleep researchers have developed other multicomponent methods that employ extinction but decrease its intensity and aversiveness for parents through the inclusion of other procedures.

Graduated Extinction

This procedure involves advising parents to ignore bedtime problem behavior for specific time intervals that gradually are increased, usually beginning with a 5-minute interval on the first episode, a 10-minute interval at the second, and 15-minute intervals for subsequent episodes on Night 1 (e.g., Adams & Rickert, 1989). These intervals increase over the course of a week, ending with 35 minutes for the first episode on Night 7, 40 minutes for the second, and 45 minutes for all subsequent episodes and nights. Although children can tantrum for longer than 45 minutes at night, published data (Adams & Rickert, 1989; see also Edwards & Christophersen, 1994) and a large amount of clinical experience described by Ferber (1985) suggest that very few do. Although the mechanism responsible for the effectiveness of graduated extinction remains unknown, one possible explanation is that increasing the response requirement to 45 minutes of crying may lean the schedule so much that the reinforcing effects of sleep supersede the reinforcing effects of parental visitation.

Positive Routines

This procedure involves a hybrid of extinction and a reinforcing bedtime ritual. Parents determine a bedtime they prefer for their child and establish the time their child typically falls asleep. Beginning shortly before the time the child typically falls asleep, parents engage the child in several quiet activities lasting no longer than 20 minutes total. During the activities, the parents issue easily followed instructions and richly supply reinforcement for compliance, followed by the terminal instruction, "Now stay in bed and go to sleep," or something equivalent, a procedure consistent with the high-probability instructional sequence used in behavioral momentum research (Mace et al., 1988). If at any time after the completion of the routines and the terminal instruction the child leaves the bed, the parents place the child back in bed, telling him or her that the routine is over and it is time for bed. Crying or verbalizations are ignored. At specified intervals (e.g., 1 week) the parents move the positive routine back in time 5 to 10 minutes. They continue this backward movement until they arrive at the bedtime they prefer for their child, which can take 6–8 weeks or more. Experimental comparison of the positive routines procedure and scheduled extinction showed that both improved bedtime behavior for children, but that the parents using positive routines reported significantly improved marital relations, suggesting a more socially valid procedure (Adams & Rickert, 1989).

The Bedtime Pass

The Bedtime Pass program involves (1) requiring that children get into bed; (2) providing them with a small, laminated note card exchangeable for one "free" trip out of the bedroom or one visit to them by the parent after being put to bed to satisfy an acceptable request (e.g., for a drink, hug, or visit to the bathroom); (3) surrender of the pass after it is used; and (4) extinction thereafter. In the initial study, the program eliminated the high rates of crying out, calling out, and coming out of the bedroom after bedtime exhibited by two children, ages 3 and 10 years. Additionally, these successful results were achieved without an accompa-

nying "extinction burst" during initial intervention periods, and a large group of sample parents rated the intervention as more acceptable than extinction alone (Friman et al., 1999). The pass program was subsequently replicated in a single-subject analysis of four 3-year-old children (Freeman, 2006) and a randomized trial involving 19 3- to 6-year-old children (Moore, Fruzetti, & Friman, 2003). The pass may have achieved its effectiveness through differential reinforcement of alternative behavior (DRA; Vollmer & Iwata, 1992), in which an appropriate mand (i.e., handing over the pass) allows the child to access potent bedtime reinforcers, and bedtime problems are placed on extinction (for a review of function-based treatments, see Fisher & Bouxsein, Chapter 20, this volume).

This brief discussion of child bedtime problems and their treatment is by no means complete. It merely involves the four ABA-derived interventions that are used most frequently and have the most empirical support (for other interventions, see Burke, Kuhn, & Peterson, 2004; Edwards & Christophersen, 1994; Friman, 2005b).

Influence of Physiological Variables on Child Behavior Problems

The fundamental assumption of ABA is that behavior occurs as a function of environmental circumstances, but this position does not disallow the influence of physiological variables. Rather, many physiological variables are indeed seen as determinative, but are themselves the result of environmental behavior contingencies that occur in a phylogenetic context (Skinner, 1966). Physiological variables often play an initiating role in behavior problems that present in pediatrics. For example, child stomach pain brought on by physiological variables (e.g., flu virus) can lead to missed school. While home from school, the child's behavior is influenced by reinforcers involving avoidance of schoolwork, as well as contact with sympathetic responses from caregivers. These influences can, in turn, result in complaints of stomach pain that do not involve physiological variables, a condition sometimes referred to as *recurrent abdominal pain* (Finney, Lemanek, Cataldo, Katz, & Fuqua, 1989). There are many other examples, and the one we want to discuss here involves constipation, a physiological variable that can cause toileting problems, ranging from resistance to a bona fide diagnostic category known as *retentive encopresis*.

Retentive Encopresis

Definition

Functional encopresis, a common presenting complaint in pediatrics (3–5% of all referrals), is a disorder in which children either voluntarily or involuntarily pass feces into or onto an inappropriate location, usually their clothing (Friman & Jones, 1998; Wright, 1973; Wright, Schaefer, & Solomon, 1979). Encopresis is not diagnosed if the problem is exclusively due to an anatomical or neurological abnormality that prevents continence. The current criteria from DSM-IV (American Psychiatric Association, 1994) are (1) inappropriate passage of feces at least once a month for at least 3 months; (2) chronological or developmentally equivalent age of 4 years; and (3) not due exclusively to the direct physiological effects of a substance (e.g., laxatives) or a general medical condition, except through a mechanism involving constipation. DSM-IV distinguishes two subtypes of encopresis, one with constipation and overflow incontinence and the other without these symptoms. We focus on encopresis with constipation and overflow because this subtype has a physiological cause (i.e., constipation), whereas the etiology of encopresis without constipation remains unknown, but it is clearly not due to constipation.

Relevant Physiology

The large intestine or colon is the distal end of the alimentary tract, which sequentially comprises the esophagus, stomach, small intestine, and colon. We provide a rudimentary description of the system here because it is necessary to understand the physiology that supplies the logic of effective treatment (for more thorough reviews, see Weinstock & Clouse, 1987; Whitehead & Schuster, 1985). The colon is a tubular shaped organ with a muscular wall. It connects the small intestine to the rectum and anus. It has three

primary functions: fluid absorption, storage, and evacuation. Extended storage and planned evacuation are the defining features of fecal continence. Movement of waste through the colon is achieved through muscular contractions called *peristalsis*, which produce a wave-like motion of the colon walls; these movements are stimulated by a variety of external events (e.g., a meal, moving about). As the waste moves through the colon, moisture is absorbed from it, creating semisolid feces.

The *rectum*, a hollow receptacle at the distal end of the colon, usually contains little or no feces until muscular contractions in the colonic wall propel feces into the rectum. This results in distension, which stimulates sensory receptors in the rectal mucosa and in the muscles of the pelvic floor, resulting in relaxation of the internal sphincter, which facilitates defecation. This process is involuntary, but the child can constrict the anal canal and inhibit defecation by contracting the external anal sphincter and the functionally related puborectalis muscle. When the urge to defecate is suppressed this way, the rectum accommodates the retained stool through the adaptive pliance of its structure and terminates the reflex relaxation of the internal sphincter. The urge gradually decays and some of the fecal matter in the rectum is returned to the descending colon by retroperistalsis.

Etiology

Between 80 and 95% of encopresis cases can be traced to a primary causal variable, constipation (Levine, 1975; Wright et al., 1979). Although definitions for constipation vary, children who frequently go 2 or more days without a bowel movement are probably prone to constipation. A common complaint by the parents of encopretic children is that the children deliberately soil their clothing (Wright et al., 1979), but this attribution is usually false (Levine, 1982). The primary cause of soiling is fecal retention (constipation), which is generally not caused by characterological or psychopathological problems (Friman, Mathews, Finney, & Christophersen, 1988; Gabel, Hegedus, Wald, Chandra, & Chaponis, 1986). Retention is usually the result of a constellation of factors, many of which are beyond a child's immediate control (Levine, 1982). These factors include a constitutional predisposition (i.e., slow gastrointestinal transit time), diet, insufficient leverage for passage of hard stools, and occasional or frequent painful passage of hard stools resulting in negative reinforcement for holding stools (Christophersen & Rapoff, 1983). In rare cases, retention may be related to sexual abuse. For some children, especially those with extreme constipation and/or treatment failure, there is an increased threshold of awareness of rectal distension, a possibly weak internal sphincter, and/or a tendency to contract the external sphincter during the act of defecation (Meunier, Marechal, & De Beaujeu, 1979; Wald, Chandra, Chiponis, & Gabel, 1986). The combined effect of all these factors is a lowered probability of voluntary stool passage and a heightened probability of fecal retention.

Chronic fecal retention results in fecal impaction, which results in enlargement of the colon. Colon enlargement results in decreased motility of the bowel system and occasionally in involuntary passage of large stools and frequent soiling due to seepage of soft fecal matter. The seepage is often referred to as *paradoxical diarrhea* because the child retains large masses of stool and thus is functionally constipated, but the colon allows passage of soft stool around the mass, which results in diarrhea (Christophersen & Rapoff, 1983; Levine, 1982). That fecal impaction is related to encopresis is well established, and 80% of patients show fecal impaction accompanying fecal incontinence via clinical exam at the first clinic visit, and 90% do so when an X-ray of the lower abdomen is used (Davidson, 1958; Levine, 1975; Wright, 1975).

Evaluation

Either prior to or directly following the initial visit, a child with encopresis should be referred to the pediatrician for a medical examination, which usually includes a routine check of history and abdominal palpation, rectal examination, and sometimes an X-ray of the abdomen to determine the extent of fecal impaction. A barium enema is rarely necessary unless features of the exam suggest Hirschsprung's disease. There are rare anatomical and neurological problems that

can lead to fecal retention and soiling (e.g., Hirschsprung's disease), including a variety of malformations and locations of the anus, which are detectable on physical exam and require medical management (Hatch, 1988).

In addition to routine behavioral assessments, the behavioral interview for encopresis should include questions related to constipation. These include asking whether (1) there is ever a long period between bowel movements, (2) bowel movements are atypically large (stop up the toilet), (3) fecal matter ever has an unusually foul odor, (4) fecal matter is ever hard and difficult or painful to pass, (5) the child ever complains of not being able to feel the movement or make it to the toilet on time, and (6) the child ever hides soiled underwear. An affirmative answer to one or more of these questions is highly suggestive of retentive encopresis, and hiding underwear suggests a history that includes some form of punishment.

Encopresis is not well understood outside of the medical community, and parents' interpretations of the condition are likely to be influenced by the characterological and psychopathological interpretations that are prevalent in Western culture, which, in turn, may influence how the children view their problem. The encopresis evaluation can actually begin treatment by providing accurate information that "demystifies" the problem. Last, the evaluation should include questions about diet and timing of meals. Low-fiber diets and irregular meals can be contributing factors in encopresis.

Treatment

During the past 15 years, several descriptive and controlled experimental studies supporting a multicomponent approach to treatment of chronic retentive encopresis have derived partly from the pioneering work of Davidson (1958), Christophersen and Rainey (1976), Levine (1975), and Wright (1975). As indicated earlier, first, the encopresis component can be addressed within the evaluation. Specifically, the entire elimination process, including its disordered manifestations, should be demystified (Christophersen & Rapoff, 1983; Levine, 1982). Generally this means providing information about bowel dynamics and the relationship of the problem to constipation (Levine, 1982). Second, if there is a fecal impaction, it should be removed with enemas and/or laxatives (Christophersen & Rapoff, 1983; Levine, 1982; O'Brien, Ross, & Christophersen, 1986). Third, the child should sit on the toilet for about 5 minutes one or two times a day (O'Brien et al., 1986; Wright, 1975). Fourth, the parents should promote proper toileting with encouragement and not with coercion. Additionally, they should not reserve all of their praise and affection for proper elimination; a child should be praised just for sitting on the toilet (Christophersen & Rapoff, 1983; Levine, 1982; Wright, 1975). Fifth, a stool softener such as mineral oil (Davidson, 1958) or glycerin suppositories (O'Brien et al., 1986; Wright & Walker, 1977), should be used to ease the passage of hard stools. Sixth, dietary fiber should be increased in the child's diet (Houts, Mellon, & Whelan, 1988; O'Brien et al., 1986). Seventh, to increase and maintain motility in the child's colon, the child's activity levels and fluid intake should be increased (Levine, 1982). Eighth, during toileting episodes, the child's feet should be on a flat surface. Foot placement is crucial to the Valsalva maneuver (the grunting and pushing necessary to produce a bowel movement; Levine, 1982; O'Brien et al., 1986). And ninth, the child should be rewarded for all bowel movements in the toilet (Christophersen & Rainey, 1976; Levine, 1982; O'Brien et al., 1986; Wright & Walker, 1977).

The literature on this approach (or variations thereof) has progressed sufficiently to lead to group trials. For example, in a study of 58 children with encopresis, 60% were completely continent after 5 months, and those who did not achieve full continence averaged a 90% decrease in accidents (Lowery, Srour, Whitehead, & Schuster, 1985). There are other examples (e.g., Stark et al., 1997).

However, not all children succeed with the conventional approach, and augmentative methods have been developed for these children. In a manner typical of ABA, developing these augmentative methods began with the study of behaviors associated with treatment failure (Stark, Spirito, Lewis, & Hart, 1990). Incorporating behavior management methods relevant to the behaviors, teaching parents to use them, and delivering treatment in a group format resulted in an 83% decrease in accidents in 18 treatment-resistant children with encopresis, and the results were maintained or even improved at

6-months follow-up (Stark, Owens-Stively, Spirito, Lewis, & Guevremont, 1990).

The general premise of this section—that physiological variables can influence or cause behavior problems—is not controversial, even within ABA, a science dedicated to environmental variables. Constipation is one such variable, and it can cause behavior problems ranging from minor toileting resistance to encopresis and many other problems (e.g., anorexia due to gastroesophageal reflux, restricted activities due to pain). Because of the physiological component of these problems, there are frequently serious health consequences for unsuccessful treatment that compound any behavior problem components. For example, extreme fecal retention can be life threatening, and even routine cases seriously decrease social standing and increase social distancing in affected children. Because of the behavioral component of these problems, a solely medical intervention is insufficient for effective treatment. Needed are treatments that deliver or aid the delivery of medical components of treatment, while addressing the behavioral components; thus, BP is an ideal context. Additionally, although many types of behavior problems stem from physiological influences, the most frequently occurring problem is some form of noncompliance with a treatment regimen for the physiological dimensions. As an example, cooperation with prescribed treatment for encopresis is so necessary for success that instructional control training is frequently a component of treatment (Friman & Blum, 2003). And the literature on improving adherence to pediatric regimens is dominated by ABA-informed methods (Rapoff, 1999). Furthermore, although progress has been made, improving pediatric compliance remains one of the most chronic problems in all of pediatric medicine. Therefore, this domain of BP provides many opportunities for applied behavior analysts interested in working in pediatric health care settings.

Influence of Behavioral Variables on Child Medical Problems

In this section we discuss the influence of behavior on physiological variables, with emphasis on the behavioral treatment of physiologically based behavior problems frequently seen in pediatrics. For decades, health-based sciences have demonstrated relationships between child behavior and health. Examples are (1) eating nutritious food and engaging in modest exercise to improve child cardiovascular health, (2) obtaining sufficient sleep to improve child emotional resiliency and adaptability, and (3) maintaining adequate personal hygiene to decrease child susceptibility to infectious disease. More recently, ABA has demonstrated a variety of healthful outcomes from changes in behavior (e.g., Finney, Miller, & Adler, 1993; Friman & Christophersen, 1986; Irwin, Cataldo, Matheny, & Peterson, 1992; Stark et al., 1993; Winett et al., 1991). A review of this literature is beyond the scope of this chapter. In this section we merely focus on biofeedback, a treatment involving the manipulation of behavioral variables to improve health and use treatment of nocturnal enuresis (NE), a physiologically based behavioral problem that is one of the most frequent presenting behavioral complaints in primary care pediatrics, as the primary example.

Biofeedback involves the use of electrical or electromechanical equipment to measure and increase the salience of stimuli associated with pertinent physiological processes and training patients to discriminate and control them to improve their own health. The penultimate goal of biofeedback is to train individuals to alter the physiological processes in healthful directions, and the ultimate goal is to train them to do so without biofeedback (Culbert, Kajander, & Reaney, 1996). Because most biofeedback treatments require sophisticated instrumentation and specialized training to use them, they may not be incorporated readily into primary care practices (e.g., anorectal manometry combined with electromyography for treatment of fecal incontinence). However, NE is highly responsive to *urine-alarm treatment*, a minimally technical, uncomplicated form of biofeedback that is readily used in primary care settings (Friman, 1986). Below we briefly review nocturnal enuresis, its relevant physiology, and its treatment.

Nocturnal Enuresis

Definition

The current criteria for enuresis (nocturnal and diurnal) from DSM-IV (American Psy-

chiatric Association, 1994) are (1) repeated urination into bed or clothing; (2) at least two occurrences per week for at least 3 months, or a sufficient number of occurrences to cause clinically significant distress; (3) chronological age of 5 or, for children with developmental delays, a mental age of at least 5; (4) not due exclusively to the direct effects of a substance (e.g., diuretics) or a general medical condition (e.g., diabetes). There are three subtypes of enuresis: nocturnal only, diurnal only, and mixed nocturnal and diurnal. There are two courses: The primary course includes children who have never established continence, and the secondary course involves children who, after establishing continence, resume having accidents. This section primarily involves NE, which is estimated to occur in as many as 20% of first-grade children (Friman, 1986, 1995; Friman & Jones, 1998).

Relevant Physiology

The bladder (detrusor) is an elastic hollow organ with a muscular wall. Its shape resembles an upside-down balloon with a long narrow neck; it has two primarily mechanical functions, storage and release of urine (Vincent, 1974). Extended storage and volitional release are the defining properties of urinary continence. In infancy, distension of the bladder leads to contraction of the bladder and automatic (nonvolitional) evacuation of urine. As children mature, the capacity of the central nervous system to inhibit bladder contraction increases, which typically coincides with the development of continence in early childhood (Berk & Friman, 1990; Koff, 1995).

The components of the urogenital system that are under volitional control to establish continence are the muscles of the pelvic floor. Except during imminent or actual urination, these muscles remain in a state of *tonus*, or involuntary partial contraction, which maintains the bladder neck in an elevated and closed position (Vincent, 1974). Even after initiation of urination has begun, contraction of the pelvic floor muscles can abruptly raise the bladder neck and terminate urination. But for children with nocturnal enuresis, these urinary inhibitory responses are either not present or sporadic (Friman, 1995; Friman & Jones, 1998; Houts, 1991).

Etiology

Although NE has a strong genetic basis, its exact cause is unknown. For decades there has been a sustained effort to link it to causal psychopathology, but contemporary research (Friman, Handwerk, Swearer, McGinnis, & Warzak, 1998), as well as several reviews of older research (Friman, 1986, 1995; Friman & Jones, 1998), suggests that most enuretic children do not exhibit clinically significant psychopathology, and when they do, it is more likely to be an outcome rather than a cause of NE. Physiologically oriented studies of NE suggest that some affected children may have difficulty concentrating their urine during the night; thus, they produce more urine nocturnally than their nonenuretic peers (Lackgren, Neveus, & Stenberg, 1997; Rittig, Knudsen, Norgaard, Pedersen, & Djurhuus, 1989). The overall importance of this factor, however, is controversial because the proportion of enuretic children with urine concentration problems may be small (Eggert & Kuhn, 1995). Finally, NE may be viewed as merely a deficit in the skills necessary to prevent urination while asleep (Houts, 1991).

Evaluation

As with encopresis, the behavior analyst should refer a child with NE to a pediatrician for a medical evaluation prior to initiation of treatment. There are pathophysiological causes of NE, and although very rare, they are real and should be ruled out. Several other elements are necessary for a full evaluation of NE, but these are well documented in other research, and because our intention in this section is merely to described alarm-based treatment, we refer the reader to elsewhere (e.g., Christophersen & Friman, 2004; Friman, 1986, 1995; Friman & Jones, 1998, 2005).

Treatment

The two most common treatments for NE are the urine alarm and the two medications, desmopressin acetate (DDAVP) and imipramine. These medications can provide symptomatic relief—approximately 25–40% of children are dry most nights when taking them; however, when the medications are

stopped, the enuresis usually returns (Moffatt, 1997). The *urine alarm* is a moisture-sensitive switching system that sounds an alarm when the child wets the bed. Repeated pairing of awakening by the alarm with episodes of wetting is consistently described in the literature as the single most effective treatment for enuresis (Christophersen & Friman, 2004; Friman, 1986, 1995; Friman & Jones, 1998, 2005). Its success rate is higher (approximately 75%) and its relapse rate lower (approximately 41%) than any other drug or skills-based treatment.

We describe use of the urine alarm as a simple form of biofeedback treatment here because its primary function is to provide "feedback" for a physiological event, urination, which occurs beneath awareness. The feedback (ringing of the alarm) increases the salience of the urination, thus aiding in the ultimate establishment of urinary self-control. The mechanism by which the alarm improves enuresis, however, is still unknown. Changes in secretion of hormones that affect the ability to concentrate urine (Friman, 1995; Friman & Jones, 1998; Houts, 1991) or alterations in the brain's inhibition of bladder contraction are at least theoretically possible but have not been investigated. The current prevailing account involves a combination of classical conditioning of pelvic floor muscles and operant conditioning of volitional behaviors related to continence via avoidance of the alarm (Houts, 1991). With this account, children are not necessarily trained to awaken to the alarm; they merely engage their urinary inhibition system even if they are asleep, a skill that would be difficult to teach without the sensory "feedback" provided by the alarm.

The enuresis alarm produces a cure slowly, and during the first few weeks of alarm use, waking, if it occurs at all, occurs only after a complete voiding. Recent research using the size of the urine stain on the soiled sheets as the dependent measure showed that prior to accident-free nights, the stain grew increasingly smaller on successive nights, suggesting a graduated process of continence attainment (Ruckstuhl & Friman, 2003). In other words, the feedback properties of the alarm gradually but inexorably strengthened the skills necessary to avoid it. The core skill involves contraction of the pelvic floor muscles and sustained elevation of the bladder neck, resulting in the cessation or, preferably, prevention of urination. There is also the possibility of increased sensory awareness of urinary need and waking to urinate, but this is a less likely outcome and actually inferior to sustained, accident-free sleep throughout the night.

However, increasing sensory awareness of urinary need prior to daytime accidents is a key component in the most empirically supported treatment for diurnal enuresis. Only two studies are available (very little research has been conducted on diurnal enuresis) and the first used a much simpler conceptualization (Halliday, Meadow, & Berg, 1987). Specifically, this early study merely suggested that the alarm served as a reminder for urination. A subsequent study utilizing the biofeedback conceptualization was conducted with a young girl who initially was unresponsive to urinary urge and onset but rapidly became responsive with use of the alarm (Friman & Vollmer, 1995). The decreasing latency between alarm onset and appropriate response was characteristic of learning curves that result from alarm-based treatment for NE and biofeedback treatments in general.

Most biofeedback treatments are much more technically complex than the urine alarm, and they are used for a broad range of physiologically based behavioral concerns that often initially present in pediatric settings. Among the physiological processes that can be monitored are muscle tension, skin temperature, respiratory rate, blood pressure, and skin moisture (perspiration). Biofeedback devices sensitive to these processes have been used in treatment of a wide variety of disorders, including headaches, other varieties of chronic pain, asthma, bruxism, anxiety disorders, sleep disorders, and dysfunction of the autonomic nervous system (Culbert et al., 1996). Additionally, evidence that biofeedback can generate operant responses that, in turn, lead to control over physiological processes, long thought to be outside of volition (e.g., skin temperature and blood pressure), is mounting. For example, verbally based "awareness" enhancement methods have been shown to alter the level of mediators of the immune system in saliva (Olness, Culbert, & Uden, 1989), and to decrease the recurrence of chronic mouth ulcers (Andrews & Hall, 1990). Collectively,

the large body of research documenting the effectiveness of the urine alarm, along with the even larger literature on the effectiveness of biofeedback treatment for a broad range of medical conditions, underscores the research and clinical potential represented by the influence of behavioral variables on physiology. This potential, in turn, represents an excellent opportunity for applied behavior analysts interested in working in pediatric settings.

Interaction between Physiology and Behavior

The distinction made thus far between the influence of physiology on behavior and behavior on physiology is an arbitrary one—made here merely for the sake of revealing the wide variety of opportunities for applied behavior analysts in pediatrics. We are well aware that physiology and behavior do not represent separate processes within individuals; they are interacting systems that can no more function independently than can the heart and the brain. As the reciprocal capacity of physiological and behavioral variables to influence each other becomes increasingly clear, decisions about selecting appropriate treatments become more complex. One reason for the complexity is that there is a rapidly growing number of medical and behavioral problems for which there are effective behavioral and physiologically based treatments. For example, both behavioral and pharmacological interventions have been shown to benefit cases involving ADHD, depression, and anxiety. Another reason is that numerous problems need a combination of behavioral and physiologically based treatments for effective care (to an extent, this is true for encopresis and enuresis). A potentially life-threatening problem that often requires medical and behavioral interventions, and for which an impressive line of ABA research has been published, involves extreme feeding resistance.

Pediatric Feeding Disorders

No human activity has greater biological and social significance than eating. During infancy, achievement of adequate physical growth is one of the primary measures used to gauge the child's health and development. Achievement of feeding milestones also to many parents is an affirmation of their competence. When feeding difficulties emerge, parents often express feelings of rejection and inadequacy, and they develop both realistic and catastrophic appraisals of the health risks for the child, if the feeding problem persists. However, feeding difficulties are quite common in children. In fact, most children exhibit difficulties during meals at some point during infancy or childhood. Some of these problems resolve in the absence of intervention (the child will "grow out of it"). But some feeding problems persist and worsen, and professionals must discriminate between children with serious and potentially life-threatening feeding problems and those whose problems resolve without professional intervention.

Definition

Feeding disorders encompass a wide variety of problems, including, but not limited to, refusal to eat; refusal to eat certain types or textures of food; dependence on a limited or developmentally inappropriate source of nutrition (e.g., bottle dependence in a 3-year-old); and skill deficits, such as inability to self-feed. Attempts at developing diagnostic criteria for feeding disorders have been woefully inadequate and fail to capture the heterogeneity of the problem and its causes. For example in DSM-IV, Feeding Disorder of Infancy and Childhood (307.59) is described as a "persistent failure to eat adequately, as reflected in significant failure to gain weight or significant weight loss over at least 1 month" with an onset prior to age 6 (American Psychiatric Association, 1994, p. 107). Criteria for diagnosis of a feeding disorder also specify that no medical condition severe enough to account for the feeding disturbance exists, and that the feeding disturbance is not better accounted for by another mental disorder or by lack of available food. By contrast, feeding problems of a nonorganic nature are excluded from the diagnosis of feeding difficulties and mismanagement (783.3) in the *International Classification of Diseases, Ninth Revision* (Practice Management Information Corporation, 2005). Attempts to characterize feeding disorders in dichotomies (e.g., organic vs. nonorganic, medical vs. nonmedical, or behavioral vs. medical) have not been useful.

In fact, recent studies have suggested that the etiology of feeding disorders is complex and multifactorial (Rommel, DeMeyer, Feenstra, & Veereman-Wauters, 2003).

Etiology

A number of studies have indicated that medical, oral–motor, and behavioral factors contribute to the etiology of feeding disorders. For example, Rommel and colleagues (2003) characterized the feeding disorders of 700 children, referred for assessment and treatment of severe feeding difficulties, as medical (86%), oral–motor (61%), and/or behavioral (18%). Combined causes (e.g., medical, behavioral, oral-motor) for the feeding problem occurred in over 60% of patients.

The high prevalence of medical conditions and oral–motor dysfunction in children with feeding disorders suggests that biological factors play an important role in the etiology of feeding problems. Children with severe feeding disorders often present with chronic medical problems that may result in pain, fatigue, and/or nausea during meals, including food allergies, malabsorption, gastroesophageal reflux disease (GERD), delayed gastric emptying, metabolic anomalies, or congenital defects of the gastrointestinal tract. For example, children with GERD may associate eating with vomiting and the pain that occurs when excess acid is released into the stomach or esophagus. Nausea, in particular, plays an important role in the development of aversions to food (Schafe & Bernstein, 1997). When nausea is paired with eating, aversions to tastes that can develop after only one or a few trials may generalize to many foods and be highly treatment resistant.

The presence of other chronic medical problems (e.g., bronchopulmonary dysplasia) also may contribute to the etiology of feeding problems because infants with complex medical histories are subjected to numerous invasive diagnostic tests and procedures that may involve manipulation of the face and mouth (e.g., laryngoscopy). Thus, the child associates the presentation of items to the mouth with discomfort and/or pain. From the child's perspective, a spoon may be indistinguishable from a laryngoscope or other devices used during invasive tests and procedures. Parents of chronically hospitalized and medically fragile children often report "oral aversions" that affect feeding and other activities associated with the face and mouth (e.g., tooth brushing, face washing).

Oral–motor dysfunction may include problems such as difficulties swallowing, inability to lateralize food (move it from side to side), tongue thrust, and difficulties sucking that may affect the child's ability to eat. Preexisting oral–motor dysfunction may be exacerbated when the child refuses to eat, contributing further to the child's failure to develop appropriate oral–motor skills; that is, food refusal interferes with the opportunity to practice the skills of eating, and without such practice, the child does not develop the oral–motor skills necessary to become a competent eater.

When eating is paired with an aversive experience, the child may develop refusal behavior such as batting at the spoon or head turning to avoid eating. These behaviors may increase in frequency as a function of caregiver responses to child behavior during meals, as described in a study by Piazza, Fisher, and colleagues (2003). They observed caregivers and their children with feeding problems during meals. Caregivers responded to inappropriate child behavior with one or more of the following consequences: (1) allowing escape from bites of food or the meal, (2) coaxing or reprimanding (e.g., "Eat your peas; they are good for you"), or (3) providing the child with a toy or preferred food.

Subsequently, Piazza, Fisher, and colleagues (2003) assessed the effects of caregiver consequences on child behavior using analogue functional analyses (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). Inappropriate behavior (e.g., batting at the spoon, head turning) produced attention (e.g., coaxing, brief verbal reprimands) during the attention condition, a break from the spoon presentation during escape, access to a tangible item (e.g., preferred food) during the tangible condition, and no differential consequence during the control condition. Of the 10 children whose functional analyses were differentiated, 90% displayed sensitivity to negative reinforcement. Multiple functions (access to adult attention or tangible items) also were identified for 80% of the children who showed differential re-

sponding during functional analyses. These results suggested that even if the etiology of the feeding disorder was related to a physiological problem, refusal behavior may be maintained by reinforcers such as escape from bites of food, adult attention, or access to tangible items.

Evaluation

Evaluation of a severe feeding disorder should be conducted by an interdisciplinary team, so that the multiple possible causes of feeding problems can be identified by professionals most qualified to rule in or out a particular cause. For example, a comprehensive medical evaluation can rule out or lead to treatment of problems that may be causing pain (e.g., GERD) during eating. An evaluation by an occupational or speech therapist can determine whether any oral–motor dysfunction may be causing or contributing to the feeding disorder. Multiple specialties (e.g., medical, speech and occupational therapy) can determine whether oral feeding is safe for a child with eating problems. As an example, due to risk of aspiration, some children are not appropriate candidates for consumption of some or all types of solids and liquids. Nutrition evaluations are needed to ensure that presented foods are nutritionally and calorically appropriate for the child's age and size. In addition, some medical conditions require the child to follow a carefully regimented diet, and failure to do so may have dire consequences. For example, a child with a glycogen storage disorder requires careful monitoring of blood sugar levels and a diet that is restricted relative to simple sugars. Drops in blood sugar levels may result in seizures, coma, and even death. Thus, as with encopresis and enuresis, behavior analysts should not initiate treatment for severe feeding disorders until appropriate evaluations have been conducted by medical and allied health care professionals.

Treatment

According to Kerwin (1999), effective treatments for feeding disorders are contingency management methods that include positive reinforcement of appropriate eating behavior and ignoring or physical guidance of inappropriate behavior (e.g., Riordan, Iwata, Finney, Wohl, & Stanley, 1984; Riordan, Iwata, Wohl, & Finney, 1980). For example, Riordan and colleagues (1984, 1980) reported the use of positive reinforcement to treat the feeding problems of four children. Acceptance reportedly increased for three of the participants with positive reinforcement alone. However, these data are difficult to interpret because refusal behaviors produced escape during baseline but were ignored during the positive reinforcement treatment. The fourth participant required physical guidance to increase acceptance. Therefore, escape extinction may have been partially responsible for the treatment gains of some or all of these participants.

Since Kerwin's 1999 article, several additional studies published on treatment of feeding disorders have demonstrated the effectiveness of procedures based on extinction of negative reinforcement (so-called escape extinction; Patel, Piazza, Martinez, Volkert, & Santana, 2002; Piazza, Fisher, et al., 2003; Piazza, Patel, Gulotta, Sevin, & Layer, 2003; Reed et al., 2004). The results of these studies have suggested that extinction of escape-maintained behavior may be an important, if not necessary, component of treatment for children with severe feeding disorders (Ahearn, Kerwin, Eicher, Shantz, & Swearingen, 1996; Cooper et al., 1995; Hoch, Babbit, Coe, Krell, & Hackbert, 1994; Patel et al., 2002; Piazza, Fisher, et al., 2003; Piazza, Patel, et al., 2003; Reed et al., 2004). The two procedures that have been evaluated most frequently as escape extinction for feeding problems are nonremoval of the spoon (NRS) and physical guidance (PG). During NRS, the spoon is held at the child's lips until he or she allows the bite to be deposited into his or her mouth. During PG, failure to accept the bite within a specified time period results in application of gentle pressure to the mandibular joint, followed by deposition of the spoon into the child's mouth. Both of the procedures theoretically eliminate the child's opportunity to escape from bite presentations via inappropriate behavior.

Piazza, Patel, and colleagues (2003) attempted to clarify the relative contribution of positive reinforcement and escape extinction as treatment of feeding problems. Four children were exposed to a series of treatments that included differential positive reinforcement (DRA), DRA plus escape extinction, and escape extinction alone. DRA was not

effective alone for increasing acceptance or decreasing inappropriate behavior. Acceptance increased, and inappropriate behavior decreased, only when escape extinction was used in treatment, independent of the presence or absence of DRA.

Similarly, Reed and colleagues (2004) showed that noncontingent reinforcement (NCR) in the absence of escape extinction was not associated with reductions in inappropriate behavior or increases in acceptance. Of note, however, was that DRA (Piazza, Patel, et al., 2003) and NCR components appeared to contribute to treatment for some children when combined with escape extinction by reducing extinction bursts, crying, and other inappropriate behavior. These results suggest that negative reinforcement–based procedures such as NRS and PG play a central role in the treatment of feeding problems, and that positive reinforcement, when combined with escape extinction, may be beneficial for some children. However, positive reinforcement alone may not be effective as treatment for pediatric feeding disorders.

The studies cited here focused primarily on increasing acceptance of food or liquid presentations and decreasing inappropriate behavior, such as batting at the spoon or head turning. However, consumption of food or liquids occurs as the result of a complex chain of behaviors that includes, but is not limited to, accepting bites of food, manipulating the food inside one's mouth (e.g., chewing), swallowing, and retaining food. Children with feeding problems often exhibit problems in multiple or even all components of the chain.

One problem often encountered in children with feeding problems is vomiting, a problem that is almost always considered physiological in origin, and the most common interventions for vomiting are medical (i.e., medications and surgery). However, some children with severe feeding problems do not respond to these medical interventions; therefore, new BP feeding applications and research have focused on decreasing levels of vomiting via behavioral intervention.

The following case example from Piazza and colleagues illustrates one aspect of this line of investigation (Cynkus, Patel, Piazza, & Bethke, 2003). The participant Jon, a 21-month-old male with a history of failure to thrive, had been admitted to a day treatment program for the assessment and treatment of poor oral intake. The researchers increased his acceptance of liquids and solids using a nonremoval of the spoon/cup procedure. They gradually increased the volume of solids and liquids to portions appropriate for Jon's age and weight based on the recommendation of the nutritionist. These volume increases were accompanied by increases in vomiting (*emesis*). Therefore, they conducted an analysis to assess the effects of volume on vomiting.

During baseline, they presented Jon with 110.9 ml of liquid in a cup (low-volume condition), which was approximately half of the recommended volume of liquid for Jon's age and weight. Then they increased the volume of liquid to 221.8 ml, which was the recommended volume of liquid for Jon based on his age and weight. Figure 26.1 depicts the results of the volume analysis. During the low-volume condition, Jon did not exhibit any vomiting in the three phases in which low volume was presented. By contrast, Jon's levels of vomiting increased markedly during both phases in which the higher volume of liquid was presented. Therefore, Jon's final treatment consisted of more frequent, low-volume feedings. In this case, the researchers were able to decrease levels of vomiting in the absence of medication or surgery, the most common interventions for chronic vomiting.

Feeding problems represent an example of the complex interaction between physiological and environmental events. It is likely that, in many cases, feeding problems emerge as a result of the pairing of eating with an aversive event. The child then develops avoidance behaviors (e.g., crying) as a result of this pairing. Caregiver responses to these behaviors probably play a role in whether the behavior improves or worsens over time. A combination of physiological and behavioral interventions are needed to (1) reduce or eliminate the aversive properties of eating, and (2) teach the child that eating is no longer aversive once the physiological problem is resolved. It is unlikely in many cases that a single-discipline approach to the problem will be effective; that is, medical intervention in the absence of a behavioral intervention may not be effective if the child continues to avoid eating even after the aversive stimulus is removed, as is often the case with avoidance behavior. In addition,

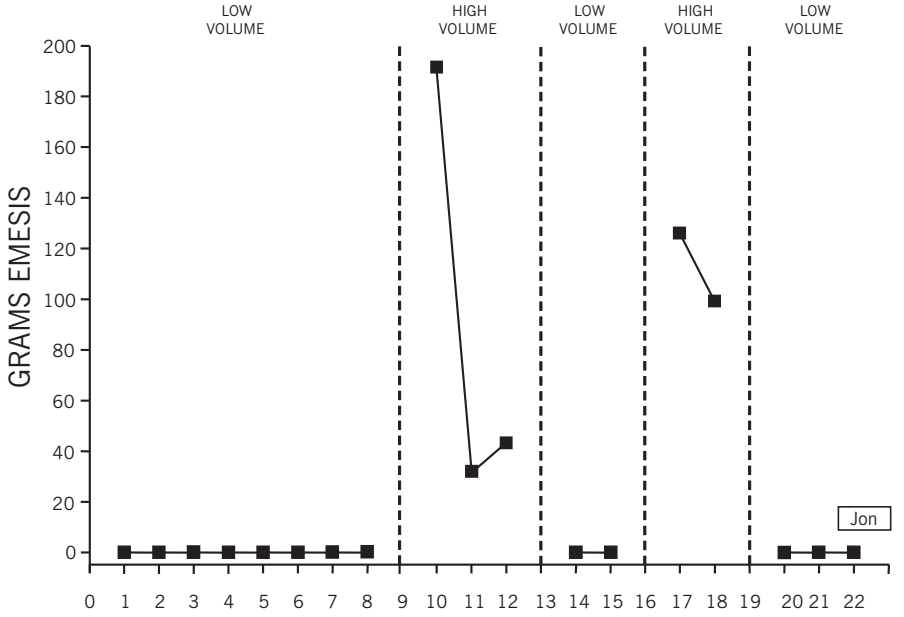


FIGURE 26.1. Grams of emesis (*y*-axis) across sessions (*x*-axis) for Jon during the low- (110.9 ml) and high-volume (221.8 ml) conditions.

behavioral treatment in the absence of medical intervention may only exacerbate the problem if eating continues to be an aversive event.

Conclusion

BP is a diverse field that includes research and treatment of common child behavior problems, as well as research on the interactions between physiology and behavior that affect child health, and treatments derived from the findings of that research. ABA is a science that conducts research on interactions between environmental and behavioral variables, and evaluates interventions for socially significant problems derived from that research. The integration of BP and ABA not only benefits both fields but it also actually extends the effectiveness of pediatricians, the primary guardians of child health in this country, thereby contributing to the health of children. We have confined our discussion to four problem areas, each representing one domain of BP. This represents a much abbreviated review of BP and the potential role of ABA, and there are many aspects of behavioral pediatrics that we have not addressed (e.g., infant colic, oppositional behaviors, habit disorders, anxiety and depressive disorders, chronic illnesses, and pain). For a broader sample, please refer to various source documents (e.g., Allen, Barone, & Kuhn, 1993; Blum & Friman, 2000; Cataldo, 1982; Christophersen, 1982; Christophersen & Rapoff, 1979; Friman & Blum, 2003; Russo & Varni, 1982).

Despite its many contributions to BP, ABA is still not widely available and accepted in the pediatric medical community. Remedying the problem of limited availability is a primary purpose of this chapter; we hope to increase the number of applied behavior analysts interested in BP. Remedying the problem of limited acceptance is an important but subsidiary concern in this chapter. Nonetheless, we suggest a few tactics that may help. For example, at a local level, applied behavior analysts interested in collaborating with pediatricians should attend and present at pediatric conferences and lectures. They should also attend case management discussions in pediatric settings and offer to help physicians implement behavioral assessments and interventions. If these contacts result in a referral, promptly sending data-based feedback on the effects

of the ABA interventions to the referring pediatrician for inclusion in the patient's medical chart not only mirrors standard practice between physicians in all domains of medicine but it also is likely to lead to more referrals. Additionally, increasing demands by third-party payers for documentation of treatment and its effects can make data-based feedback necessary for continued reimbursement for costs accruing from needed ongoing treatment. This fact, coupled with the value ABA places on ongoing data collection, makes applied behavior analysts increasingly attractive as collaborators in pediatric medicine. Applied behavior analysts could also become more involved in medical professional organizations, thereby providing a community resource for questions pertaining to behavior. More systemically, incorporating the clinical phenomena, referred to by hypothetical constructs such as depression, anxiety, or temperament, into behavior analytic theories and making those phenomena the focus of ABA assessments and interventions could advance the field and increase its acceptance (e.g., Friman, Hayes, & Wilson, 1998). Last, and consistent with the primary purpose of this chapter, designing and testing treatments for problems that frequently present in pediatric settings contributes to the recognition of ABA as a resource and acceptance of it as a valuable science by pediatricians. Perhaps more than any other subspecialty in medicine, pediatrics is a pragmatic specialty, and effective and efficient interventions readily trump ideological differences.

In conclusion, the large and mounting body of evidence documenting the many ways ABA has found to influence behavior, coupled with the mutually determinative role played by behavior and physiology, suggests that a partnership between applied behavior analysts and pediatricians would benefit the health of children in this country. This chapter argues that BP is the ideal locus for the partnership.

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CHAPTER 27

Behavior Analysis and Treatment of Drug Addiction

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Drug addiction is among the most serious and costly health problems in the United States. The National Institutes of Health estimated that drug addiction, including illicit drugs, alcohol and tobacco, is associated with annual costs of $500 billon (Office of National Drug Control Policy, 2004). This cost exceeds the estimated cost of other major U.S. health problems, including heart disease ($183 billion), mental illness ($161 billion), Alzheimer's disease ($100 billion), obesity ($99 billion), diabetes ($98 billion), and cancer ($96 billion). Available substance abuse treatments are not effective in all patients (Hubbard, Craddock, & Anderson, 2003), and many individuals with substance use problems remain out of treatment (John, Kwiatkowski, & Booth, 2001). Extensive evidence from the laboratory and the clinic suggests that drug addiction can be viewed as operant behavior and effectively treated through the application of principles of operant conditioning (Higgins, Silverman, & Heil, 2008). This chapter provides an overview of operant laboratory models of drug addiction and research on the treatment of drug addiction through the direct application of operant conditioning.

Operant Laboratory Models of Drug Addiction

The application of operant principles to the understanding and treatment of drug addiction is rooted in impressive laboratory models of drug addiction, which evolved in the early 1960s (Schuster & Thompson, 1969). The pioneers in this area recognized the importance of operant principles in understanding drug addiction. In their review of early progress in this field, Schuster and Thompson (p. 483) suggested that, "the literature regarding the behavioral aspects of drug dependence can most profitably be interpreted within the framework of operant conditioning principles." Outlining the direction for this emerging field, they suggested, "The principal goal of the experimental analysis of the behavioral aspects of drug dependence is to determine the biological and environmental variables which modify a drug's reinforcing efficacy, that is, the extent to which a drug is self-administered" (p. 483).

Drug Reinforcement and Drug Self-Administration

Methods for studying drug reinforcement were established by the end of the 1960s

(Schuster & Thompson, 1969). Extensive research has shown that nonhumans and humans will self-administer a range of drugs, most notably cocaine (Carroll & Bickel, 1998; Johanson & Fischman, 1989), opiates (Schuster & Johanson, 1981), alcohol (Meisch, 2001), benzodiazepines (Griffiths & Weerts, 1997), nicotine (Le Foll & Goldberg, 2005), and marijuana (Justinova, Goldberg, Heishman, & Tanda, 2005). Early laboratory studies showed that drug reinforcement could exert seemingly overwhelming control over an animal's behavior. In a striking early study, Johanson, Balster, and Bonese (1976) showed, for example, that rhesus monkeys given virtually unlimited access to stimulants would self-administer those drugs persistently over days to the point of death. In general, the same drugs that are self-administered by nonhumans are also self-administered by humans, and furthermore, are also abused in society (Brady, 1991; Griffiths, Bigelow, & Henningfield, 1980). As a result, maintenance of drug self-administration in nonhumans is considered a reliable predictor of abuse potential in humans (Brady, 1991). Consequently, nonhuman self-administration procedures frequently provide information about novel drugs and the likelihood of human abuse (e.g., Kaminski & Griffiths, 1994).

Environmental Modulation of Drug Self-Administration

Despite the seemingly overwhelming power of drug reinforcement revealed in early studies, an extensive body of research has shown that drug self-administration is highly malleable. These studies show that the same types of environmental variables that affect other operant behaviors can modulate drug self-administration. Drug self-administration can be modulated, for example, by manipulating the schedule of drug reinforcement, by scheduling conditioned reinforcers, by reinforcing alternative incompatible responses, and by altering the magnitude and immediacy of reinforcement (Bigelow, Griffiths, & Liebson, 1975; Carroll & Bickel, 1998; Griffiths et al., 1980).

The lives of human drug users are full of a range of responses controlled by both drug and nondrug reinforcers. A concurrent schedule arrangement in which one response produces drug reinforcement and another produces a nondrug reinforcer provides a reasonable laboratory model of human drug use in a multiresponse and multireinforcer world. Such concurrent schedule arrangements have been studied extensively in both nonhumans and humans. Decreases in drug self-administration due to concurrent availability of nondrug reinforcers varies as a function of the magnitude of reinforcers/drug dose, the schedule requirements, the length of access to the drug, and whether delivery of the alternative reinforcer is mutually exclusive with delivery of the drug reinforcer (Carroll & Bickel, 1998). In human studies, the alternative reinforcer used is frequently money or tokens/vouchers that can later be exchanged for money or goods. Money has been shown to decrease consumption of intranasal cocaine (Higgins, Bickel, & Hughes, 1994), smoked cocaine (Hart, Haney, Foltin, & Fischman, 2000), intravenous cocaine (Donny, Bigelow, & Walsh, 2004), intravenous heroin (Comer et al., 1998), marijuana (Ward, Comer, Haney, Foltin, & Fischman, 1997), and cigarettes (Epstein, Bulik, Perkins, Caggiula, & Rodefer, 1991). Consistent with nonhuman studies, changes in drug consumption in humans vary directly as a function of the magnitude of the nondrug alternative reinforcer (Comer et al., 1998; Higgins, Bickel, et al., 1994).

Abstinence Reinforcement in the Treatment of Drug Addiction

In the initial volume of the *Journal of Applied Behavior Analysis*, Tighe and Elliott (1968) recognized a fundamental challenge faced in applying principles of operant conditioning to address social problems in typical outpatient therapy settings, noting:

> A behavior modification program is likely to be successful to the degree to which it provides control over the relevant response–reinforcement contingencies. That human behavior may be readily modified under conditions which permit precise control of reinforcement variables, as in the laboratory, the clinic, or the institution, has been abundantly demonstrated. Yet in the usual form of outpatient behavior therapy the therapist has little if any control over the major reinforcements and punishments for the patient's behavior. Direct

> contact with the patients is typically intermittent and brief, and when it does occur, the therapist's attempts to change behavior often consist of verbal persuasion rather than the direct manipulation of reinforcement. (p. 263)

The principles of operant conditioning have been applied to the treatment of drug addiction in a variety of ways, from providing a conceptual framework for behavioral counseling to the direct conditioning of therapeutically important behaviors in contingency management interventions (Higgins et al., 2008). However, they have been applied most extensively, and arguably with the greatest impact, in abstinence reinforcement procedures, which arrange for the relatively direct reinforcement of drug abstinence. Under these procedures, patients provide biological samples (e.g., urine) that can be tested for an abused target drug. Reinforcement is then delivered when testing confirms recent drug abstinence. Extensive research has shown that abstinence reinforcement can be highly effective in promoting abstinence from a range of drugs and in diverse populations. At a theoretical level, the research shows that even the drug use of clinical populations is sensitive to its consequences and is operant in nature. At a practical level, the research shows the broad utility of operant approaches in the treatment of drug addiction.

A Historical Perspective and Overview

Early Applications

Between the 1960s and 1980s, abstinence reinforcement interventions were evaluated in several major populations: chronic alcohol users, patients enrolled in methadone treatment programs, health professionals, and cigarette smokers. This research established a firm scientific foundation for the development of abstinence reinforcement interventions, and illustrated a range of creative and useful applications of an abstinence reinforcement technology.

Abstinence Reinforcement in "Skid Row Alcoholics." An elegant series of laboratory studies in "Skid Row alcoholics" in the 1970s provided some of the earliest and most compelling evidence that drug addiction in humans could be modified by manipulating the consequences of drug self-administration (Bigelow et al., 1975). In these studies, participants described as "Skid Row alcoholics" lived on a residential unit and could consume alcohol under monitored conditions. The studies showed that abstinence could be increased by making access to an enriched environment contingent on controlled drinking, by increasing the response requirement for alcohol, by providing monetary reinforcement for abstaining, and by imposing brief periods of isolation contingent on drinking.

Applying these principles, Miller, Hersen, Eisler, and Watts (1974) used a reversal design to evaluate an alcohol abstinence reinforcement intervention in a 49-year-old male. This individual had a 20-year history of heavy drinking and a recent history of drinking "from 1 pint to one-fifth of whiskey together with wine and beer on a daily basis" (p. 261). Breath samples were collected on a quasi-random basis twice per week over 12 weeks. After a baseline, the participant received a $3 coupon booklet for every alcohol-negative breath sample. The coupons could be exchanged for items at the hospital commissary. Breath alcohol levels decreased when the contingency was imposed, increased when the coupons were provided on a noncontingent basis, and then decreased again when the contingency was reimposed.

Miller (1975) then evaluated an extraordinary abstinence reinforcement intervention in 20 men described as "Skid Row alcoholics." Participants reported at least a 5-year history of abusive drinking; a sporadic work history; residence in downtown "rooming houses, hotels, or missions"; and repeated arrests for public drunkenness. These men were randomly assigned to a control or a contingency management group. Control participants received the standard services provided to this population by local social service agencies, including goods and services (food, clothing, and other essentials), housing, and employment. Contingency management participants could receive the same services; however, if they were observed using alcohol (as assessed on random breath alcohol tests or by direct observation of gross intoxication), they lost access to the privileges for 5 days. The contingency man-

agement intervention decreased arrests for public drunkenness and increased days of employment, relative to the control group.

Although the Miller (1975) study was small and lacked important features (e.g., no breath samples were collected from controls), it exemplified some important characteristics. First, the study applied the intervention to a treatment-resistant population that had exhibited persistent heavy drinking despite considerable external pressures (e.g., from local law enforcement). Second, the intervention employed large-magnitude reinforcers, including true essentials of living such as food, clothing, housing, and employment. Finally, although the reinforcement magnitude appeared substantial, the intervention appeared to be practical, since those reinforcers (food, clothing, housing, and employment) were already being provided to the population by local social service agencies; Miller simply arranged a contingency in which access to those reinforcers was made contingent on abstinence. Since this early work, little research has applied abstinence reinforcement interventions to treat alcohol addiction (Higgins & Petry, 1999).

Abstinence Reinforcement in Adults Enrolled in Methadone Treatment. Much of the research on abstinence reinforcement has been conducted with patients enrolled in methadone treatment. *Methadone* is an opioid agonist used in the treatment of heroin addiction. Taken on a daily basis and in adequate doses, methadone can decrease heroin use in many patients. While methadone reduces heroin use, many patients continue intermittent use. Furthermore, many methadone patients use other illicit drugs. In an early series of studies, Stitzer, Bigelow, Liebson, and McCaul (1984) studied the effectiveness of abstinence reinforcement in promoting abstinence from opiate and benzodiazepine use.

One early study examined the effects of abstinence reinforcement in promoting abstinence from opiates in seven adult males enrolled in methadone maintenance (Stitzer, Bigelow, & Liebson, 1980). Participants provided urine samples under observation on Mondays and Fridays every week. The samples were immediately tested for morphine, a metabolite of heroin, using onsite urinalysis equipment. On randomly selected weeks, if a participant's urine sample tested negative for opiates, the participant could receive a choice of one of three reinforcers: $15 cash, two methadone take-home doses, or the opportunity to self-regulate one's own methadone dose for 2 days. All participants continued to provide at least some opiate-positive urine samples, but the abstinence reinforcement contingency decreased rates of opiate-positive urine samples in five of the seven participants. In the ensuing years, extensive research (some of which is described below) demonstrated the effectiveness of abstinence reinforcement in methadone patients (Griffith, Rowan-Szal, Roark, & Simpson, 2000; Robles, Silverman, & Stitzer, 1999),

Contingency Contracting with Health Professionals. In the 1980s, Crowley developed a classic contingency management intervention to treat licensed health care professionals addicted to various drugs of abuse (e.g., Crowley, 1986). Under this intervention, Crowley created a written contract that contained two key elements. First, it specified that the health care professional would submit to random and observed urine testing. Second, it specified that if the participant ever provided a drug-positive urine sample or failed to provide a scheduled sample, the therapist would send a letter to the health care professional's licensing board, reporting that he or she had relapsed to drug use and must therefore surrender his or her medical license. This research did not demonstrate the effectiveness of this intervention through a controlled study, but it provided promising descriptive data and an important illustration of a novel and potentially useful contingency management application.

Smoking Cessation Studies. In one of the earliest studies of an abstinence reinforcement intervention, Elliott and Tighe (1968) conducted an uncontrolled evaluation of a novel intervention in which smokers were required to leave a small monetary deposit at the start of treatment and could earn back portions of that deposit for remaining abstinent over successive periods of time. Winett (1973) conducted a controlled evaluation of the deposit contracting procedure, comparing contingent and noncontingent return of the deposits. Under the contingent procedure, each participant was required to leave

a $55 deposit, which could be earned back over the next several weeks for reducing and then stopping smoking. Although the contingencies and the outcome data were based on participants' self-report of smoking, albeit verified by significant others, the study provided some evidence that the deposit contracting was effective during treatment. Other early studies, which also relied on patient self-report of smoking, showed similar effects (e.g., Paxton, 1981). A later study (Bowers, Winett, & Frederiksen, 1987) demonstrated the effectiveness of deposit contracting using biochemical verification. Although much of the research on deposit contracting has had methodological limitations (e.g., reliance on participant self-report of smoking), these studies made several important contributions: (1) They provided an early model of abstinence reinforcement that others could extend; (2) they suggested a potentially practical method (deposit contracting) for funding abstinence reinforcement; and (3) they provided evidence that deposit contracting can be effective while the contract is in effect. The research also showed that relapse was common after the contracts were discontinued, thereby identifying an area that required particular attention.

A seminal series of early studies by Stitzer and Bigelow (1982, 1983, 1984, 1985) provided rigorous experimental evidence of the effectiveness of abstinence reinforcement procedures for smoking cessation using biochemical verification of abstinence. The studies investigated the effects of offering money contingent on reductions of carbon monoxide (CO) levels assessed one time per day. One study (Stitzer & Bigelow, 1984) arranged a conjugate abstinence reinforcement schedule in which the magnitude of the monetary reinforcement increased as the CO level decreased. Participants were exposed in random order to several conjugate schedules in which the maximum amount of monetary reinforcement varied between $0, $1.50, $3.00, $6.00, and $12.00 per day. As the maximum amount of money available increased, smoking decreased. The studies in this series provided firm evidence of the malleability of smoking by monetary abstinence reinforcement.

Beginning in the 1980s, large-scale studies of abstinence reinforcement were conducted in two contexts, workplaces and whole communities. In general, the interventions in these applications employed infrequent monitoring of smoking and low-magnitude reinforcers. In one study by Glasgow, Hollis, Ary, and Boles (1993), 19 worksites were randomly assigned to "incentive" or "no incentive" conditions. Smokers assigned to the "Incentive" condition could earn $10 and a very small chance to win a lottery prize once per month for 12 months for providing a CO sample that confirmed recent abstinence. The lottery prize was between $5 and $50. In addition, in the 12th month, abstinent participants could earn a chance to draw for one of three larger lottery prizes of $50, $100, or $200. The study failed to show an effect of the "incentive" condition on smoking. The results from similar studies in this literature have not been encouraging (Matson, Lee, & Hopp, 1993; Moher, Hey, & Lancaster, 2005). Given the low reinforcement magnitude and low rate of monitoring used in these studies, the results are not surprising. Despite the poor outcomes, the research is important because it shows that workplaces can be viable contexts for abstinence reinforcement programs if studies identify effective parameters. Recent research using higher-magnitude abstinence reinforcement has shown that worksite smoking cessation interventions can be effective (Volpp et al., 2009).

In the 1980s, the Minnesota Heart Health Program initiated a series of Quit and Win contests to promote smoking cessation among residents in the local communities (Lando, Pechacek, & Fruetel, 1994). Participants were recruited through radio, TV, and newspaper advertisements as well as brochures distributed at schools, worksites, and medical facilities. Applicants had to provide evidence that they were smokers. Participants who abstained from all forms of tobacco for the 30-day contest period entered a drawing for contest prizes. At the end of the contest month, a random sample of entries was selected to win the available prizes. A substantial grand prize was available (e.g., a trip to Disney World), as were lesser prizes (e.g., bicycles, health club memberships, and gift certificates). Since their initiation, Quit and Win contests have been conducted in many communities around the United States and other countries, including Finland, Argentina, and China (Hey & Perera, 2005).

In general, Quit and Win contests engage a small percentage of smokers, and there is some limited, nonexperimental evidence that they can promote smoking cessation (Hey & Perera, 2005). Although the effectiveness of these contests is not clearly known, they are important because they show the willingness of large communities in many cultures to use abstinence reinforcement as a smoking cessation intervention. For a review of abstinence reinforcement studies in smokers, see Donatelle and colleagues (2004) and Sigmon, Lamb, and Dallery (2008).

Voucher-Based Abstinence Reinforcement

By the 1980s, cocaine use had increased in the United States, but no treatments had been proven effective in addressing the problem (Tims & Leukefeld, 1993). At that time, Higgins and his colleagues (1991) developed a behavioral treatment that combined community reinforcement approach (CRA) counseling and a novel abstinence reinforcement intervention. Under the abstinence reinforcement intervention, cocaine-dependent participants could earn points for providing cocaine-negative urine samples three times per week for 12 weeks. The points were printed on vouchers and had monetary values; each point was worth $0.15. Participants could accumulate and exchange vouchers for goods and services that were consistent with their individual treatment goals. The voucher system employed a unique schedule of escalating reinforcement for sustained abstinence, designed to reinforce sustained abstinence differentially. Under that schedule, the number of points earned for each cocaine-negative urine sample started low (10 points) and increased by a small amount (5 points) for each consecutive cocaine-negative urine sample provided. If the participant ever provided a cocaine-positive sample or failed to provide a scheduled sample, he or she did not receive a voucher, and the value of the next voucher was reset to the initial low value. In addition, participants could earn a voucher worth $10 for every four consecutive cocaine-negative urine samples. A participant who was continuously abstinent for 12 weeks could earn about $1,000 in vouchers. This voucher intervention represented an important innovation in the history of contingency management research. It proved unusually effective in its original application and was readily adopted by many investigators treating other populations and other behaviors (Higgins, Heil, & Lussier, 2004; Lussier, Heil, Mongeon, Badger, & Higgins, 2006).

Voucher-Based Reinforcement of Cocaine Abstinence. Higgins and his colleagues developed the voucher intervention to treat primary cocaine dependent patients and the intervention proved extraordinarily effective for this difficult population. The voucher intervention produced substantial increases in treatment retention (Higgins, Budney, et al., 1994) and cocaine abstinence (Higgins, Budney, et al., 1994; Higgins, Wong, Badger, Ogden, & Dantona, 2000). In the Higgins, Wong, and colleagues (2000) study, 70 cocaine-dependent participants were randomly assigned to receive vouchers contingent on providing cocaine-negative urine samples (contingent group) or to receive vouchers independent of their urinalysis results (noncontingent group). By providing cocaine-negative urine samples, participants in the contingent group earned vouchers for 12 weeks and $1 Vermont lottery tickets twice per week for 12 more weeks. They achieved significantly higher rates of cocaine abstinence while the intervention was in effect (Figure 27.1), and for 6 months after abstinence reinforcement intervention ended.

In the early 1990s, as now, cocaine use was a widespread problem in methadone patients that was difficult to treat with available interventions (Silverman, Stitzer, & Bigelow, 1998). A series of studies was initiated in Baltimore City to investigate the effectiveness of promoting cocaine abstinence in poor, inner-city, injection drug users who persisted in using high rates of cocaine despite exposure to standard counseling and methadone treatment (Silverman, 2004). In the first study (Silverman, Higgins, et al., 1996), participants who continued to use cocaine during the first 4 weeks of methadone treatment (n = 37) were randomly assigned to an abstinence reinforcement group or a noncontingent yoked control group. Participants in the abstinence reinforcement group were exposed to a voucher-based abstinence reinforcement intervention in which they could earn up to $1,155 in vouchers for providing cocaine-negative urine samples over

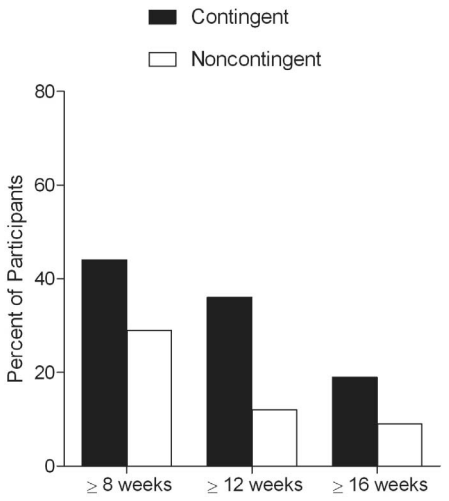


FIGURE 27.1. Percentage of participants in the contingent and noncontingent conditions documented using urinalysis testing to have achieved durations of 8 or more, 12 or more, and 16 or more weeks of continuous cocaine abstinence during the 24-week treatment period. Condition differences were significant at the .05 level for the 12 or more weeks duration only. From Higgins, Wong, Badger, Ogden, and Dantona (2000, p. 67), Copyright 2000 by the American Psychological Association. Reprinted by permission.

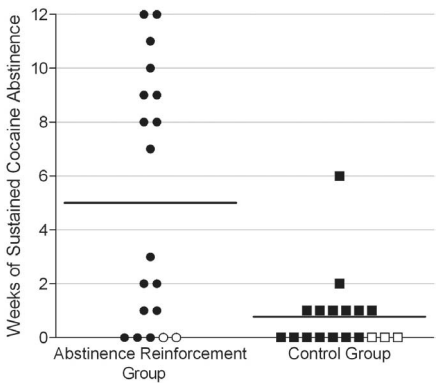


FIGURE 27.2. Longest duration of sustained cocaine abstinence achieved during the 12-week voucher condition. Each point represents data for an individual patient, and the lines represent group means. The 19 abstinence reinforcement patients are displayed in the left column (circles), and the 18 control patients in the right (squares). Open symbols represent patients who dropped out of the study early. From Silverman, Higgins, et al. (1996, p. 413). Copyright 1996 by the American Medical Association. Reprinted by permission.

12 weeks. Participants in the control group received vouchers independent of urinalysis results. Almost half (9 out of 19) of the abstinence reinforcement participants sustained cocaine abstinence lasting between 7 and 12 weeks, whereas only one (1 out of 18) control participant achieved over 2 weeks of sustained abstinence (Figure 27.2). The difference between groups on this and other measures was significant. In the 4 weeks after the vouchers ended there were still significant differences between the two groups in rates of cocaine abstinence, although many participants in the abstinence reinforcement group resumed using cocaine, and the between-group differences were diminished. A number of studies since that initial study have replicated these results (e.g., Epstein, Hawkins, Covi, Umbricht, & Preston, 2003; Rawson et al., 2002).

A *Cochrane Library* review of randomized psychosocial treatments for cocaine addiction (Knapp, Soares, & Silva de Lima, 2008) concluded that voucher-based reinforcement may be the most effective treatment available for cocaine addiction.

Voucher-Based Reinforcement of Opiate Abstinence. Methadone is effective in reducing heroin use, but many patients continue to use heroin during methadone treatment. Several studies have shown that voucher-based abstinence reinforcement can be effective in promoting opiate abstinence in methadone patients (e.g., Preston, Umbricht, & Epstein, 2000; Robles, Stitzer, Strain, Bigelow, & Silverman, 2002). Preston and colleagues (2000), for example, randomly assigned methadone patients who continued to use heroin during treatment to receive either a methadone dose increase (n = 31), voucher reinforcement of opiate abstinence (n = 29), both interventions (n = 32), or neither (n = 28). Participants exposed to the voucher intervention could earn up to $554 in vouchers over 8 weeks. The methadone dose increase did not significantly affect opiate urinalysis results, but the voucher intervention did (Figure 27.3).

Voucher-Based Reinforcement of Smoking Abstinence. Voucher reinforcement has

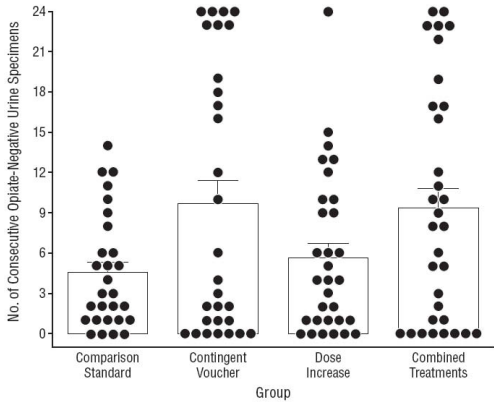


FIGURE 27.3. Longest duration of sustained abstinence from illicit opiates during the 8-week intervention: comparison standard group (no dose increase and noncontingent vouchers [*N* = 28]; contingent voucher group [*N* = 29]; dose increase group [*N* = 31]; and combined treatments group [*N* = 32]). Each point represents maximum number of consecutive opiate-negative urine specimens for an individual patient; the bars and brackets represent means and standard error of mean of each treatment group. From Preston, Umbricht, and Epstein (2000, p. 401). Copyright 2000 by the American Medical Association. Reprinted by permission.

been shown to be effective in promoting smoking cessation in methadone patients (e.g., Shoptaw et al., 2002), pregnant smokers (Donatelle, Prows, Champeau, & Hudson, 2000; Higgins, Heil, Solomon, et al., 2004), adolescents (e.g., Corby, Roll, Ledgerwood, & Schuster, 2000), and adults with schizophrenia (e.g., Roll, Higgins, Steingard, & McGinley, 1998). In one study, Higgins, Heil, Solomon, and colleagues (2004) compared outcomes for two groups of pregnant smokers who received either contingent (*n* = 31) or noncontingent (*n* = 27) vouchers. Women earned contingent vouchers for providing biological verification of smoking abstinence. During the initial week, reinforcement was contingent on negative breath CO samples collected daily. After the first week, reinforcement was contingent on collection of negative urinary cotinine results at varying frequencies depending on the time in treatment (from twice per week to every other week) until 12 weeks postpartum. Voucher values started at $6.25 and increased by $1.25 for every consecutive negative sample provided thereafter, to a maximum of $45; positive or missed samples reset the vouchers to the original low value. Noncontingent participants received vouchers independent of breath CO or urine cotinine results. Significantly more women in the contingent group were abstinent at the end of pregnancy (37% of participants in the contingent group vs. 9% in the noncontingent group) 12 weeks postpartum (33 vs. 0%) and 24 weeks postpartum (27 vs. 0%). Importantly, the effect of the voucher intervention was observed at the 24-week postpartum time point, 12 weeks after the voucher intervention ended. A more recent study replicated the effectiveness of the voucher-based abstinence reinforcement intervention in initiating smoking cessation in pregnant women (Heil et al., 2008). Importantly, that study also showed that voucher-based reinforcement of smoking cessation in pregnant women can produce increases, in fetal growth (i.e., increases in fetal weight, femur length, and abdominal circumference), presumably as an indirect effect of the increases in smoking cessation achieved by women exposed to the abstinence reinforcement intervention.

Over the past several years, Dallery and his colleagues have developed a novel, Internet-based approach to promoting smoking cessation (e.g., Dallery, Glenn, & Raiff, 2007). Under that system, individuals provide breath CO samples in front of a video camera connected to the Internet. A video is transmitted of the individual as he or she provides the breath sample, as well as the level displayed on the meter. Reinforcement is delivered if the CO level displayed on the meter meets the criterion for abstinence reinforcement. This Internet-based approach appears effective in promoting smoking cessation. Because of the ease with which individuals can be observed frequently and at various times throughout the day without having to travel to a clinic, this approach could have broader applications beyond smoking cessation.

Voucher-Based Reinforcement of Marijuana Abstinence. Voucher-based reinforcement has also been effective in the treatment of marijuana dependence. Budney, Higgins, Radonovich, and Novy (2000) conducted a randomized controlled trial that compared

the effectiveness of three interventions in marijuana-dependent adults: motivational enhancement therapy, motivational enhancement therapy plus cognitive-behavioral coping skills therapy, and motivational enhancement therapy plus cognitive-behavioral coping skills therapy and voucher-based abstinence reinforcement. Under the voucher intervention, urine samples were collected three times per week, and participants could earn up to $570 in vouchers for providing marijuana-negative urine samples over 12 weeks. The addition of the coping skills therapy had no effect, but the voucher intervention significantly increased the percentage of abstinent participants at the end of treatment (35%) compared to the other two groups (5 and 10%, respectively).

Prize Reinforcement. Petry, Martin, Cooney, and Kranzler (2000) developed a modification of the voucher intervention in which participants were given opportunities to draw prize vouchers from a fishbowl contingent on providing drug-free breath or urine samples; the vouchers were slips of paper that were exchangeable for prizes of varying values. Under this procedure, samples were collected 2 or 3 days per week. If a participant provided a drug-negative sample, then he or she was given an opportunity to draw a paper slip from a fishbowl containing about 500 slips of paper. Half of the slips had the words "good job" printed on them; the other half read "small prize," "large prize," or "jumbo prize," worth about $1, $20, and $100, respectively. Most of the slips were for small prizes; only one slip was for a jumbo prize. To arrange a schedule of escalating reinforcement for sustained abstinence, the number of allowed draws increased as the number of consecutive drug-free breath or urine samples increased.

The prize reinforcement intervention was recently evaluated in two multisite studies in the National Institute on Drug Abuse (NIDA) Clinical Trials Network, a collaborative program designed to test drug abuse treatments in community treatment programs throughout the United States. In one of those studies (Peirce et al., 2006), methadone patients from six programs (n = 402) were randomly assigned to a usual care control or an abstinence incentive group. Abstinence incentive participants could earn opportunities to draw for prizes by providing urine samples negative for cocaine, amphetamine, methamphetamine, and alcohol under a prize reinforcement system similar to that developed by Petry and colleagues (2000), described earlier. Participants could earn bonus draws for providing opiate-negative samples. Both groups provided urine samples 2 days per week for 12 weeks. Abstinence incentive participants provided significantly more stimulant-negative urine samples than did the usual care control participants (54 vs. 38%, respectively; Figure 27.4).

Improving Abstinence Outcomes

As the foregoing review shows, abstinence reinforcement contingencies have been highly effective in promoting abstinence from a range of drugs in diverse populations and contexts. The demonstrations of effectiveness are particularly noteworthy because many of the studies were conducted with patients who persisted in using the target drug(s) despite exposure to standard treatment. Yet outcomes from abstinence reinforcement interventions still can be improved in at least two ways. First, although many individuals initiate abstinence when exposed to abstinence reinforcement, many others do not. Second, although some individuals sus-

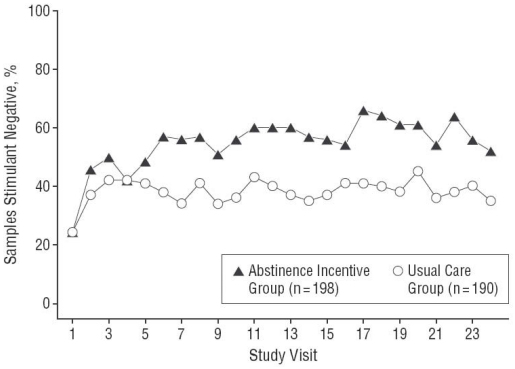


FIGURE 27.4. The mean percentage of submitted samples testing negative for stimulants and alcohol for the abstinence incentive (N = 198) and usual care control (N = 190) participants at each of the 24 study visits (i.e., urine collection opportunities). From Peirce, Petry, Stitzer, et al. (2006, p. 206). Copyright 2006 by the American Medical Association. Reprinted by permission.

tain abstinence after abstinence reinforcement is discontinued, many successful patients resume drug use at some point after the intervention is discontinued. Thus, both the magnitude and durability of abstinence reinforcement effects can be increased.

Improving Effectiveness

In all of the examples presented in this review, as well as in the studies not described here in detail, some proportion of patients continues to use the target drug despite exposure to an abstinence reinforcement intervention. Indeed, in many studies, these resistant participants represent a substantial proportion of those treated. Evidence gathered primarily, although not exclusively, by comparing results across studies in reviews and meta-analyses suggests the importance of a variety of parameters of abstinence reinforcement interventions in improving abstinence outcomes. The effectiveness of the interventions appears greater when high versus low reinforcement magnitude (Lussier et al., 2006) and immediate versus delayed reinforcement is used (Griffith et al., 2000; Lussier et al., 2006), when abstinence from single versus multiple drugs is required (Griffith et al., 2000; Higgins, Heil, & Lussier, 2004; Lussier et al., 2006), and when frequent versus less frequent drug testing is conducted (Griffith et al., 2000). These findings suggest that the effectiveness of abstinence reinforcement varies as an orderly function of parameters of operant conditioning identified in laboratory research.

Of all the parameters considered, the beneficial effects of reinforcement magnitude have been most clearly established. This research demonstrates three points. First, abstinence outcomes usually increase as the magnitude of abstinence reinforcement increases, a finding that is also consistent with laboratory studies of concurrently available alternative reinforcement. As described earlier, early research by Stitzer and Bigelow (1984) demonstrated this principle in cigarette smokers. Evidence of this principle has also been provided in other studies (e.g., Dallery, Silverman, Chutuape, Bigelow, & Stitzer, 2001; Petry et al., 2004; Silverman, Chutuape, Bigelow, & Stitzer, 1999) and in a meta-analysis (Lussier et al., 2006).

Second, studies conducted with methadone patients provide evidence that increasing reinforcement magnitude can increase abstinence in treatment-resistant patients. In one study (Silverman et al., 1999), methadone patients who used cocaine consistently during treatment (baseline) were exposed to an intervention in which they could earn up to $1,155 in vouchers for providing cocaine-negative urine samples over 13 weeks. Participants who failed to achieve sustained abstinence under this intervention (N = 22) were exposed to three 9-week voucher conditions in which they could earn vouchers for providing cocaine-negative urines samples three times per week. The voucher conditions varied only in the magnitude of voucher reinforcement. Participants exposed to zero-, low-, and high-magnitude voucher conditions in counterbalanced order could earn vouchers worth $0, $380, and $3,400, respectively. Cocaine abstinence increased significantly during the high-magnitude condition relative to the other two conditions (Figure 27.5). A second study (Dallery et al., 2001) showed similar results when both cocaine and opiate abstinence were required to earn vouchers.

Finally, some studies have also shown that decreasing reinforcer magnitude can eliminate effectiveness of an abstinence reinforcement intervention. The study of outpatient cocaine users by Petry and colleagues (2004) illustrated this point. Participants exposed to high-magnitude prize reinforcement (maximum earnings of about $240 in prizes over 3 months) achieved more abstinence than participants in standard treatment and participants exposed to a low-magnitude condition (maximum earnings of about $80 in prizes). There were no significant differences between the low-magnitude and standard groups. These results not only confirmed the effectiveness of prize reinforcement but also showed that there are limits to how much the reinforcement magnitude can be reduced without losing effectiveness.

Promoting Long-Term Abstinence

Drug addiction is frequently referred to as a *chronic relapsing disorder* (McLellan, Lewis, O'Brien, & Kleber, 2000). This characterization is derived in part from the observa-

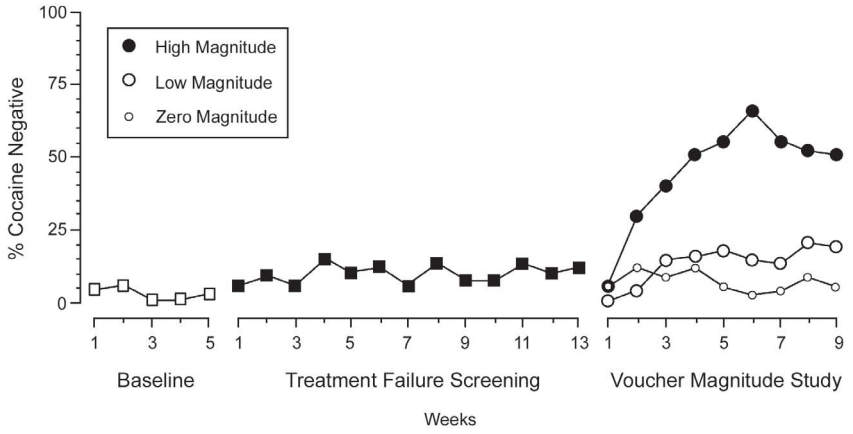


FIGURE 27.5. Percentage of urine samples negative for cocaine across the weeks of the study for 22 patients who completed the entire study. Open squares represent data collected during the first 5 weeks of methadone treatment (baseline). Filled squares represent data collected during the 13-week screening for treatment failures, in which patients were given the opportunity to earn up to $1,155 in monetary vouchers for providing cocaine-free urine samples; only data for treatment failures are included in this figure. The small open circles, large open circles, and large filled circles represent data from the zero-, low-, and high-magnitude voucher conditions, respectively, of the voucher magnitude study. From Silverman, Chutuape, Bigelow, and Stitzer (1999, p. 133). Copyright 1999 by Springer Science and Business Media. Reprinted by permission.

tion that many patients exposed to virtually all types of drug abuse treatment resume their drug use in the months and years after treatment ends (Hubbard et al., 2003). Some studies have shown that abstinence reinforcement can produce lasting effects (e.g., Higgins, Wong, et al., 2000), described earlier; however, as with other treatments, many patients resume drug use after abstinence reinforcement is discontinued. We do not clearly understand the conditions under which relapse does and does not occur. However, it is clear that relapse following discontinuation of abstinence reinforcement interventions is common in studies that assess postintervention effects. High rates of relapse have been observed for some individuals following discontinuation of abstinence reinforcement, for example, in cigarette smokers (Shoptaw et al., 2002; Winett, 1973), benzodiazepine users (e.g., Stitzer, Bigelow, Liebson, & Hawthorne, 1982), opiate users (e.g., Silverman, Wong, et al., 1996), and cocaine users (e.g., Preston, Umbricht, Wong, & Epstein, 2001; Silverman et al., 1999). Despite these common findings, relatively few studies have investigated methods to promote long-term abstinence.

Combining Abstinence Reinforcement with Relapse Prevention Counseling. Several studies have investigated the possibility that abstinence reinforcement might produce lasting effects if it were combined with a counseling intervention designed to prevent relapse. To investigate this possibility, five studies investigated the effects of combining cognitive-behavioral relapse prevention therapy with voucher reinforcement of abstinence from cocaine use (Epstein et al., 2003; Rawson et al., 2002, 2006), cigarette smoking (Shoptaw et al., 2002), and methamphetamine use (Shoptaw et al., 2005). All of these studies showed that voucher-based abstinence reinforcement produced higher rates of abstinence during treatment than the cognitive-behavioral therapy when each was presented alone, and that the combined treatment did not increase rates of abstinence compared to the voucher intervention alone either during or after treatment. Furthermore, during the follow-up periods after the voucher interventions had been discontinued, none of the studies showed significant differences between groups exposed to the voucher-based abstinence reinforcement interventions and other groups.

The Relationship between During-Treatment and Posttreatment Abstinence. In the study described earlier in which Higgins, Wong, and colleagues (2000) found significant long-term effects of the abstinence reinforcement intervention, they also noted that the duration of abstinence participants achieved during treatment was associated with rates of abstinence after treatment. To study this relationship, Higgins, Badger, and Budney (2000) conducted an analysis of 190 cocaine-dependent participants from multiple, randomized controlled trials of voucher-based abstinence reinforcement. Across those trials, 125 participants had been exposed to a behavioral counseling intervention along with voucher-based reinforcement of cocaine abstinence, and 65 had been exposed to a control condition. The probability of being abstinent from cocaine at the 12-month follow-up increased as a function of the duration of cocaine abstinence achieved during treatment. Interestingly, the functions for participants who had and had not been exposed to the CRA and voucher-based abstinence reinforcement were virtually identical, suggesting that it did not matter how the during-treatment abstinence was achieved. These data suggest that abstinence reinforcement may produce long-term abstinence by increasing the overall durations of abstinence during treatment.

Abstinence Reinforcement as a Maintenance Intervention. Recognizing the tendency of many patients to relapse following termination of all types of drug abuse treatment, McLellan and colleagues (2000) suggested that treatments for drug addiction adopt long-term care strategies similar to those used in the treatments of other chronic disorders, such as diabetes and hypertension. Indeed, many effective medical treatments must be maintained over extended periods of time to maintain their effectiveness. Methadone is certainly one of the most effective and useful of all drug abuse treatments; yet it is extremely difficult to discontinue without precipitating high rates of relapse to opiates (Robles et al., 2002; Sees et al., 2000). Methadone *maintenance* appears to be important to sustain long-term opiate abstinence for many patients.

In an early study in cigarette smokers, Winett (1973), described earlier, observed high rates of relapse to cigarette smoking after discontinuation of an abstinence reinforcement intervention, particularly among a subgroup of participants that had the highest base rates of cigarette smoking. Commenting on this, Winett suggested that an extended period of abstinence reinforcement might be required to prevent relapse. Citing a personal communication with L. Krasner (p. 59), Winett further suggested, "It is possible that some smokers will require a contract that simply never terminates."

A few investigators have provided evidence that abstinence reinforcement contingencies can be used to maintain abstinence over time (e.g., Preston et al., 2001; Silverman, Robles, Mudric, Bigelow, & Stitzer, 2004). Silverman and colleagues (2004) began an investigation of the use of abstinence reinforcement as a maintenance intervention in a study of 78 injection drug users who continued to use cocaine persistently during methadone treatment. After a 10-week baseline period, participants were randomly assigned to one of three groups: usual care control, take-home only, or take-home plus voucher groups. All groups provided urine samples three times per week. Usual care control participants continued receiving standard methadone treatment. Take-home only participants received the same methadone treatment but could also earn up to three take-home methadone doses per week for providing urine samples negative for opiates and cocaine. Conditions for the take-home plus voucher group were identical to the take-home only participants, except they could also earn vouchers for providing cocaine-negative urine samples under a schedule of escalating reinforcement for sustained cocaine abstinence, similar to prior voucher studies. Unlike previous studies, however, participants in this study could earn vouchers for an entire year and could earn up to about $5,800 in vouchers. Participants in the take-home plus voucher group achieved significantly higher rates of cocaine abstinence than participants in the other two groups, and those effects were maintained throughout the yearlong intervention period. Figure 27.6 shows that participants in the take-home plus voucher group who initiated cocaine abstinence typically sustained their cocaine abstinence uninterrupted until the end of the voucher

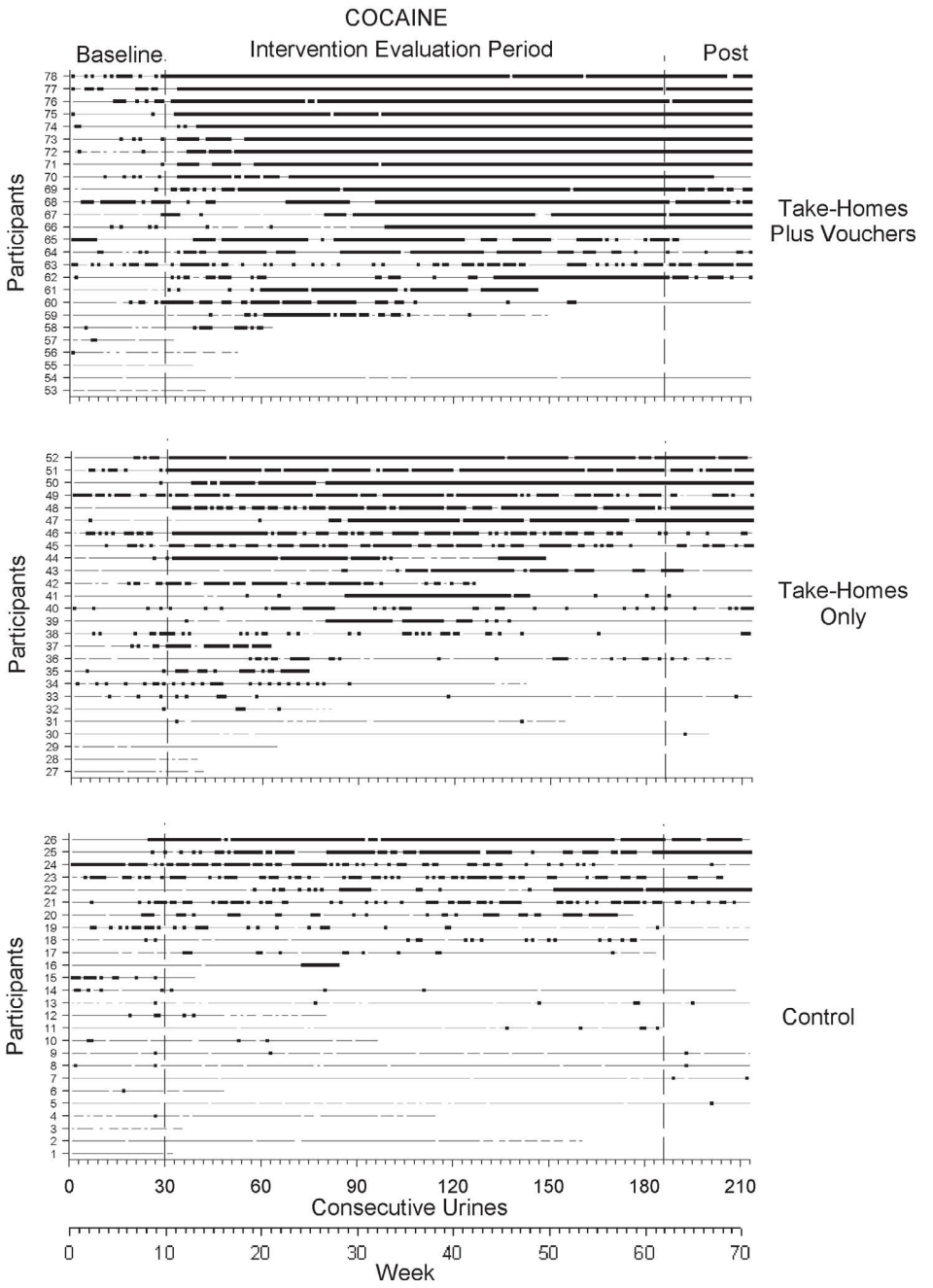


FIGURE 27.6. Cocaine urinalysis results across consecutive urine samples for individual participants in each of the three experimental conditions. Top, middle, and bottom panels represent data for the take-home plus voucher, take-home only, and usual care control conditions. The vertical dashed lines divide each panel into three periods: the baseline (left), the intervention (center), and the postintervention (right). Within each panel, horizontal lines represent the cocaine urinalysis results for individual participants across the consecutive scheduled urine collections of the study. The heavy portion of each line represents cocaine-negative urinalysis results, the thin portion of each line represents cocaine-positive urinalysis results, and the blank portion represents missing urine samples. Within each panel, participants range from those showing the least abstinence (fewest cocaine-negative urines) at the bottom of the panel to participants with the most abstinence at the top. The numerals on the ordinates represent participant identification numbers. From Silverman, Robles, Mudric, Bigelow, and Stitzer (2004, p 847). Copyright 2004 by the American Psychological Association. Reprinted by permission.

intervention and frequently beyond that point. Participants in the other two groups rarely achieved sustained abstinence at any point in treatment. This study showed that abstinence reinforcement can be used successfully as a maintenance intervention.

Dissemination

Research findings on treatments for drug addiction have not been incorporated reliably into routine clinical practice (Lamb, Greenlick, & McCarty, 1998). Even a data-based recommendation as simple as the appropriate methadone dose has been slowly and inconsistently adopted in community methadone programs (D'Aunno & Pollack, 2002; Willenbring, Hagedorn, Postier, & Kenny, 2004). Like other proven treatments, it seems that abstinence reinforcement interventions have not been employed widely in community treatment programs (McGovern, Fox, Xie, & Drake, 2004; Willenbring et al., 2004).

Application in Drug Abuse Treatment Clinics

Researchers have focused primarily on designing abstinence reinforcement interventions for use in standard drug abuse treatment clinics. Given their limited resources (McLellan, Carise, & Kleber, 2003), drug abuse treatment clinics may have difficulty even supporting the frequent drug testing required to implement abstinence reinforcement contingencies. In this context, researchers have tried to use reinforcers that are available in clinics, to devise ways to pay for reinforcers, and to use low-cost reinforcers.

The take-home methadone dose as a reinforcer in methadone clinics is certainly one of the most well-known, practical, and useful methods. It can be made available with relatively little added expense, and there is some evidence that a small percentage of clinics use such reinforcers (Willenbring et al., 2004). Deposit contracting was used in the earliest abstinence reinforcement studies in cigarette smokers (e.g., Elliott & Tighe, 1968) and elsewhere (e.g., Boudin et al., 1977). Donations from the community have also been employed to obtain reinforcers for Quit and Win contests (Lando et al., 1994) and interventions for pregnant smokers (Donatelle et al., 2000). There is also some evidence that treatment programs use available funds to purchase reinforcers for voucher reinforcement contingencies. Kellogg and colleagues (2005) described the adoption of a voucher reinforcement system by New York City Health and Hospitals Corporation, a large municipal health care provider that operates over 40 substance programs around the city. Multisite investigations in the NIDA Clinical Trials Network (e.g., Peirce et al., 2006) show that abstinence reinforcement programs can be applied effectively in community programs.

Although lower-magnitude reinforcement can have important beneficial effects (e.g., Peirce et al., 2006), as reinforcement magnitude is reduced, the magnitude of the abstinence effects are likely reduced and, in some cases, eliminated. The large-scale applications for cigarette smokers in worksites provided a clear and disconcerting illustration of this point by employing very low-magnitude reinforcement and consistently failing to show effects of rates of smoking cessation (Glasgow et al., 1993; Matson et al., 1993; Moher et al., 2005).

Despite the need for relatively high-magnitude reinforcement, recent experience from the United Kingdom suggests that some treatment systems incorporate higher-magnitude voucher-based abstinence reinforcement into routine clinical care. The National Institute for Health and Clinical Excellence (NICE), an independent organization responsible for providing guidance on promoting health to the U.K.'s National Health Service, conducted a rigorous review of the literature on psychosocial treatments for drug addiction and concluded that voucher-based reinforcement interventions are among the most effective available psychosocial treatments. Based on that review, NICE recommended routine use of voucher-based reinforcement interventions for the treatment of drug addiction ("substance misuse") in the U.K.'s National Health Service (Pilling, Strang, & Gerada, 2007). Consistent with that recommendation, the National Health Service (2009) now lists voucher-based reinforcement as one of its main interventions in the treatment of drug addiction.

Harnessing Existing Reinforcers Beyond the Clinic

The research reviewed in this chapter suggests that high-magnitude and long-duration abstinence reinforcement may be required to initiate and sustain long-term abstinence in at least some patients. Identifying practical ways of arranging such abstinence reinforcement is a critical challenge for researchers and clinicians. Interspersed throughout the history of research on abstinence reinforcement, a handful of researchers have integrated abstinence reinforcement contingencies outside of the drug abuse treatment clinic, contexts where high-magnitude reinforcers are sometimes available and might be harnessed for therapeutic purposes. Miller's (1975) early application for homeless and unemployed adults represents a seminal example of this approach. As described earlier, at the time of the study, local agencies were providing goods and services (e.g., food, clothing, and other essentials), housing, and employment to the community's homeless and unemployed adults. To promote abstinence, Miller simply arranged contingencies in which participants had to remain abstinent to continue receiving those reinforcers.

In an impressive series of studies, Milby and his colleagues (1996) showed that abstinence-contingent access to housing could increase retention and promote abstinence in homeless, cocaine-dependent adults. Ries and colleagues (2004) have tested the effectiveness of using Social Security disability benefits to promote abstinence in adults with severe mental illness and co-occurring substance dependence. They developed a system in which adults with severe mental illness can gain progressively more control over disability benefits as their abstinence increased. A randomized controlled study showed positive effects of the intervention. Drebing and colleagues (2005) began to investigate the integration of abstinence reinforcement into the U.S. Department of Veterans Affairs Compensated Work Therapy Program, which provides access to paid training and supported paid employment opportunities to veterans with chronic employment problems.

Several investigators have arranged abstinence-contingent access to employment to promote abstinence (Cohen, Bigelow, Hargett, Allen, & Halsted, 1973; Crowley, 1986; Milby et al., 1996; Miller, 1975; Silverman, Svikis, Robles, Stitzer, & Bigelow, 2001; Silverman et al., 2002). In many ways, workplaces are ideal contexts for abstinence reinforcement contingencies (Silverman, 2004): Workplaces control powerful reinforcers, most notably salary or wages, that could be used to reinforce abstinence. Employees maintain regular contact with their places of employment, which allows for frequent collection of biological samples (e.g., urine samples) to monitor drug use. Since employment is frequently maintained over extended periods of time, workplaces could be ideal places to maintain long-term abstinence reinforcement. Finally, workplaces are accepted contexts for monitoring drug use through workplace drug-testing programs and for providing substance abuse treatment services through employee assistance programs.

To implement employment-based abstinence reinforcement, a contingency can be arranged in which employees must remain abstinent to work and to earn wages or salary. Whereas many workplaces simply terminate employees for continued drug use, more therapeutic contingencies can be employed to maintain employment over time, and simultaneously increase and sustain abstinence. To investigate systematically the effects employment-based abstinence reinforcement contingencies, Silverman and colleagues (2001) developed a model "therapeutic workplace" (see Silverman, 2004, for an overview of this research) designed to treat poor and chronically unemployed adults with long histories of heroin and cocaine addiction. The essential features of the workplace were simple: Participants were hired and paid to work. To promote abstinence, participants were required to provide drug-free urine samples on a routine basis to gain and maintain daily access to the workplace. If a participant ever provided a drug-positive urine sample, he or she was not allowed to work that day. Participants were never terminated from employment for providing drug-positive urine samples. They were always encouraged to return the next day or any day thereafter to try again. Initially, participants were hired as trainees and earned voucher pay under a schedule of escalating pay for sustained ab-

stinence and attendance. After participants achieved sustained abstinence and acquired job skills, they were hired as employees and paid in standard paychecks.

The therapeutic workplace intervention was initially evaluated in pregnant, and recently in postpartum, women in methadone treatment. Participants were included in the study if they continued to use heroin and/or cocaine during treatment. Those women (N = 40) were randomly assigned to a therapeutic workplace or usual care control group. Therapeutic workplace participants were invited to attend the workplace every weekday for several years. Both groups were monitored over time. Relative to the usual care controls, therapeutic workplace participants provided approximately twice the rate of opiate- and cocaine-negative urine samples during the first 6 months of the study (Silverman et al., 2001), and those effects were maintained for 3 years after intake (Silverman et al., 2002). Compared to controls, significantly more therapeutic workplace participants were abstinent from cocaine (5 vs. 30%, respectively) and from opiates (5 vs. 30%, respectively) at all of the 3-year monthly assessment time points.

More recent research has isolated the role and effectiveness of the employment-based abstinence reinforcement contingency embedded in the therapeutic workplace to initiate (Silverman et al. 2007) and to maintain (DeFulio, Donlin, Wong, & Silverman, 2009) drug abstinence. The study by DeFulio and colleagues (2009) evaluated the most critical feature of the therapeutic workplace intervention: the use of employment-based reinforcement as a maintenance intervention in the treatment of drug addiction. In that study, adults who used cocaine while enrolled in community methadone treatment were invited to attend an initial 6-month phase of the therapeutic workplace intervention designed to initiate drug abstinence and establish needed job skills (Phase 1). During this phase, participants were required to provide cocaine-free and opiate-free urine samples to gain and maintain access to the workplace. Participants who initiated cocaine and opiate abstinence and acquired needed skills during this initial 6-month phase were hired in a model data entry business for 1 year and randomly assigned to an employment-only group or an abstinence-contingent employment group. As employees, all participants could work 30 hours per week and were paid biweekly. Participants assigned to the employment-only condition could work independent of their urinalysis results, similar to typical employment. In contrast, abstinence-contingent employment participants were required to provide drug-free urine samples to work and to maintain maximum pay; the frequency of urine testing gradually decreased over the course of the year. Analyses of monthly urine samples from participants in both groups throughout the year of employment in the data entry business showed that abstinence-contingent employment participants provided significantly more cocaine-negative samples than employment-only participants (79.3 and 50.7%, respectively; Figure 27.7). Interestingly, the two groups worked virtually the same number of hours and earned almost identical hourly wages. This study showed clearly that employment-based abstinence reinforcement could be used to maintain drug abstinence over extended periods of time.

Concluding Comments

Just over 40 years ago, Clark, Schuster, and Brady (1961) found that saline delivered through an indwelling jugular catheter could reinforce lever pressing in two water-deprived rhesus monkeys. Commenting on the significance of this finding, they suggested (p. 1830), "Future exploitation of this technique will permit an experimental analysis of the reinforcing properties of many pharmacologic agents under varying conditions of behavioral control." In the relatively short time since that early study, an elaborate and expanding experimental analysis of drug reinforcement has provided a framework for the operant analysis and treatment of drug addiction. Laboratory research following that early discovery has revealed a range of conditions under which drugs can serve as reinforcers, and has identified environmental conditions that modulate drug reinforcement. In turn, that research has provided a firm foundation for the development of effective operant treatments for drug addiction, most notably the abstinence reinforcement interventions reviewed in this chapter. Abstinence reinforcement interventions have

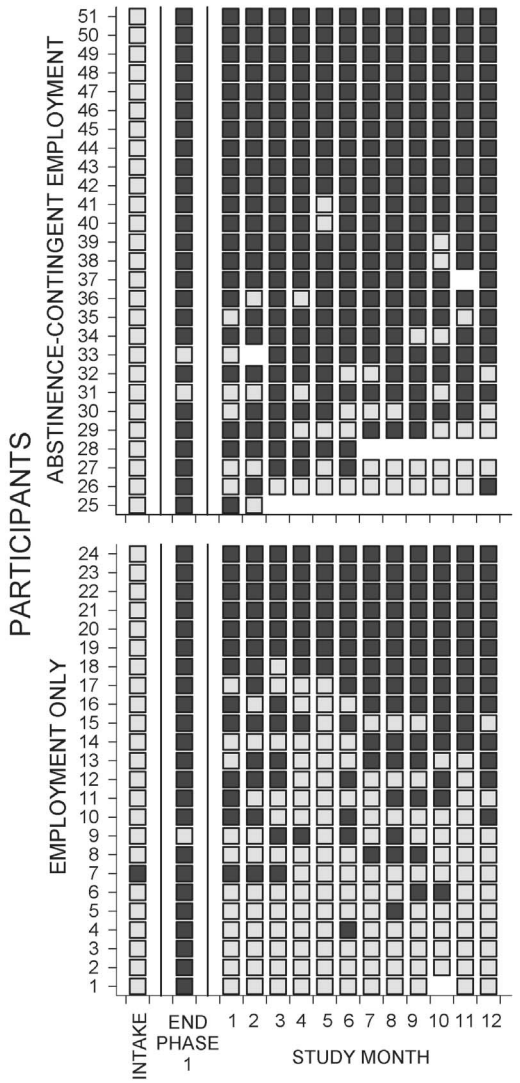


FIGURE 27.7 Cocaine urinalysis results at intake, end of initial phase (Phase 1), and across consecutive months during the intervention (employment phase). Within each panel, rows of data represent the cocaine urinalysis results for individual participants. Filled squares indicate cocaine-negative urine samples, and open squares indicate cocaine-positive urine samples. Empty sections indicate missing samples. Within each panel, participants arrange from those showing the least abstinence (fewest cocaine-negative urine samples) at the bottom to those with the most abstinence at the top. From DeFulio, Donlin, Wong, and Silverman (2009, p. 1534). Copyright 2009 by the Society for the Study of Addiction. Reprinted with permission from John Wiley and Sons, Inc.

been shown to be effective in promoting abstinence from most commonly abused drugs in diverse patient populations; using a range of reinforcers and contingencies; and in many contexts, from the drug abuse treatment clinic to the workplace. Their effectiveness has been demonstrated in small, within-subject designs and in large-scale, multisite randomized controlled clinical trials. Given the serious and costly nature of drug addiction in society and the limitations of available treatments, the broad and robust effectiveness of these abstinence reinforcement interventions has important implications for the treatment of drug addiction.

Despite the promise of abstinence reinforcement interventions, more development is required to increase the proportion of patients that achieves abstinence when exposed to the interventions, to develop procedures that ensure long-term success of patients and practical applications for widespread use in society. Advances in all of these areas of development have already been made, but the work has only just begun. The substantial scientific foundation in operant conditioning and drug reinforcement that originally gave rise to abstinence reinforcement procedures can guide the continued development of these procedures. Through persistent and creative research programs that rigorously apply basic operant principles, we should continue to advance the behavior analysis and treatment of drug addiction that researchers have pursued so successfully over the past 40 years.

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CHAPTER 28

Behavioral Gerontology

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Global and national demographics have shifted steadily toward an older population, with adults 65 years or older projected to account for 20% of the total U.S. population by the year 2030 (American Psychological Association Working Group on the Older Adult Brochure [APA-WGOA], 1998). The group that is age 85 and older, referred to by researchers as the oldest-old, is growing faster than any other demographic group, with a disproportionate increase for women and minority groups (APA-WGOA, 1998; Belsky, 1999). These adults will need a range of medical and psychological services because they are likely to experience increased poor health conditions, sensory deficits, and cognitive impairments that are costly, debilitating, and potentially socially isolating (Belsky, 1999). However, the infrastructure for providing these services is projected to be woefully inadequate as "baby boomers" age and demand alternatives to traditional palliative care nursing environments (Molinari et al., 2003). As a result of the growing discrepancy between needs, infrastructure, and research base, enormous research and practice opportunities exist for psychologists interested in working with older adults.

Behavioral gerontology refers to the application of behavior analysis and therapy to older adults, ranging from basic behavioral research to clinical applications to organizational issues in service delivery agencies (Adkins & Mathews, 1999; Burgio & Burgio, 1986). Behavior analysts have long advocated the use of behavioral interventions and environmental modifications to enhance the lives of older adults (Lindsley, 1964). Prominent behavior analysts have suggested that natural contingencies for older adults support ineffective behavior (Skinner, 1983), and that basic operant principles readily account for aging-related phenomena and for experimental evidence that many skill declines in older adults are reversible (Baltes & Barton, 1977).

Several reviews, book chapters, and handbooks published in the 1970s and 1980s documented the early interest in behavioral gerontology (Baltes & Barton, 1977; Lewinsohn, Teri, & Hautzinger, 1984; Patterson & Jackson, 1981; Wisocki, 1984). In spite of this early growth, many prominent psychologists lament the failure of psychology and the subfield of behavior analysis to learn sufficiently about the aging process, disseminate acquired knowledge, and directly improve the lives of older adults (Carstensen, 1988; Storandt, 1983). Burgio and Burgio (1986) commented that behavioral geron-

tology had enormous potential for positive social impact, but interest in the field waned and publications were infrequent. Carstensen (1988) echoed these sentiments and advocated for clinical behavioral research with older adults but identified practical concerns (e.g., difficulty finding appropriate and receptive non-aging outlets) as barriers that might lead many to abandon work in the area.

Since the mid-1980s a small, stable number of publications on aging has appeared in behavioral journals, while behavioral gerontologists have increasingly published works in multidisciplinary aging journals (Altus, Engelman, & Mathews, 2002a, 2002b; Burgio et al., 2002; Hussian & Brown, 1987). These and other publications have attempted to illustrate for nonbehavioral audiences the advantages of a behavioral approach to aging. These benefits include avoidance of ageism and focus on environmental factors that promote or suppress behavior, belief in the potential reversibility of decline, and cost-effectiveness and consistency in treatment approach (Dupree & Schonfeld, 1998). This chapter provides a review of the literature on behavioral gerontology from all of these publication sources for behavior analysts who may not be familiar with the area. The chapter is organized in three main content areas (basic research, clinical application, organizational application), with an emphasis on studies published in the past 20 years.

Basic Behavior Analytic Research on Aging

Basic research on aging has been dominated by the study of memory and cognition from an information-processing perspective (Birren & Schaie, 2001; Cherry & Smith, 1998), with very little published literature from a behavior analytic perspective. Derenne and Baron (2002) identify basic research as the area of largest disparity between traditional and behavior analytic studies of aging. The behavior analytic experimental literature on aging is small and focuses primarily on age-related changes in classically conditioned responses, response to schedules of reinforcement, signal detection, and formation of stimulus equivalence classes. A few of the most consistent findings are briefly summarized below. Additional research is needed in each of these areas to clarify conflicting findings and to explore the parameters of age-related differences in performance.

A series of studies has documented clear age- and dementia-related changes in classically conditioned responses. Durkin, Prescott, Furchgott, Cantor, and Powell (1993) documented that two older groups (i.e., ages 50–63, 66–78) showed impaired acquisition of classically conditioned eyeblink and heart-rate responses compared to two younger groups, but greater conditioning than a no-trials control group. Changes in classically conditioned response acquisition appear in later middle age and progress into old age (Finkbiner & Woodruff-Pak, 1991; Woodruff-Pak & Jaeger, 1998; Woodruff-Pak & Thompson, 1988) with even greater changes observed for individuals with dementia. Conditioned eyeblink responses reliably differentiate typically aging individuals from those with cerebrovascular dementia and those with dementia–probable Alzheimer's type (Woodruff-Pak, 2001; Woodruff-Pak, Papke, Romano, & Li, 1996).

Several studies have examined age-related sensitivity to reinforcement with somewhat mixed findings. Fisher and Noll (1996), who compared discriminations of young and old subjects between concurrent variable interval schedules using a two-choice operant task, found slower initial acquisition for older individuals but improved responding with increased exposure to reinforcement contingencies. Tripp and Alsop (1999) compared children, young adults, and older adults on a signal detection task requiring discrimination between two pattern types under various ratio schedules. Older adults demonstrated the slowest reaction times and the lowest bias toward the higher ratio stimuli, suggesting decreased sensitivity to frequency of reinforcement. Plaud, Plaud, and von Duvillard (1999), who investigated sensitivity to changing operant schedules when reinforcement density was manipulated using a computer-based task, found adequate sensitivity to reinforcement contingencies but behavioral perseveration when contingencies were changed.

Two studies that have examined the performance of older and younger adults in stimulus equivalence preparations found generally weaker formation of equivalence classes for

older adults. Wilson and Milan (1995) compared groups of older and younger adults, and found slower response times and poorer performance on posttests of equivalence relations for older adults. Perez-Gonzalez and Moreno-Sierra (1999) used single-subject analysis to examine equivalence class formation and found slightly better, but still impaired, formation of equivalence classes in older adults.

Clinical Applications in Behavioral Gerontology

Clinical behavioral gerontologists have focused primarily on mental health problems (e.g., depression), health maintenance, and various problems associated with dementia. In each area, a medical rather than psychosocial model has been dominant, perhaps because 85% of older individuals have health concerns warranting regular medical visits (Butler, Finkel, Lewis, Sherman, & Sutherland, 1992), whereas few older adults have regular contact with psychological professionals (Belsky, 1999). Though the medical model is dominant, evidence in each of these areas supports the principle of dynamic interdependence (i.e., person and environment interact reciprocally), and that change in the environment can produce change in behavior even when medical options cannot alter physical or cognitive status. The effectiveness of behavioral interventions in each area is reviewed below.

Mental Health Problems: Depression and Anxiety

Depression and anxiety are common mental health problems for older adults (Sorocco, Kinoshita, & Gallagher-Thompson, 2005) that often go undetected due to differing presentation in older adults (i.e., less report of sadness), high comorbidity, and assumptions that organic rather than psychosocial conditions account for diagnostic indicators such as sleep problems, fatigue, inactivity or agitation (APA-WGOA, 1998; Zarit & Zarit, 1998). Depression is characterized by sadness, feelings of worthlessness and guilt, lethargy, sleep and appetite disturbances, and loss of interest in activities. Major depression occurs in 1–6% (Mojtabai & Olfson, 2004) of community-dwelling older adults, 10–15% of medically ill or frail individuals (Dick & Gallagher-Thompson, 1996), and 30% of individuals with dementia (Zarit & Zarit, 1998). An additional 9–30% of community-dwelling older adults report subthreshold symptoms that significantly impact quality of life (Blazer, 1993; Thompson, Futterman, & Gallagher, 1988). Generalized anxiety disorder (GAD), the most common anxiety disorder, occurs in approximately 3–17% of older adults and is characterized by worry (Ladouceur, Leger, Duga, & Freeston, 2004; Stein, 2004), with subthreshold anxiety symptoms occurring for an additional 15–43% of healthy older adults (Mehta et al., 2003).

Cognitive-behavioral therapy (CBT) is an empirically supported intervention for both depression and anxiety for older adults (Arean, 2004; Stanley, Diefenbach, & Hopko, 2004), with evidence for the effectiveness of individually administered CBT (Arean, 2004; Gallagher-Thompson & Thompson, 1996; Teri, Logsdon, Uomoto, & McCorry, 1997) and group-based CBT (DeVries & Coon, 2002). CBT generally involves education about depression/anxiety, self-monitoring of negative or anxious thoughts and emotion states, replacement of dysfunctional beliefs and self-statement with functional ones, scheduling of pleasant events, and skills training (e.g., problem solving, coping, relaxation) (Dick & Gallagher-Thompson, 1996; Dick, Gallagher-Thompson, & Thompson, 1996; Gatz et al., 1998). Several appealing features of CBT are its brevity and structure of interventions (Dick et al., 1996; Secker, Kazantzis, & Pachana, 2004), the availability of therapist manuals to guide treatment (Stanley et al., 2004), and the general acceptability of the intervention to older adult consumers (Zeiss & Breckenridge, 1997). Recently, modifications to CBT make it especially suitable for older adults, including altered use of homework (Kazantzis, Pachana, & Secker, 2003) and enhancement with learning and memory aids (Mohlman et al., 2003).

Several recent studies illustrate the benefits of CBT over therapeutic-contact control groups, nonspecific therapies, and desipramine. Stanley and Novi (2000) reviewed the effects of CBT for GAD in older adults. They identified six controlled group comparisons and found relaxation training, cognitive restructuring, and multicomponent

CBT interventions to be superior to a waitlist control. In a subsequent empirical study, Stanley and colleagues (2003) compared CBT to weekly phone contact and found significant improvement in reported worry and anxiety, depressive symptoms, and quality of life with CBT, with most gains maintained at 1-year follow-up. Barrowclough and colleagues (2001) compared weekly in-home CBT to in-home supportive counseling and found improvement with both, but greater improvement and better maintenance for the CBT group. Finally, Thompson, Coon, Gallagher-Thompson, Somer, and Koin (2001) found that CBT alone and CBT plus desipramine were equally effective for depressed older adults and superior to desipramine alone. The combined therapy was most effective for patients who were more severely depressed.

Health Maintenance: Diet, Hydration, and Continence

Compliance with health or medication recommendations is referred to as *treatment regimen adherence*, and the degree of compliance is typically a primary determinant of overall health status (Meichenbaum & Turk, 1987). Nonadherence estimates for medication regimens by older adults range from 43 to 62% (Meichenbaum & Turk, 1987) even with education and the threat of dire consequences, such as blindness or death. Recommendations involving lifestyle change and long-term risk produce the poorest adherence in spite of their potential for long-term improvement in quality of life. For example, poor diet and dehydration contribute to risk for cancer, diabetes and heart disease, delerium, urinary tract infections, and medication toxicity (Ho, Lee, & Meyskense, 1991; Kannel, 1986; Sanservo, 1997; Warren et al., 1994). Yet older adults who are particularly susceptible to these problems consistently show little to no change in compliance with psychoeducation (Sands & Holman, 1985). However, other interventions involving prompts and behavioral contingencies for diet and hydration have proven effective.

Stock and Milan (1993) compared the effects of two behavioral intervention packages on dietary practices of older adults in a retirement community. Baseline involved prompts (i.e., identification of healthy selections), while the first intervention involved enhanced prompts (e.g., media, buttons, verbal reminders) with feedback (i.e., graphed percentage of healthy items) and praise upon report of a personal selection. The second intervention incorporated a token-based lottery system with immediate and delayed reinforcers contingent on healthy selections. The first intervention increased healthy selections from a baseline mean of 24–65%, with marginal increase (68% healthy selections) with the addition of the lottery, and diminished effects upon return to the baseline condition.

Prompt systems have proven more effective in increasing healthy fluid consumption for older adults in nursing homes than for those in retirement communities. Spangler, Risley, and Bilyew (1984) had nursing aides present a cup and offer nursing home residents a choice of beverages every 1.5 hours, resulted in clinically and statistically significant improvements in urine specific gravity measures of hydration. Simmons, Alessi, and Schnelle (2001) manipulated the frequency of systematic prompts and beverage choices, and found that 80% of nursing home residents increased their average daily fluid intake with systematic prompts alone. The addition of choice of beverage produced an additional 21% increase in fluid intake and a decrease in the number of beverage refusals.

Urinary incontinence becomes more common with age due to muscle weakness, decreased mobility, memory loss, and communication difficulties (Burgio & Locher, 1996). Older adults may restrict fluid intake in an effort to avoid accidents (Simmons et al., 2001) leading to dehydration and the related problems described earlier, as well as potential social stigma and increased care requirements in nursing homes. Several interventions have proven effective in targeting incontinence, including psychoeducation/behavioral training, prompted voiding schedules, and the use of discriminative stimuli.

Behavioral continence training consists of education about mechanisms of bladder control and specific recommendations, insession practice contracting and identifying relevant muscles, and assigned practice in contraction exercises (Burton, Pearce, Burgio, Engle, & Whitehead, 1988). This intervention produced an 82% reduction in

incontinence compared to a 79% reduction for community-dwelling participants in a behavioral training plus bladder–sphincter biofeedback condition. Burgio and colleagues (2002) replicated the comparison between behavioral training and biofeedback-assisted behavioral training, and also found equal reductions (69 and 63%, respectively) compared to a 58% reduction for participants in a self-administered procedure based on written instructions. These studies indicate that relatively brief behavioral training is sufficient to produce substantial reductions in incontinence, without the need for biofeedback.

Two alternative interventions have proven promising for individuals residing in nursing home facilities. Prompted voiding schedules involve education, scheduled restroom visits with assistance, positive reinforcement for dry intervals and continent voids, and encouragement to resist urinary urges between scheduled visits (Fantl, Wyman, Harkins, & Hadley, 1990; Jeffcoate, 1961). According to Fantl and colleagues (1990), the scheduled visits should begin at either 30- or 60-minute intervals and increase by 30 minutes with each adjustment, until the patient reaches a 3- to 4-hour interval with consistent dryness. In their review, Fantl and colleagues reported 47–100% increases in continence with this procedure; Burgio, Engel, McCormick, Hawkins, and Scheve (1988) reported a 32% increase in continence using the same protocol.

Overdependence: Ambulation and Activities of Daily Living (ADLs)

Independent ambulation and self-care (i.e., grooming, bathing) result in fewer care demands, increased privacy, and enhanced quality of life; but naturally occurring contingencies in many residential care settings support dependence rather than independence (Baltes, 1988). Overdependence may result when well-meaning caregivers provide unnecessary levels of assistance (Engelman, Mathews, & Altus, 2002) in an effort to be helpful and protective, or as a result of failure to recognize individual strengths when serving multiple older adults. Caregivers may want to hasten the process if an older adult proves slow in ambulating, dressing, or bathing, or the caregiver may fear a fall or other injury if the older adult operates independently (Engelman et al., 2002). Temporary injury or illness may lead to persistent overassistance or limits to ambulation, which can increase risk of falls. Increased falls leads to further restriction in ambulation and self-care routines and activities that require standing or walking (Burgio, Westley, & Voss, 1989; Suzuki, Ohyama, Yamada, & Kanamori, 2002).

Several studies have demonstrated the benefits of targeting increased independence directly with non-labor-intensive interventions that actually decrease staff effort while maintaining older adult safety. Burgio, Burgio, Engel, and Tice (1986) increased older adults' ambulation by training nursing home staff to prompt ambulation and praise successively more independent ambulation (e.g., less staff assistance, no walker). All eight participants increased independent ambulation with immediate change for six older adults who rarely walked independently prior to intervention, though they had the physical capacity to do so. In a second study, Burgio and colleagues also used prompting and praise for increased ambulation, with an added component of restriction of access to wheelchairs. Three wheelchair-bound older adults attending a day center program were restricted from wheelchair use by staff removing the chair upon arrival and returning it when they left for the afternoon. The combination of wheelchair restriction, prompting, and praise effectively increased ambulation for all three participants, from a mean of 13.3 feet walked per day in baseline to 290.3 feet during intervention.

Two studies illustrate the effects of training nursing home staff in the use of a simple system of least prompts (SLP) procedure (i.e., verbal, gestural, physical) in increasing independence in activities of daily living (ADLs). Engelman and colleagues (2002) trained three staff members in the SLP procedure, using instruction, modeling, rehearsal and feedback. All participants were dependent on staff assistance completely in baseline but became more independent in intervention. One resident became completely independent with the procedure. In a second study, Engelman, Altus, Mosier, and Mathews (2003) investigated brief caregiver training in SLP to target independent dressing. Staff members increased their use of prompts from a

median of 0 in baseline to a median of 2 during the intervention, and increased their use of praise from 0.05% to 22%. Older adults became more independent in dressing, with no increase in the time required to complete the dressing routine.

Behavioral Disturbances Related to Dementia

Clinically significant behavioral disturbances occur in 50% of outpatient dementia clinic clients and 75% of nursing home patients. Problem behaviors are also the most common precipitating factor for institutionalization (O'Donnell et al., 1992; Plaud, Moberg, & Ferraro, 1998). Behavioral excesses (e.g., aggression, wandering) are targeted more commonly for intervention than deficits because they are problematic for caregivers (Plaud et al., 1998). Pharmacological interventions are used to address behavioral disturbances (Carstensen & Fisher, 1991; Fisher & Swingen, 1997), however, behavioral problems often persist despite antipsychotic use with medication-induced risk of falls, extrapyramidal symptoms, sedation, and cognitive decline (Talerico, Evans, & Strumpf, 2002). Overreliance on neuroleptic medications prompted creation of the Federal Nursing Home Reform Act, part of the Omnibus Budget Reconciliation Act of 1987 (OBRA '87; VandenBos & DeLeon, 1998), which stated that older adults should be free of unnecessary and inappropriate physical and chemical restraints, and prohibited medication use for behavior modification without prior attempts at less restrictive interventions, such as behavioral interventions. Behavioral interventions have several advantages over pharmacological interventions, in that they emphasize increasing functional repertoires and access to reinforcers, minimize the need for chemical or physical restraints, and do not decrease mobility of already-compromised repertoires of individuals with diminished cognitive abilities (Fisher, Harsin, & Hayden, 2000; Fisher & Swingen, 1997).

Behavioral interventions for problem behavior typically involve environmental modification or active skills building (Fisher et al., 2000; Teri, 1996). Recent studies have focused on functional assessment of the environmental contingencies that function as a reinforcer for problem behavior, and incorporation of that information into individualized function-based treatments. Function-based interventions typically involve direct manipulation of the environment to establish relevant discriminative stimuli, to decrease the relevant establishing operations for problem behavior, or to provide the relevant reinforcers (e.g., social interactions, escape from aversive situations, sensory stimulation) independent of the occurrence of problem behavior (Carr, Coriaty, & Dozier, 2000).

Aggression

Up to 86% of individuals with dementia display physical aggression that can contribute to placement in long-term care facilities, use of chemical and physical restraints, and caregiver burnout (Bourgeois, Schulz, & Burgio, 1996; Burgio & Bourgeois, 1992; Cohen-Mansfield, Marx, & Rosenthal, 1989; Cohen-Mansfield, Werner, Culpepper, Wolfson, & Bickel, 1996; Raskind, 1999). The most commonly identified function for aggression in older adults with dementia is escape from a situation perceived as threatening or unpleasant, with common antecedents including task demands, verbal prompts, and physical contact by care providers during ADLs (Burgio & Bourgeois, 1992; Cohen-Mansfield et al., 1996; Fisher & Swingen, 1997; Patel & Hope, 1993). A recent study by Baker, Hanley, and Mathews (2006) illustrates the use of a function-based intervention for aggression associated with bathroom routines. Following a staff-conducted functional analysis suggesting escape-maintained aggression during bathroom routines, noncontingent escape (NCE) resulted in near-zero levels of aggression.

Earlier studies using behavioral but non-function-based interventions to manage aggression illustrate that punishment procedures may be used more commonly when no functional analysis is incorporated. Rosberger and MacLean (1983) used differential reinforcement and time-out to address the aggression of an older adult woman with dementia. Staff members differentially praised her appropriate interaction attempts, while aggression resulted in removal from activities and physical restraint. Aggression occurred 3–16 times per day in baseline, decreasing to near zero levels during intervention. Vaccaro (1988) used a multicomponent be-

havioral intervention for aggression during 1-hour group activity sessions with six older adults. Tangibles and social praise were provided in a 10-minute differential reinforcement of other behavior (DRO) contingency. Aggression resulted in loss of the potential reinforcer, as well as a verbal reprimand and a 10-minute time-out, during which the participant left the group and watched from a remote area. Aggression decreased from a baseline mean of 25.5 per hour to 7.8 per hour in intervention, with simultaneous decrease in a generalization setting.

Wandering

Wandering, typically defined as excessive pacing without purpose, or ambulation into unsafe areas, is estimated to affect from 3 to 59% of all older adults (Burns, Jacoby, & Levy, 1990; Reisberg et al., 1987). Wandering occurs at all levels of cognitive impairment but is more common with greater impairment (Chenoweth & Spencer, 1986; Teri, Hughes, & Larson, 1990). It increases the likelihood of getting lost or injured, having conflict with others (i.e., entering others' rooms), and losing a placement, and it presents serious health concerns due to excessive calorie expenditure, dehydration, and exposure to the elements (Cohen-Mansfield et al., 1996; Hussian, 1988). Simple environmental manipulations, such as reducing clutter and locking doors that lead to unsafe areas (e.g., cleaning supplies), can ensure a safe environment for wandering and minimize the likelihood of establishing an attention function because caregivers do not have to shift their attention suddenly to the older adult following episodes of wandering (Peskind & Raskind, 1996). For example, Hussian and Davis (1985) used a stimulus control procedure to teach three patients with dementia to wander only in safe areas by pairing different colored stimuli with specific consequences in relevant areas (i.e., orange/safe = food reinforcer; blue/unsafe = loud, aversive noise). Posting the colored stimuli successfully decreased wandering into inappropriate areas.

When secure wander areas are not feasible, alternative environmental interventions such as visual barriers and WanderGuard® may prove beneficial. Visual barriers operate on the premise that many individuals with dementia perceive two-dimensional patterns as three-dimensional barriers, without the need to create a real barrier (Hussian & Brown, 1987). Hussian and Brown effectively reduced exit-seeking with a simple grid of masking tape in front of doors. Namazi, Rosner, and Calkins (1989) used seven different visual barriers (e.g., cloth across a door handle, other doorknob patterns, various floor grid patterns) and found that cloth barriers were the most effective in preventing patients with Alzheimer's disease from exiting through an emergency door. Feliciano, Vore, LeBlanc, and Baker (2004) effectively used a visual barrier and extinction to decrease client entry into a staff office area with safety hazards. WanderGuard is a small transponder worn by older adults that emits an alarm when the individual attempts to exit a door. The alarm may function as an aversive stimulus, punishing the behavior of approaching the door and establishing the door as a discriminative stimulus for punishment. However, the alarm may result in a shift to monitoring and interaction following the alarm rather than continuous monitoring, which could result in attention-maintained wandering if the right establishing operations are in effect.

Common behavioral functions of wandering include access to or escape from sensory stimulation (e.g., sights, smells, sounds) and access to attention or preferred items (Cohen-Mansfield et al., 1996; Heard & Watson, 1999). One study has examined the function of wandering directly, with subsequent development of function-based interventions. Heard and Watson (1999) conducted functional analyses that identified maintaining variables of attention for two participants, access to tangibles for one participant, and sensory stimulation for one participant. The relevant functional reinforcer was then incorporated in a DRO intervention for each participant, with substantial reductions in time spent wandering.

Disruptive Vocalizations

Disruptive vocalizations are loud repetitive requests and self-talk, screaming, negative remarks, and use of obscenities (Cariaga, Burgio, Flynn, & Martin, 1991; Cohen-Mansfield, 1986). Unlike aggression and wandering, disruptive vocalizations pose no

immediate threat to safety but produce constant irritation for caregivers that may lead to an older adult's social isolation, nursing home placement, or chemical restraint (Burgio & Bourgeois, 1992). Conversely, moderate decreases in such behavior often produce meaningful social impact by allowing prolonged community placement or eliminating the need for restraint because safety is not an issue,. For example, Green, Linsk, and Pinkston (1986) taught spousal caregivers to reinforce appropriate statements socially and ignore inappropriate verbalizations for two community-dwelling older adult men who faced impending nursing home placement. The behavior change was sufficient to result in continued community placement, and the effects were maintained at a 6-month follow-up.

Common functions of disruptive vocalizations are access to social attention and increased stimulation. Buchanan and Fisher (2002) illustrated the use of functional analysis of disruptive vocalizations and found that repetitive vocalizations in two older adult nursing home patients were attention-maintained, with a possible secondary function of increased stimulation. They effectively reduced the frequency of disruptive vocalizations using noncontingent presentation of the identified reinforcers (i.e., attention, music). Based on the possibility that disruptive vocalizations might provide increased stimulation for some individuals, Lund, Hill, Caserta, and Wright (1995) used interactive videotapes to provide an alternative source of stimulation. A "video respite" system was used on a large scale in 10 nursing home units, with staff ratings indicating a decrease in both wandering and verbal agitation when using the videotapes. Similarly, Burgio, Scilley, Hardin, Hsu, and Yancey (1996) used two "white noise" audiotapes of soothing sounds to decrease verbal agitation in nursing home residents. The nursing home staff provided tape players and headphones with the tape identified as the most effective for that individual during periods of heightened verbal agitation, producing an average 23% reduction in verbal agitation.

Memory Problems

Memory deficits are the hallmark feature of dementia and can lead to communication difficulties, social isolation, wandering, failure to take medication, and agitation (Golden & Chronopolous, 1998). Behavioral interventions for memory deficits typically involve use of *memory aids*, which are discriminative stimuli (i.e., pictoral, textual prompts) for increased independence and communication.

Several studies illustrate the use of simple memory aids with older adults with dementia. Nolan, Mathews, and Harrison (2001) placed portraits with large-print nameplates in hallways to aid adults with dementia in finding their own rooms in a residential setting. Correct, independent room finding increased from a mean of 34% in baseline to 85% during this simple intervention. Bourgeois (1993) used memory aids to enhance conversational content and social skills in adults with dementia. Eight individuals placed into dyads were given memory aid wallets for one dyad member. The wallets included 18–35 pictures about their daily schedule, family, and other life facts. The memory aids increased on-topic and novel utterances for both members of three of four dyads. Though these memory aids are not technology based, electronic memory aids are becoming increasingly popular. Recently, Cohen-Mansfield and colleagues (2005) surveyed 100 healthy older adults about the use of electronic memory aids. Their results indicated that 58% of older adults would use an electronic memory aid for tasks such as personal self-care tasks, reminders for medication, and appointments and important dates, and that they would like the device to be small and portable.

Disengagement

Inactivity or disengagement is common for residents in institutional settings and can lead to skills loss and increased risk for falls and mental health problems (Suzuki et al., 2002). However, relatively simple behavioral interventions have proven effective in increasing levels of engagement of older adults in nursing homes (Altus et al., 2002a; Engelman, Altus, & Mathews, 1999; Jenkins, Felce, Lunt, & Powell, 1977). For example, Jenkins and colleagues (1977) increased engagement with a simple intervention of increased presentation of leisure materials and prompts for engagement. Staff members

presented a choice of four leisure activities several times during 2-hour periods twice a day, with praise and interaction contingent on engagement. The number of participants in the lounge area tripled during intervention, and the number of residents engaging in activities increased as well.

In two studies, Mathews and colleagues targeted engagement in nursing homes across several contexts. Engelman and colleagues (1999) used a "resident check-in" procedure that required staff to make personal contact with each resident every 15 minutes, provide praise for specific behaviors, and offer a choice of at least two activities if a participant was not engaged. The check-in procedure increased appropriate engagement of five participants from 41% of intervals in baseline to 81% of intervals in intervention, with a corresponding increase in the variety of activities. Altus, Engelman, and Mathews (2002b) targeted increased engagement in the form of participation and conversation during mealtime. "Family-style mealtime" involved changing mealtime routines to enhance participants' involvement and communication compared to the typical baseline procedure of prepared plates in nursing homes. The "family-style" meal presentation, combined with staff prompts and praise for appropriate behaviors, substantially increased participation from 10 to 65% of intervals, and conversation from 5 to 18% of intervals.

Recently, Camp, Orsulic-Jeras, Lee, and Judge (2005) evaluated the effects of a Montessori-based intergenerational program on the engagement of adults with dementia using a crossover group design. The program consisted of 20-minute sessions in which dyads of adults ages 50–95 with a diagnosis of dementia and children ages 2½–5 years worked on Montessori activities. Results indicated that the adult participants showed increases in constructive engagement and pleasure, as well as decreases in passive engagement (e.g., watching) and nonengagement.

Organizational Applications

Behavioral interventions are clearly useful for a variety of clinical issues faced by older adults, but residential settings often have organizational characteristics that greatly decrease the likelihood of effective use of behavioral interventions. First, long-term care facilities have low staff–client ratios that can make functional analyses and individual behavioral interventions cumbersome. An employee is responsible for the basic safety, health, and personal care of six to eight individuals during a shift. Any new job duties must fit in with primary care activities (e.g., feeding, toileting, transporting) without substantially increasing work requirements or time constraints. Second, people who directly interact with older adults often are unfamiliar with behavioral procedures. Approximately 80–90% of a nursing home resident's contact occurs with certified *nursing* assistant (CNA) staff (Burgio et al., 2002) who are familiar with the medical model but have little exposure to behavior analysis. Consequently, CNAs need training in basic principles, as well as consistent implementation of behavioral interventions and data collection procedures. Third, frequent staff turnover means that training must be nearly constant to ensure consistency across staff and a culture shift toward proactive behavioral strategies.

Consistency of implementation is critical because the positive effects of behavioral intervention in individuals with dementia are often only evident when the intervention is in place and accurately implemented, with resulting immediate relapse when the intervention is removed. Several studies illustrate that independence and skill use that emerged when one person implemented an intervention were not evident with other staff members until they used the interventions as well. Mathews and Altus (1997) and Engelman and colleagues (2002) taught CNAs to use SLP procedures to increase independence in elderly adults. Increased independence in dressing occurred during intervention with a specific CNA, but the effects did not occur with other CNAs until they were explicitly taught the intervention and used it consistently. Burgio and colleagues (2002) increased continence using prompted voiding schedules on a specialty care unit but found that continence gains did not maintain when individuals returned to a general care unit. All staff members had to be trained to implement schedules consistently. Thus, effective training with a well-structured, sys-

temswide program with regular practice, feedback, and supervision is imperative.

Typical staff training in nursing home settings consists of didactic instruction during a one-day workshop or in-service (Burgio, 1991; Burgio & Burgio, 1990), with 85% of training lasting 1 hour during or between shifts (Wieland, Wendland, & DeRyke, 1992). Even though lecture or didactic instruction is common, more effective training systems have been established and commonly are used in business settings and in other organizational systems. Strategies such as explicit practice with feedback, offsite education, career development, and incentive systems are becoming increasingly popular methods of successful staff training in businesses (Wieland et al., 1992). Many of these same strategies used successfully in long-term care for individuals with developmental disabilities have not been fully incorporated into mainstream nursing home care, presenting an enormous dissemination need and opportunity (Burgio, 1991).

Recently, behavioral gerontologists have incorporated effective training and systems management strategies in nursing home settings. For example, Burgio and colleagues (2002) compared formal staff management (i.e., self-monitoring, feedback, incentives) and conventional staff management (i.e., status quo supervision without feedback or incentives) for maintenance of previously trained behavioral skills in CNAs. Formal staff management resulted in better skills maintenance than did conventional management. Other studies have examined training and feedback strategies when investigating increases in engagement, independence, and continence (Engelman et al., 1999, 2002, 2003) with positive effects.

Summary and Conclusion

Behavioral gerontology has enormous potential for positive social impact; however, several prominent behavior analysts have suggested that behavioral gerontology has neither flourished as a subfield (Burgio & Burgio, 1986; Carstensen, 1988) nor fully explored all potential applications of behavior analysis to aging (Derenne & Baron, 2002). As an example, there have been relatively few functional analysis studies of older adults with dementia compared to the thriving literature on functional analysis in individuals with developmental disabilities (Hanley, Iwata, & McCord, 2003), even though older adults with dementia are just as likely to have troublesome behaviors. Behavior analysts interested in aging have almost unlimited potential for research and clinical opportunity due to the growing demand for a range of services for older adults.

Additional, basic human operant studies are needed for virtually every aspect of responding that might be impacted by age-related changes in human functioning. In the applied area, more studies are needed that incorporate functional assessment and address health and mental health issues in community-dwelling elders. Additionally, future applied studies in residential settings must focus on incorporation of electronic technology and organizational strategies to improve overall efficiency and effectiveness of service delivery. Behavior analysts must continue to publish studies in journals on aging and those specific to other disciplines (e.g., nursing, occupational thearpy) to introduce these groups to the benefits of the behavioral approach. However, behavior analysts also must continue to publish enough studies on behavioral gerontology in flagship behavior analytic outlets to ensure that new behavior analysts remain interested in the field.

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PART VIII

PROFESSIONAL ISSUES

CHAPTER 29

Behavior Analysis and Ethics

William O'Donohue and Kyle E. Ferguson

Behavior analysis has a complex relationship with the field of ethics. In this chapter we describe the general structure of this relationship, as well as some of the major complexities and unsettled issues. Ethical discourse has typically been construed as occurring at three distinct levels:

1. *Meta-ethics,* which attempts to address questions (e.g., What kind of thing is ethical discourse? Is it the same or different from empirical discourse? If it is the same, what natural kinds does ethical discourse belong to? If different, what kind of thing is ethical discourse and how is the truth value of ethical claims to be evaluated?).
2. *Normative ethics*, which addresses the question of which ethical claims, among many possible candidates for ethical principles, are correct. Is doing *X*, for example, morally right, wrong, or indifferent (where *X* can range from having a late-term abortion to prescribing facilitated communication for an autistic child, to eating an orange)? Normative ethics tries to address the questions of which moral prohibitions, permissions, or mandates are actually correct and how are they justified.
3. *Descriptive ethics*, which addresses the empirical question of what ethical claims or beliefs are held by some sample of individuals. This is an interesting question, and research might be conducted to see what ethical claims behavior analysts hold, but because no research on this issue could be found, this dimension of ethics is discussed further in this chapter.

Behavior Analysis and Controversies at the Meta-Ethical Level

Behavior analysis has paid most attention to two key meta-ethical problems: First, behavior analysts, following Skinner, have responded to the meta-ethical question "Is ethical discourse even possible (in a deterministic worldview)?" in the affirmative, although it becomes a somewhat different kind of discourse than that in common folk discourse assuming choice points in which an individual is free to choose morally bad or morally good alternatives. Second, behavior analysts have answered the question "What kind of thing is ethical discourse?" with the response that it is naturalistic discourse, similar to talk of other observable

properties of the world, such as color and smell. We first turn our attention to the issue of morality in a deterministic worldview.

Meta-Ethical Question 1: Determinism and Kant's Dictum "Ought Implies Can"

The moral philosopher Immanuel Kant (1997) asserted "ought implies can"; that is, it makes no sense to assert that someone *ought* to have done something unless this person *could* have done it. For example, it makes no sense to assert that Jane ought to have jumped 20 feet in the air when it is physically impossible for Jane to do so. Thus, according to Kant, moral discourse presupposes choice (the person can do something because he or she is free to choose to do this); thus, morality presupposes free will.

Skinner, particularly in *Beyond Freedom and Dignity* (2002), discussed the conflict between a scientific worldview and a view based on choice and free will. Science presupposes some form of determinism because it assumes order, and it assumes there are causal relations to be discovered. Science is based on the presupposition that the world is orderly, and this order can be captured in lawful relations. A scientific law, however, describes an impossibility. According to the law of gravity, for example, it is impossible for two objects to behave other than the ways the law states. Objects are not free to choose other ways of behavior, or to choose other relationships. The law describes the only way that the objects can behave. Skinner points out that if people are free to choose their behavior, then a science of behavior is not possible. Thus, Skinner aptly titled his book *Beyond Freedom and Dignity* to argue that the scientific enterprise, when applied to human behavior, must move beyond the notion of free choice. Therefore, taking Kant seriously, behavior analysts must assume that ethical discourse does not make sense.

How can behavior analysts come to terms with this issue? Behavior analysts, of course, can take the stance that adopting an ethical code for behavior analysts or individual ethical utterances are themselves just more determined behavior, but at the same time they must see that to remain consistent it is a kind of behavior that is "beyond normal ethical discourse"—they did not choose to do this; thus, they should not be praised or punished for this because they could have done nothing else. Normal ethical discourse takes choice seriously and is a kind of argument to make "good choices" when at these moral crossroads. Behavior analysts do not countenance the existence of such "moral choices." Thus, meta-ethically, morality is a different kind of thing to any determinist than to any libertarian.

Ringen (1996) addresses this question in the following:

> The scientific account of human action requires that every event is completely causally determined, so there are no acts that are free of determining causal influences. The conclusion is that the causal determinism involved in the scientific account of human action is incompatible with the account of autonomy and self-determinism that legal, political, and ethical arguments require.... This incompatibilist view entails that one can't consistently accept scientific determinism and the traditional conception of human beings as acting in a self-determining way. The reason is that if determinism is true, no human act is, in the relevant sense, free of controlling influences. (p. 356)

Accordingly, if we are to presume determinism within the science of behavior, to what extent does it even make sense to have an ethics code for psychologists? If "ought implies can," then how can an individual be held morally culpable when he or she could not have done otherwise (O'Donohue & Ferguson, 2003, p. 7)? As we see later, from a deterministic, scientific standpoint, if we want behavior analysts to behave ethically we need to better understand the controlling influences or contingencies (i.e., antecedents and consequences) of which ethical (and unethical) behavior is a function.

Meta-Ethical Issue 2: Skinner's Naturalistic Approach to Ethics and Moral Reasoning

Philosophers have made a variety of claims about what kind of entity ethical discourse actually is. A brief list follows:

1. *Ethical discourse derives from some divine source (usually resulting in some divine commandments) and as such is a kind of religious discourse.* This view has held wide sway in the history of humankind and still has a significant number of proponents.

It can be argued that much of the founding discourse of Western Civilization (witness the theological–ethical connection in the U.S. Declaration of Independence and the Constitution) is based on this view. However, behavior analysis is clearly not associated with this view, and its emphasis upon naturalistic, evolutionary accounts may generally be regarded as critical of the view that ethical discourse is theological discourse.

2. *Ethical discourse is meaningless.* It is "language gone on holiday," to use Wittgenstein's (1963) felicitous phrase. The logical positivists held this view. They proffered an "emotivist" meta-ethical theory and claimed that since "*x* is bad" has no direct observational basis, it violates their verifiability principle, and hence is meaningless. Their positive claim, though, was that humans tend to make these kinds of utterances because humans are not only logical, rational animals but also emotional ones, and it is this emotional capacity that causes humans to make these utterances. "Murder is bad" is equivalent to "Uck!" or "I hate murder," and nothing more. Behavior analysis has not been influenced by logical positivism to the extent that many distant observers think (see Smith, 1986), and it does not hold an emotivist view of ethics.

3. *Ethical discourse makes reference to an entirely empirical, natural phenomenon that can be cashed out in similar ways to other empirical, descriptive discourse (other descriptive or even causal discourse).* "*X* is bad" is equivalent to "I have observed that *X* has some empirical property." Skinner (2002) held this view (discussed in more detail below); thus, this view has been most influential in behavior analysis. In brief, Skinner held that "*X* is good" means that "*X* is reinforcing," where reinforcing is an empirical matter (i.e., increases the response rate of the behavior it is contingent on). Skinner argued that ethics is a completely natural discourse (but see for critiques of this position below).

4. *Ethical discourse is* sui generis. Ethical utterances and claims are not similar to descriptive, empirical discourse. In fact, they are not similar to any other kind of discourse: Ethical discourse is wholly unique. This is the view of many ethical theorists, such as Immanuel Kant (1997) and G. E. Moore (1988). There is an ethical realm, and, as such, ethical claims have a wholly different status than empirical claims in the observable world. The exact status of ethical discourse depends on the specific ethical theorist. Behavior analysis has generally disagreed with this position, instead attempting to naturalize the normative.

Although Skinner originally maintained that ethics and moral reasoning are beyond the purview of behavior analysis (e.g., Skinner, 1953, p. 328), in his later writings he adopted a position akin to naturalism (e.g., Skinner, 1953). According to Skinner (2002),

> Good things are positive reinforcers.... When we say that a value judgment is a matter not of fact but how someone feels about a fact, we are simply distinguishing between a thing and its reinforcing effect. Things themselves are studied by physics and biology, usually without reference to their value, but the reinforcing effects of things are the province of behavioral science, which, to the extent that it is concerned with operant reinforcement is a science of values. (pp. 103–104)

Naturalism is the theory that moral values can be derived from facts about the world (MacIntyre, 1998). From this perspective, as is the case in the previous quotation, "is" can imply "ought." Presumably, from a Skinnerian standpoint, one *ought* to behave in ways that eventuate in reinforcement. Or, conversely, one *ought not* to behave in ways that result in punishment. One *should* escape or avoid negative reinforcement. Skinner (2002) adds:

> Things are good (positively reinforcing) or bad (negatively reinforcing) presumably because of the contingencies of survival under which the species evolved.... It is part of the genetic endowment called "human nature" to be reinforced in particular ways by particular things. (p. 104)

Thus, human beings are in a sense "hardwired" to know right from wrong, good from bad. It is "part of our genetic endowment." What follows, therefore, is that "all reinforcers eventually derive their power from evolutionary selection" (Skinner, 2002, pp. 104–105). Simply, individuals whose behavior is maintained by certain types of

reinforcers live to reproduce, while those insensitive to the same die off. Thus, morality evolved insofar as our species evolved.

The inherent problem with Skinner's naturalistic position is that the concept of reinforcement is not clear. Early accounts were entirely functional: If an animal were appropriately deprived (e.g., 80% of *ad libitum* weight), certain events were highly likely to function as reinforcers (e.g., delivery of food pellets). Thus, one also has to understand reinforcing effects by contextualizing the behavior in a matrix of variables that affect reinforcement (e.g., setting events). Ethical statements become very complex, such as "When *X* is deprived of *Y* to extent *Z*, and emits behavior *B, R* is reinforcing (morally correct) to *X* until satiation point *S* is achieved, and then *R* becomes punishing (morally wrong) (see Allison & Timberlake's [1975] response deprivation model of reinforcement). It is unclear how many parameters need to be a part of such sentences because the field's understanding of the mechanisms of reinforcement is still not complete. Thus, a problem with this view is that the construct of reinforcement is by no means clear, and the controversies surrounding this construct spill over to make ethical pronouncements unclear and uncertain.

In addition, there seem to be some problematic counterexamples: Take pedophilia as a case in point. *Pedophilia* is sexual attraction to prepubescent children. Few would argue—other than, possibly, pedophiles—that their behavior is not morally wrong, blameworthy, and so forth. However, stimuli associated with prepubescent children, either in the form of child pornography or the children themselves, are highly reinforcing to certain behaviors of such individuals. According to Skinner's position, therefore, the pedophile's sexual behavior is morally good, at least for the pedophile. They might like pedophilic stimuli (i.e., find them rewarding), but can nothing else be said here? Does Skinner's naturalistic account force us into a relativism in which we can say that "child pornography is good" for *X* because it functions as a reinforcer for *X*? Certainly, the problem is clear. *X* can be a reinforcer for *Y* but still be morally wrong.

The problem with Skinner's approach is due to what G. E. Moore (1988) called *naturalistic fallacy*. Moore stated:

> "Good," then, if we mean by it that quality which we assert to belong to a thing, when we say that the thing is good, is incapable of any definition, in the most important sense of that word. The most important sense of definition is that in which a definition states what are the parts which invariably compose a certain whole; and in this sense good has no definition because it is simple and has no parts. It is one of those innumerable objects of thought which are themselves incapable of definition because they are the ultimate terms of reference to which whatever is capable of definition must be defined.... There is, therefore, no intrinsic difficulty in the contention that good denotes a simple and indefinable quality.... Consider yellow, for example. We may try to define it, by describing its physical equivalent; we may state what kind of light-vibrations must stimulate the normal eye, in order that we may perceive it. But a moment's reflection is sufficient to show that those light-vibrations are not themselves what we mean by yellow. *They* are not what we perceive. Indeed, we should never have been able to discover their existence, unless we had first been struck by the patent difference of quality between the different colours. The most we can be entitled to say of those vibrations is that they are what corresponds in space to the yellow which we actually perceive. (Section 10, paragraphs 1 and 2, original emphasis)

To the extent that "yellow" does not possess the property of "yellowness," reinforcers do not possess the property of "goodness." Such value judgments have to be made regardless of their reinforcing properties; otherwise, we run into the same problem as in our pedophile example. Labeling behavior good or bad, right or wrong, seems to concern aspects of consequent stimuli (thus far, indefinable) unrelated to their reinforcing characteristics.

Normative Ethics: Controversies Concerning an Ethical Code

The Florida Association for Behavior Analysis (1987) was the first chapter to develop an ethical code. The Texas Association for Behavior Analysis soon followed suit in the early 1990s, followed by the California Association for Behavior Analysis in 1996. Recently, the Association for Behavior Analysis (ABA) has adopted the American Psycho-

logical Association's (2002) *Code of Ethics*, thus obviating those developed under individual chapters. Likewise, the Behavior Analyst Certification Board by and large adopted (though with some modification) the American Psychological Association's *Code of Ethics* in 2004. Accordingly, criticisms of the American Psychological Association's *Ethical Code* are relevant with respect to ABA's code because they are virtually the same.

Ethical codes (other than those *believed* to be prescribed by an infallible God, which does not concern us here) are not above criticism (O'Donohue & Ferguson, 2003). Ethical codes are the product of human behavior and, like all human activity, are fallible. The American Psychological Association's Ethics Code (2002) is no exception.

The Ethical Code is a fallible document. How fallible and in what ways is the crux of the matter. Of concern, though, is that individual behavior is either pronounced unethical when it is not or ethical when it is not, as a result of the problems of this code. That the code is fallible is easy to discern. First, if it were infallible, why would it have undergone eight revisions since its inception (in 2002)? Of course, the American Psychological Association can argue that the code has morphed in accordance with changing ethics, and that successive iterations have accommodated these changes accurately. However, no such argument has been advanced by the American Psychological Association, and, generally speaking, morality—at least as it concerns professional matters—remains largely static over time (e.g., the standards of beneficence and nonmaleficence, fidelity and responsibility, integrity, justice, and respect for individual rights and dignity do not change appreciably; O'Donohue & Ferguson, 2003).

Second, the American Psychological Association employed fallible procedures in developing the code. Codes were voted in or out based on the decision of committee members (none of whom were behavior analysts, we might add). Knowledge by way of authority (barring an infallible God) is, of course, fallible due to imperfect judgment, heuristic biases (e.g., representative biases), and the like, on the part of committee members. No experimental analyses were conducted; hence, there were no safeguards in place to mitigate against these biases—which probably were operating at some level during committee meetings.

Third, other professional organizations within the behavioral sciences have their own codes of ethics, some of which differ on fundamental points in relation to the Ethics Code (e.g., the Association for the Advancement of Behavior Therapy's higher standard of evidence before interventions ought to be used). Ethical codes developed within individual chapters in behavior analysis (e.g., California Association for Behavior Analysis [Cal-ABA], 1996; Florida Association for Behavior Analysis [FABA], 1987) also reveal inconsistencies between the Ethics Code and theirs. The question then becomes: Which one is right (O'Donohue & Ferguson, 2003)? Although there are no hard and fast rules in determining this experimentally, we can evaluate these standards by following their line of reasoning and turning to the empirical literature for support (or counterevidence).

Let us take the *Behavior Analyst Certification Board Guidelines for Responsible Conduct for Behavior Analysts* (2004) as a case in point. Consider Code 1.4.2 (Exploitative Relationships):

> Behavior analysts *do not engage* in *sexual relationships* with *clients,* students, or supervisees in training over whom the behavior analyst has *evaluative* or *direct authority,* because such relationships *easily impair judgment* or become *exploitative*. (emphasis added)

Although not explicitly stated as such, a likely interpretation of these guidelines is that therapists ought not to engage in sexual relationships with clients (ever) because "authority" never ends. Namely, behavior analysts have a special knowledge and skills set (whereas clients [typically] do not) that places them at an unfair advantage. The relationship is thus unilateral. There is a power differential. This specialized knowledge puts therapists in the role of authority. Therapists, therefore, ought not to engage in sexual relationships with clients under any circumstances because "such relationships easily impair judgment and become exploitive (due to this power differential)."

Now consider the American Psychological Association's Ethics Code, Code 10.08

(a) (Sexual Intimacies with Former Therapy Clients/Patients):

> Psychologists do not engage in sexual intimacies with former clients/patients for at least two years after cessation or termination of therapy. (p. 4)

This, of course, is vastly different from the Certification Board's guidelines regarding such dual relationships. Ignoring the power differential as mentioned earlier, Code 10.08 (a) of the American Psychological Association's Ethics Code posits that this is not a problem, provided that either party holds out for a minimum of 2 years. *Why 2 years?* is a reasonable question to ask, and it is anyone's guess as to why the American Psychological Association has not provided any empirical evidence why 2 years is better than, say, 1 year, or 6 months, or 10 years, and so forth. Nor has it provided any evidence to support that even having sexual relationships with former clients—irrespective of the interval of time—is beneficial to either party, or, at the very least, does not cause any harm.

Reason would suggest that the American Psychological Association's standard is patently wrong. Among other concerns, once therapists begin having sex with former clients, they might start viewing current clients differently; that is to say, outside of a professional relationship (seeing them as potential lovers). This, of course, can obfuscate professional boundaries, and, as such, compromise the therapeutic alliance.

A fourth problem concerns the relationship between the Ethics Code and justification for these standards. Simply making the claim that one action is ethical and another is unethical, without alluding to some ethical theory or general ethical standard, is insufficient for several reasons (O'Donohue & Ferguson, 2003). First, how can we know if we are interpreting a given standard correctly? For example, deontological theory judges the rightness or wrongness of an action based solely on the nature of the act itself (structural characteristics), irrespective of its consequences. Some actions are deemed unethical even though they bear functional similarities to actions that are not (e.g., stealing out of a client's purse might be deemed unethical by some parties, while excessive charges for services rendered is deemed ethical). Utilitarian ethics, by contrast, judge the rightness or wrongness of an act based solely on its consequences. If no one got hurt, the act would not be deemed unethical in spite of malicious intent. Accordingly, deontic versus utilitarian ethical theorizing provides different interpretations of the same code. Given that the American Psychological Association has not explicitly stated its position on this matter, either interpretation is defensible. Furthermore, should an alleged ethical violation come under investigation by the Certification Board, the decision to take disciplinary steps would differ considerably based on members' theoretical orientation.

Relatedly, a second problem concerns identifying the relevant conditions for determining whether a standard has been violated (O'Donohue & Ferguson, 2003). For example, does the motive to do harm versus actual harm constitute an ethical violation? The American Psychological Association is silent on this matter as well. Technically speaking, these contrasting views concern motivist ethical theory and utilitarian ethics, respectively. From a motivist perspective, having sufficient evidence of *the intent* of maleficence warrants disciplinary action. By contrast, from a utilitarian perspective, the intent of wrongdoing is insufficient cause to take disciplinary steps. One needs sufficient evidence that the client was harmed in some way or other. Accordingly, because the American Psychological Association does not explicate the morality upon which its Ethics Code is based, how can it ensure due process of ethical inquiries (O'Donohue & Ferguson, 2003, p. 7)? It simply cannot ensure a fair trial.

Skinner's Contingency Analysis of Moral and Ethical Behavior

Although Skinner's science of behavior is inadequate in helping us determine *what* in fact is moral or ethical behavior (i.e., normative ethics), his analysis of the contingencies by which people behave ethically is highly useful in helping us understand *why* people behave as they do (i.e., meta-ethics). By iden-

tifying the contingencies of which ethical behavior is a function, one can then create the conditions that foster ethical behavior, and, more importantly, avoid those conditions that promote unethical behavior.

According to Skinner (1972), "We cannot choose a way of life in which there is no control.... We can only change the controlling conditions" (pp. 97, 99, 194–195). What he meant by this is that our behavior is always under the control of genetic and environmental determinants (i.e., antecedent and consequential stimuli). Skinner's views on promoting ethical behavior, therefore, entail changing these controlling conditions. The most important aspect of these controlling conditions is the presence of countercontrol (Skinner, 1972).

Countercontrol is the "emotional reaction of anger ... including operant behavior," on the part of the controllee (i.e., the person whose behavior is under the control of another), that "injures or is otherwise aversive to the controller" (Skinner, 1953, p. 321). In other words, countercontrol is the controllee's attempt at changing the aversive contingencies of which his or her behavior is a function. Several examples of countercontrol are as follows: An abused spouse murders her husband; an incarcerated criminal escapes from prison; citizens protest against their government.

How countercontrol relates to ethics can be summed up in the following passage:

> The consequences responsible for benevolent, devoted, compassionate, or public-spirited behavior are forms of countercontrol, and when they are lacking, these much-admired features of behavior are lacking.... The point is illustrated by five fields in which control is not offset by countercontrol and which have therefore become classical examples of mistreatment. They are the care of the very young, of the aged, of prisoners, of psychotics, and of the retarded. It is often said that those who have these people in charge lack compassion or a sense of ethics, but the conspicuous fact is that they are not subject to strong countercontrol. The young and the aged are too weak to protest, prisoners are controlled by police power, and psychotics and retardates cannot organize or act successfully. Little or nothing is done about mistreatment unless countercontrol, usually negative, is introduced from outside. (Skinner 2002, pp. 196–197).

Here, Skinner is very clear as to what needs to take place to ensure ethical behavior on the part of professionals. In those circumstances where individuals are disadvantaged, such that they have no effective mechanisms of countercontrol, external agencies need to step in to offset this imbalance. Within recent times, no other area in health care illustrates the role of countercontrol and ethics better than the care of elderly with dementia and other intellectual impairments.

Countercontrol and Elder Abuse

Due to the heavy burden experienced by their caregivers, older persons with cognitive and behavior disorders are at particularly high risk of elder abuse (Lachs et al., 1997). *Elder abuse* is defined as physical, psychological, sexual, and financial exploitation and/or neglect that may result from the actions of others (e.g., caregivers; Dyer, Pavlik, Murphy, & Hyman, 2000). The prevalence of elder abuse ranges from 1 to 12%, although these figures likely underestimate the problem due to methodological weaknesses and a reluctance to report abuse by both care recipients and caregivers (Tueth, 2000). After all, elder abuse is a felony and can result in criminal charges.

Characteristics that place persons with dementia at risk for abuse include the presence of challenging behaviors, such as physical aggression, and their need for increasingly intense hands-on care as they deteriorate (Lachs et al., 1997). It is within the context of hands-on caregiving that physical abuse is most likely to occur. When a caregiver has direct contact with aggressive and/or noncompliant behavior in a person with dementia, the caregiver is likely to be emotionally distressed, possibly angry, and in physical pain (if injured by the patient) (Paveza et al., 1992; Teri et al., 1992). Most importantly, given their overall impairment and oftentimes frail condition, persons with dementia are unable to exert effective countercontrol.

Although elder abuse has of late received widespread attention in the media, the treatment of elderly individuals has improved considerably over the last several decades as states have stepped in to ensure that better countercontrol mechanisms are in place. Re-

porting and documentation have become increasingly stringent. Moreover, skilled nursing facilities (nursing homes) are subject to random checks by government agencies.

Closing Remarks

Behavior analysis has a complex relationship with ethics. This chapter described the complexities of this relationship, as well as some of the unsettled issues. One of the major unsettled issues is: Is it even possible to reconcile a scientific view of behavior with an indeterministic view or the notion of free will, which presupposes the American Psychological Association's *Code of Ethics*? Does it even make sense to have an ethics code for behavior analysts who espouse a scientific view of behavior? If "ought" indeed implies "can," then how can a professional be held morally and ethically responsible when he or she could not have behaved otherwise (O'Donohue & Ferguson, 2003, p. 7)? His or her unethical behavior was beyond his or her personal control. That is to say, his or her unethical behavior was due to genetic variables and deficiencies in the prevailing contingencies of which such behavior and other, incompatible ethical behavior are a function.

In *Beyond Freedom and Dignity*, Skinner (2002) discussed this conflict between a scientific worldview and a view based on choice and free will. Science presupposes determinism because it assumes *order* in the universe. Based on the presupposition that the world is orderly, science is then in a position to elucidate those lawful relations (e.g., contingencies of survival and reinforcement) that enable our species to better predict and control natural phenomena. Insofar as matter does not get to choose what natural forces operate on it, organisms do not get to choose what behavior gets emitted. Accordingly, the answer to the earlier question is "no." The American Psychological Association's *Code of Ethics* is incompatible with the science of behavior. Therefore, it should be dropped entirely.

Skinner's contingency analysis of moral and ethical behavior should supplant the American Psychological Association's *Code of Ethics*. Although Skinner's science of behavior is inadequate in helping us determine *what* in fact is moral or ethical behavior, his analysis of the contingencies by which people behave ethically is highly instrumental in getting professionals to behave ethically. Although individuals might disagree about particulars, we can all agree about what is and is not ethical in most instances. For example, it is unethical to strike patients under any circumstances. Likewise, an ethical practice might be to maximize a patient's independence, while decreasing his or her dependence on other people. By identifying the contingencies of which ethical behavior is a function, psychology and behavior analysis can then create the conditions that foster ethical behavior and, more importantly, obviate those conditions that evoke unethical behavior.

In closing, the recent wholesale adoption of the American Psychological Association's *Code of Ethics* should come as a surprise to the behavior analytic community given that it is antithetical to the tenets of the science of behavior. However, surprisingly, the community has remained largely silent about this change. In light of the community's lack of response, one might assume one of two things. First, behavior analysts are silent on this issue because they deem the American Psychological Association's code to be acceptable. Hence, there are no criticisms to be made. This, of course, does not seem to be the case, as most behavior analysts would be outraged by the ABA's recent adoption of the American Psychological Association's *Code of Ethics* had they considered this action carefully. Second, they have not read the American Psychological Association's *Code* and/or they consider ethics in general perfunctory at best. Although this remains an empirical question, one might safely assume that this is indeed the case. This attitude notwithstanding, members of the behavior analytic community should note that there are serious implications or consequences for accepting the American Psychological Association's *Code of Ethics*. Among other things, should they ever find themselves in a situation where ethical charges are made against them, there are no safeguards inherent in the American Psychological Association's *Code* to ensure due process of ethical inquiries (O'Donohue & Ferguson, 2003, p. 7). Simply, there are no contingencies (or countercontrol mechanisms) in place to ensure a fair trial.

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CHAPTER 30

Training and Professional Certification in Applied Behavior Analysis

Gerald L. Shook and James M. Johnston

Professional Credentialing

Holding a professional credential is the common means for professionals to demonstrate to the public that they have met specific, recognized standards of competence in their chosen field. Consumers generally use the professional credential as a necessary qualification when making decisions about which professional to use. For example, most of us would not obtain the services of a surgeon, attorney, or dentist unless he or she were properly credentialed.

Likewise, if we moved to a new town and needed the services of an attorney, it would be reasonable to begin our search by obtaining a list of attorneys with the proper professional credential. If we needed specialized service, say, in the area of real estate law, we might look for an attorney who also held a specialty credential in that area. Of course, we also would do a number of other things to help ensure that we hired a competent attorney (e.g., obtain references, talk with community members, and review pubic records relating to the attorney's practice), but verifying that the attorney is properly credentialed is a reasonable and common first step in the selection process. Employers and government agencies find that a similar approach is an efficient and effective means of hiring professionals or designating the required qualifications for a particular position. Although merely having a credential may not be sufficient for an individual to obtain a given professional position, it is most often a necessary requirement for applicants to make the final cut. Consumers, employers, and government agencies find that a professional credential is a convenient and effective means to help identify qualified professionals.

Until fairly recently, behavior analysts had no professional credential specific to behavior analysis. Consumers seeking qualified behavior analysts did not have a credential on which they could rely to aid their search, but rather were forced to use less reliable means of assessing practitioner qualifications, such as word of mouth, a review of the practitioner's curriculum vitae, and practitioner advertisements. Employers and government agencies found themselves in a similar predicament and were forced either to make up their own criteria for a "qualified" behavior analyst or to specify that individuals possess an existing credential (e.g., psychology license or teacher certification).

This "homemade" criteria development and qualification assessment process proved to be tedious and ineffective compared to the ease of simply recognizing a credential based on professionally developed standards and evaluation. Furthermore, recognizing a professional credential based on non-behavior-analytic content usually did little to identify those who were qualified in behavior analysis. Other credentials did not require or guarantee that the practitioner had any level of education, training, or competence in behavior analysis, nor did such non-behavior-analytic credentialing examinations contain significant numbers of meaningful test items in that content. To the consumer, however, the use of these non-behavior-analytic credentials often gave a dangerous false sense of confidence.

The problem of identifying qualified behavior analyst practitioners approached a critical level when substantial funding became available for applied behavior analysis (ABA) therapy and educational training for people with autism (Shook & Favell, 1996). Individuals whose motivations were primarily monetary, but who apparently lacked meaningful professional preparation and skills, quickly offered to meet this growing demand. These bogus purveyors of behavior analytic services were unable to provide effective services, which often resulted in consumer claims that behavior analysis "didn't work." This state of affairs had an adverse effect on the field of behavior analysis in general and the reputation of qualified behavior analysts in particular.

Nature of Professional Credentials

Professional credentials often take the form of licenses issued by the state, provincial, or national government. These licenses usually are established through a law that limits either the use of a professional title or engagement in specified professional practice to those holding the appropriate license. Under a title law, for example, individuals may hold themselves out as an attorney only if they are so licensed by the state. Similarly, under a practice law, individuals may practice law only if they are licensed as an attorney. If the law combines title and practice features, individuals may not use the title or engage in the practice of law unless they are appropriately licensed. Usually the government licensure law also establishes a professional board or professional college to oversee the licensing process and review disciplinary matters involving professionals licensed under the law.

A second form of credential is professional certification. Although licensure and professional certification take fundamentally the same approach to the credentialing process, professional certification differs from licensure in that it is usually issued by a private agency rather than a government, is most often not limited to a single state but rather crosses state and national borders, and can be voluntary or mandatory for practice. Because professional certification typically is developed and issued by a private agency and not by the government, certification is usually driven more by the profession and is not as subject to the whims of a politically influenced governmental process. Because professional certification can cross state and national boarders, it is more "portable" for certificants than local government licensure (Hall & Lunt, 2005), and the international credential represents a broader perspective than the more parochial local government credential. Behavior analysis lends itself particularly well to an international certification approach because it is based on the science of behavior (Skinner, 1953) and the basic content is therefore highly consistent from one country to another. It is important to note that both licensure and professional certification programs must adhere to the same legal, psychometric, and professional standards in the development of their credentials and measurement instrument(s), and execution of their credentialing programs. Professional certification programs generally obtain national accreditation in order to demonstrate that their credentialing process meets the rigorous standards of these accrediting bodies (American National Standards Institute, 2003; National Commission for Certifying Agencies, 2003).

Recognition of Professional Credentials

Professional credentials can be used by consumers, employers, and governments in several ways. At the most basic level, consum-

ers and employers can make decisions based partly on whether individuals hold the professional credential. All else being equal (or unknown), individuals who have the professional certification can be chosen over those who do not. Consumers and employers can also recommend that an individual hold a particular credential to qualify for a position. At another level, consumers and employers can include a particular professional credential as one of a number of credentials that would be acceptable to qualify for a position. For example, a school program could indicate that any one of five specified credentials be used to qualify for a position. At still another level, consumers and employers may mandate that the individual hold the professional credential to qualify for a job. For example, a university may decide that a particular professional certification is necessary for a faculty position, or an individual school district may decide to require a given professional certification for a particular position or job category.

Of course, governments can introduce stipulations in law or regulation on a state, provincial, or national level. For example, a province could include a specific certification as one of many credentials that would qualify an individual for a particular position or to perform a certain function. In another instance, a national government might require a particular certification for an individual to access a specific governmental funding stream. Additionally, governments may use existing professional certification as the basis for a government licensure program. In order to maintain the license, the government could require that the individual keep his or her professional certification current. The government may require the individual to pass a local "laws and rules" examination. The government also could have the license fall under the auspices of a professional board that would be charged with deciding local disciplinary matters. When compared with a government developing and maintaining a professional credentialing program on its own, deference to a valid and current professional certification as the basis for governmental licensure substantially reduces both the fiscal impact and the infrastructure requirements for the responsible government agency.

Credentialing Program Components and Requirements

A professional credentialing program, whether for licensure or professional certification, consists of three main components: eligibility standards, a written examination, and some form of continuing education for credentialed individuals.

Applicants must meet specific eligibility standards to qualify for examination. These standards usually require the applicant to have a minimum educational degree, specific university coursework, and some form of supervised experience. Professional credentials usually require a graduate degree, although several credentials are offered at the undergraduate level as well. Degrees usually must be in a particular area of study (e.g., licensed psychologists typically must have a degree in psychology) or particular educational department or school (e.g., a medical doctor must be a graduate of a school of medicine). In some professional fields, such as in behavior analysis, the training is not housed in a particular department; rather, it may be found in a variety of university training venues. Some sort of supervised experience is generally required to qualify for examination, although in a few professions, some of the experience may be acquired after the individual has qualified for and passed the written examination. University training in behavior analysis, through coursework and supervised experience, is covered in some detail later in this chapter.

The cornerstone of any professional credentialing program, however, is the professionally developed written examination. To be viable, the written examination must meet both psychometric and legal standards; that is, the examination must be able not only to separate those who know from those who do not know but also to stand up to scrutiny in a court of law. To these ends, examinations must be constructed following psychometric principles developed and accepted by experts in this field and by standards-setting bodies (American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 1999; American National Standards Institute, 2003; National Commission for Certifying Agencies (2003); U.S. Equal Employment Opportunity Commission,

1978). Examination construction must also be in compliance with the multiple principles established in a well-developed body of case law addressing the subject. Even a psychometrically sound examination must be able to withstand a courtroom test or it is of little use to consumers, prospective certificants, or licensees because the credentialing program might cease to exist.

The development of a professional credentialing examination follows a well-defined and logical sequence of steps (Browning, Bugbee, & Mullins, 1996). One of the most critical steps is the *job task analysis,* which defines the content of the profession (Foxall, 2002). This process is well-documented in the test construction literature, and the requirement for completing a job task analysis is supported by case law. One product of the job task analysis is a *task list* of tasks and subtasks that define the content domains on which the examination will be built. This task list provides a link between content included on the examination and the actual practice of the profession. This link serves as the primary evidence for supporting the validity of the examination by demonstrating that the examination is testing what it is supposed to test (i.e., content that is recognized as important to the practice of the profession).

Although there is some variation in the methods for conducting a job task analysis, the process usually begins with a panel of 10–20 subject-matter experts who are convened to develop an initial task list (or to review an existing task list) and establish basic content areas that should be addressed in the test instrument. Often this meeting is a multiday affair, replete with spirited debate among the subject-matter experts. Once the initial task list is complete, a second panel of subject-matter experts often is convened to verify and, if necessary, edit the initial task list. This refined task list forms the basis of a survey to determine the essential content an entry-level practitioner must know to practice competently. This survey is then field-tested with 50 or more subject-matter experts to determine the adequacy of the survey instrument and the content that is covered. After the survey has been revised to reflect the field-tested information, it is sent out to a large number of certificants or licensees (frequently several thousand) and other subject matter experts for their input. These individuals are asked to rate the importance of each item relative to the competency and functioning of an entry-level practitioner. After the data collected in the survey have been compiled and reduced to a usable summary document, another panel is convened to review the survey results and determine which content tasks should remain on the task list and, subsequently, be covered on the certification examination. Additional panels of subject-matter experts write and review test items, linking each item to the new task list. Multiple items are written for each content task, and these are stored in an item bank for use in the construction of new test instruments.

Applicants who meet all of the eligibility requirements and are in compliance with disciplinary standards are approved to sit for the examination. Because professional credentialing involves high-stakes examinations, the test environment requires a high level of security. Candidates must document their identity to enter, through palm vein recognition technology or similar means, and are usually under constant observation (by persons, as well as video, in many cases) for the duration of the examination period. After the examinations are scored, they undergo specific statistical analyses to determine the strength of the items, to identify possible problem items, to equate examination forms for difficulty, and to meet other psychometric requirements. An expert panel reviews any items identified as suspect based on the statistical analysis, and the examinations may be rescored, if needed, prior to determining who has passed or failed. Candidates are then informed of their fate. It is important to note that minimum passing scores on certification examinations must be established following widely accepted formal procedures (e.g., Angoff, 1984). Establishing a passing score is a policy decision that must be made by the credentialing organization based on psychometric evidence rather than use of an arbitrary standard. If the passing score is not valid, even a well-developed examination can be meaningless.

Individuals who become credentialed usually must obtain continuing education credit to maintain their credential's currency. The purpose of a continuing education requirement is to help ensure that the credentialed professional continues to grow profession-

ally and keep abreast of new developments and techniques in the field. Continuing education may be earned by attending professional conferences, going to special continuing education events, taking appropriate university courses, engaging in professional activities associated with the credentialing body, and participating in a number of other learning events specified by the credentialing organization.

The credentialing organization normally also includes a fourth step of disciplinary or ethical compliance. This ongoing oversight process begins at the time of application and continues through the duration of certification. Often the disciplinary standards address a number of scenarios, such as competency to practice, ethical compliance, and mandatory reporting requirements. Typically, a disciplinary process is a combination of self-reporting and organization investigatory and review procedures, along with due process–influenced notice, hearing and appeal procedures.

Certification of Behavior Analysts

History

There have been several attempts to establish behavior analyst certification programs. For example, the State of Minnesota initiated a state worker–based certification program in the 1960s that eventually fell victim to changes in philosophy and priorities within the state (Thomas, 1979), and the Association for Behavior Analysis–International (ABAI) sponsored a certification program in the mid-1980s, although it was later dissolved for legal reasons (Shook et al., 1988). As a result of misuse of behavioral procedures (Bailey & Burch, 2005; Johnston & Shook, 1987), Florida implemented a certification program based on a professionally developed examination in the mid-1980s (Johnston & Shook, 1993, 2001; Starin, Hemingway, & Hartsfield, 1993). Oklahoma, Texas, California, Pennsylvania, and New York followed suit in the 1990s with programs based on Florida's successful program, and using Florida's examination. It was highly unusual for one state to provide examination administrations for other states, but in the case of applied behavior analysis, this is exactly what happened. Florida paved the way for other states to follow, and they did. As additional states and governments became interested in Florida's program, it was clear that the field needed an international credentialing program.

The Behavior Analyst Certification Board® (BACB®),[1] based on the Florida model, was formed in 1998, in response to a need for certification at the international level. In 1999, the BACB entered into an agreement with Florida to use the well-developed Florida examination, and held its first examination administration in May 2000. In response to the successful implementation of the BACB certification program, Florida transferred the examination to the BACB and all of the state-operated certification programs, including that of Florida, closed and turned over their certification responsibilities to the BACB. Almost immediately, it became apparent that there was a great deal of interest in certification outside of the United States, and the BACB has increased its international activities to be responsive to this growing role (Hughes & Shook, 2007; Virués-Ortega et al., 2009).

The BACB certification programs currently are accredited by the National Council for Certifying Agencies. The BACB is endorsed by the Association of Professional Behavior Analysts, the Association for Behavior Analysis International, Division 25 (Behavior Analysis) of the American Psychological Association, and the European Association for Behavior Analysis.

BACB Certifications

The BACB offers two categories of behavior analyst certification: Board Certified Behavior Analyst® (BCBA®) and Board Certified Assistant Behavior Analyst® (BCaBA®). Both certification categories have specific degree, coursework, and supervised experience requirements that applicants must meet to qualify for the appropriate written examination. (The details of course and experience training are described in a later section.) In

[1]BACB®, Behavior Analyst Certification Board®, Board Certified Behavior Analyst®, BCBA®, Board Certified Assistant Behavior Analyst®, and BCaBA® are the trademarks of the Behavior Analyst Certification Board. Unauthorized use of these trademarks is strictly prohibited. See *www.bacb.com* for information regarding who is entitled to use these trademarks.

order to qualify for the BCBA examination, applicants need at least a masters' degree in an acceptable related field, graduate coursework in specific behavior analysis content, and supervised professional behavior analytic experience. The supervised professional experience may be obtained within three categories: supervised independent fieldwork, practicum, and intensive practicum. These three categories are ordered from least intensive to most intensive in terms of hours of required experience, and amount and kind of supervision provided. Practicum and intensive practicum may be obtained only through universities that have their experience approved by the BACB. A special designation is available for BCBAs who have doctorate degrees and meet other requirements: Board Certified Behavior Analyst–Doctoral (BCBA-D).

To qualify for the BCaBA examination, the applicant needs at least a bachelor's degree in an acceptable related field, undergraduate or graduate coursework in specific areas of behavior analysis, and supervised professional behavior analytic experience. The content areas are the same as those for the BCBA qualification. The supervised experience categories and general requirements are the same as for the BCBA, except the total number of hours in each category is less for BCaBA than for BCBA.

Universities may apply to have their BCBA and BCaBA course sequences approved by the BACB, so that both the university and students may be confident that the course sequences satisfy the BACB coursework requirement. Universities with BACB-approved course sequences that choose to offer professional supervision in addition to the coursework may apply to have the BACB approve their practica and intensive practica.

Written Examination

Construction of the BCBA and BCaBA examinations is based on accepted professional standards to meet the appropriate psychometric and legal requirements (Shook, 2005). The development process includes a job task analysis and follows the general procedures outlined in the earlier examination development section. The most recent job task analysis survey was sent to over 7,060 certificants and behavior analytic subject-matter experts in 39 countries, with 2,236 individuals (32%) responding to the survey. Shook, Johnston, and Mellichamp (2004) have published a detailed description of this job task analysis process and its results. A new job task analysis is currently being conducted.

Continuing Education

Once certified, BACB certificants are required to participate in continuing education to help maintain an acceptable level of professional currency and competence in the developing field of behavior analysis. Certificants may earn continuing education in a number of ways, such as passing university behavior analysis courses, attending state and national conferences, taking online tutorials, presenting approved sessions at conferences, and teaching university courses in behavior analysis. Certificants may also earn continuing education for participating in BACB-sponsored activities, such as content expert panels, item writing or review workshops, or presentations on professional matters. Alternatively, certificants may fulfill their continuing education requirement by retaking and passing the appropriate BACB examination every 3 years. BCBAs and BCaBAs must earn continuing education in ethics and professional behavior as part of their 3-year recertification continuing education requirement (see *www.bacb.com* for the current continuing education requirements). In addition, BCaBAs must be supervised by a BCBA to maintain their certification.

Maintaining Ethical and Professional Behavior

In addition to the continuing education requirement, the BACB Professional Disciplinary and Ethical Standards and the BACB Guidelines for Responsible Conduct for Behavior Analysts© help to ensure that certificants maintain appropriate levels of ethical and professional behavior when they apply to the BACB and after they have become certified.

The BACB Guidelines for Responsible Conduct for Behavior Analysts were developed by John Jacobson, using codes of ethics from several professional organizations as models. The BACB Guidelines for Responsible Conduct, however, were developed specifically for behavior analyst practitioners and focus on their unique practices and working

environments. The guidelines cover the wide range of ethical and professional situations faced by behavior analyst practitioners, as evidenced by the main categories. Behavior analysts may refer to the detailed guidelines to help manage their professional behavior when they face with ethical situations. Consumers and employers also may refer to the guidelines as a resource when they are trying to determine what manner of behavior is appropriate and should be expected from a behavior analyst faced with ethical and professional issues. The Guidelines for Responsible Conduct are not enforced by the BACB except as referenced in the BACB Professional Disciplinary and Ethical Standards. They are intended to be used as an aid for behavior analysts, consumers, and employers in the process of finding answers to ethical and professional quandaries related to the practice of behavior analysis.

The BACB Professional Disciplinary and Ethical Standards deal with certificant adherence to BACB policy, as well as professional, ethical, and legal issues that generally go beyond the Guidelines for Responsible Conduct. The Professional Disciplinary and Ethical Standards are enforced by the BACB through a process designed to provide consumer protection, appropriate due process for the certificant involved, and consequences to the certificant for violation of the Professional Disciplinary and Ethical Standards. The BACB, through a formal review committee, may impose any number of sanctions for standards violation, including, but not limited to, warning notices, fines, suspensions, mandatory education, and revocation of certification. Although documented violations of the Professional Disciplinary and Ethical Standards are relatively few in number, it is important for consumers, certificants, and the field that the BACB be able to address such problems in an appropriate and definitive manner, and that the BACB maintain a record of doing so. The results of significant disciplinary actions, including those that involve suspension or revocation of an individual's certification, are posted on *www.bacb.com*. The BACB recently increased the scope of its Professional Disciplinary and Ethical Standards to include a wider range of standards, incorporating selected provisions of the Guidelines for Responsible Conduct.

Growth of BACB Certification

The BACB has enjoyed considerable growth in a number of areas since it first began issuing certificates in 1999. The number of certificants in the United States at both BCBA and BCaBA levels has increased significantly (see Figure 30.1). Much of the increase for the first few years may be attributed to cer-

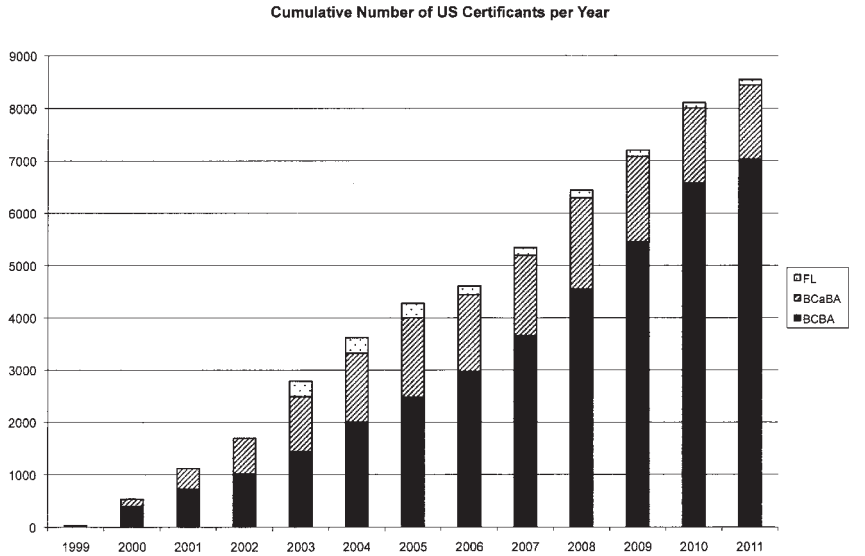


FIGURE 30.1. Cumulative number of U.S. certificants.

tificants who transferred from state certification programs that transferred behavior analyst credentialing over to the BACB. However, all recent growth must be attributed to new certificants of the BACB.

Of particular interest is the recent growth of certificants outside the United States, where both consumers and behavior analysts value BACB certifications. Between 2000 and 2009, the total number of BCBAs and BCaBAs in countries other than the United States grew from 2 to 436, a rate of growth even more rapid than that observed in the United States.

Of course, growth in the number of certificants is directly related to the number of college and university training programs preparing students for certification. The total number of approved course sequences, and the number of universities with approved course sequences, has increased steadily since the BACB began approving them. The BACB also has observed recent increases in the number of universities outside the United States with approved course sequences. In many instances, the BACB has worked closely with these international training institutions to ensure a smooth transition to BACB standards and to equate the educational experience provided in these countries with that found in the United States. As of the 2009–2010 academic year, there were 169 universities in the United States offering approved course sequences in applied behavior analysis and 33 such universities in other countries.

Future Developments

Although the robust BACB examinations are developed to professional psychometric, legal, and procedural standards, some behavior analysts are uncomfortable with the evaluation instrument being based on a series of forced-choice items. They argue for an evaluative instrument based on direct observation of behavior in the natural environment—what testing professionals call a "practical" testing procedure. "Practical" testing procedures are rarely used in professional testing because associated fiscal and reliability constraints preclude their use.

New computer-based testing technologies are being developed that approximate "practical" evaluation procedures within the professionally developed examination. "Drag and drop" or "hot spot" items may be used to assess skills such as graphing data or locating critical points on a graph. Video vignettes may replace written questions to approximate more closely the natural environment stimuli. Candidates may be able to see persons behaving, so they may be asked to count the number of responses in the vignette. Candidates also may be able to select certain computer keys that allow the candidates to emit various responses to varying effects. For example, candidates will be able to watch a vignette and hit a key whenever they believe reinforcement should be delivered. Their responses will be collected in temporal "bins," and a response will be counted as correct if it falls within the acceptable time frame. Computerized adaptive testing procedures, in which test questions can be targeted to candidates' ability levels, will rapidly determine whether they have met the required standards.

Training of Behavior Analysts

College and University Coursework

Curriculum

Among faculty that offer courses in behavior analysis, there are varying opinions about what content should be mastered by students (e.g., Baer, 1981; Michael, 1980). One of the major effects is that a certification program provides a mechanism for addressing this issue that systematically involves not only recognized experts in the field but a wide sampling of individuals who, by some criteria, may be defined as behavior analysts.

This mechanism is a job task analysis, as described earlier. The current task list constitutes a relatively detailed curriculum targeted to practitioners in the field. The content is defined by a range of behavior analysts through a systematic process established independently by professionals in the field of psychometric testing and upheld by a body of case law (see *www.bacb.com* for the current task list). The BACB itself does not determine the content, but it rather systematically facilitates the process.

As stated earlier, the BACB requires that applicants wishing to take either BCBA or the BCaBA examination complete a certain

number of classroom hours of coursework in behavior analysis, in addition to holding the minimum required academic degree. These hours of classroom instruction must be distributed across the content areas of the task list, with different areas receiving various proportions of hours (see *www.bacb.com* for the current BCBA and BCaBA coursework requirements).

Approved Course Sequences

It should not be surprising that promulgation of a curriculum for training applied behavior analysts would encourage colleges and universities already providing instruction in this field to modify existing courses and initiate new courses, so that their offerings meet BACB requirements. After all, student enrollment in degree programs and courses is important to academic administrators. As already noted, the BACB encourages this effort by offering a mechanism for colleges and universities to apply for approval of their course sequences as fully meeting BACB coursework requirements. Such approval allows departments to promote their instructional programs to potential applicants, and it helps students determine which programs would ensure that they meet BACB coursework standards.

If the only schools responding to the opportunity to develop approved course sequences were those already offering instruction in applied behavior analysis, the effects of the coursework approval contingency would be limited. However, a further outcome of this contingency is to encourage administrators of institutions who have not traditionally offered programmatic instruction in applied behavior analysis to establish such programs. Many approved course sequences are now offered by schools that might previously have offered only one or two courses, if any, in this field (Shook & Neisworth, 2005). As a result, the number of approved course sequences has continued to grow well beyond the number of programs offering training in behavior analysis.

Content Limitations of Certification-Based Training

As Shook and colleagues (2004) noted, the curriculum originating in the certification process does not represent the comprehensive content of the field of behavior analysis. The certification curriculum naturally focuses on the needs of applied behavior analysis practitioners. It therefore does not address the need for training applied researchers, much less basic researchers, and those who will teach them. The job task analysis process does exemplify a method for developing curricula that serve these other interests, however.

The BACB curriculum covers the conceptual, philosophical, and methodological underpinnings of the field only as they relate to practitioner needs. The BACB coursework standards require only 20 hours of classroom instruction in this critical area—half that of a college course. Textbooks that accommodate this limitation must be exceedingly brief and cannot provide instructional detail in all areas. For example, the role of steady states of responding is at the heart of within-subject comparison designs, yet textbooks serving applied behavior analysis practitioner interests offer only paragraph-level coverage. A more comprehensive curriculum for the entire field of behavior analysis would likely involve broader and deeper coverage. After all, Sidman (1960) devoted two chapters to this topic, and it is no less important today.

Not surprisingly, BACB coursework requirements do not cover all of the diverse interests of the basic research literature. Of course, it is not reasonable to demand that practitioners demonstrate equivalent competencies in all areas of the field, any more than it is for basic researchers to master the literature of applied behavior analysis. Nevertheless, a comprehensive curriculum for behavior analysts would likely involve substantial coverage of what might be termed *basic concepts*, as detailed in texts such as that by Catania (1998).

Supervised Experience and Practicum Training

Rationale

It is unlikely that any applied behavior analyst practitioner would argue that a sequence of classroom courses, however well designed and taught, would be sufficient to build the full range and depth of professional skills minimally required for effective performance in service delivery settings. Reading

about, or being able to talk about, how reinforcement works is a necessary skill, but many other skills are necessary to deal effectively with behavior change challenges under varied practical circumstances. From the outset, the BACB has accompanied its coursework standards with a set of requirements for obtaining certain kinds of supervised experience. These requirements were initially broad and general because a limited number of individuals were available to serve as qualified supervisors. As training resources grew, however, the BACB, guided by feedback from certificants, as well as from college and university programs, issued a revised set of experience or practicum requirements that represented a much higher standard of training and supervision.

Categories

The current experience standards require individuals who wish to take the certification examination to accumulate a defined number of hours of supervised experience. In an effort to provide individuals and schools with as much flexibility as possible, the number of hours required depends on the circumstances under which the experience is acquired and how it is supervised. Supervised field experience for individuals preparing to become BCBAs may be obtained, independent of an academic program with an approved course sequence. Academic programs that offer course sequences approved by the BACB are permitted to offer one or more of three types of experience training: supervised field experience, practicum, and intensive practicum.

The general principle underlying these options is that the more intensive the supervision, the fewer the hours required. Therefore, the practicum category requires more intensive supervision than does supervised fieldwork; however, the total number of experience hours required is less. In turn, the intensive practicum option requires more intensive supervision than the practicum; however, fewer total experience hours are required in the latter. The requirements for the BCaBA certificate are fundamentally similar, although the number of required experience and supervision hours is lower. Please see *www.bacb.com* for current experience requirements.

Additional Requirements

The requirements for behavior analytic experience extend well beyond the quantitative definitions in the task list. In general, the applicant's primary focus should be on learning new behavior analytic skills related to the current task list, and there are a number of details and restrictions. In addition, supervisors must be BCBAs or have been approved as an instructor in a BACB-approved course sequence. There are also detailed requirements for the role of supervisors. For example, they must observe the applicant's work with a certain frequency, and a specified amount of supervision time must involve one-to-one contact. Supervisor and applicant must regularly document these interactions on a form, and applicants for the examination must be prepared to submit these forms, if requested. Of course, all requirements for becoming certified and maintaining certification are continually under review and may change over time (see *www.bacb.com* for current requirements).

Future Developments

As the certification process matures and evolves, it is likely that supervised experience will become an increasingly important component of this process. In addition to the development of new "practical" testing technologies that will be introduced to the examination process, supervised experience likely will evolve to contribute to the "practical" assessment process.

A number of universities are developing sophisticated, competency-based evaluation procedures to enhance the effectiveness of supervised experience. In many instances, this is accomplished through the use of detailed, competency-based checklists based on the BCBA task list. Supervisors observe individuals behaving in natural or contrived settings to ensure that they can demonstrate competence in each of the checklist items. In such programs, the individual must demonstrate competence in all the checklist items to complete the supervised experience.

As the BACB certification program and the field continue to grow and mature, there will be efforts in individual states to pass behavior analyst licensure bills to ensure the right to practice and to access funding streams.

Because BACB certification programs are built to the same standards and contain all the essential components of licensure, it is a natural extension for states to use BACB certifications as the basis for state behavior analyst licensure. In fact, this has already occurred in several states and is being considered by a number of others. Behavior analysts who consider pursuing licensure in their state should approach the matter with some caution, however. Because each state and country has its own unique set of circumstances, behavior analysts should assess the political climate and likelihood of success carefully and comprehensively. It may be that the desired goals may be accomplished through government recognition of certification or other, less intrusive and potentially dangerous approaches (Green & Johnston, 2009a, 2009b; Shook & Favell, 2008). Nevertheless, the licensure of behavior analysts has a number of advantages and will more than likely become commonplace as the field grows and evolves.

Effects of Behavior Analyst Credentialing

Perhaps the most obvious effect of a credentialing program is to produce a cadre of practitioner professionals identified as meeting a set of entry-level competencies in the practice of applied behavior analysis. Although the number of such individuals was initially small, the annual increase in both groups of BACB certificants has been rapid by any standard. Nevertheless, because the number of credentialed behavior analysts may always fall short of the increasing demand for such expertise, the growing cohort of certificants is now sufficient to create numerous desirable "side effects."

For example, the standards and practices of the BACB certification program, together with the body of certificants, now allow the diverse community of consumers to distinguish among individuals who hold this credential and those who profess expertise in applied behavior analysis but do not hold the credential. Before the certification program existed, making this discrimination was difficult for employers who were not experts in applied behavior analysis. The clarity of this distinction not only facilitates hiring of qualified individuals but it also augments demand for them; that is, the existence of this credential encourages employers to seek out and hire those who hold it in preference to those who do not. Employers can now advertise a position requiring this credential. The fact that certificants have demonstrated their potential competence and are more likely to be effective in the workplace than individuals lacking certification, in turn, increases the likelihood that the employer will appreciate the advantages of hiring other individuals with the certification.

The growing number of certificants in the workplace is also encouraging employers and governmental administrative entities to adapt positions, salaries, policies, regulations, and even laws relating to the availability of individuals with the BCBA or BCaBA credentials. The assurance of quality provided by certification and the ease of referring to BACB certification, encourages its use in job descriptions and other documents, where it would be impossible, or a least unwieldy and ineffective, to include home-made qualifications. For example, many job postings for behavior analysts to work with individuals with autism include a BCBA as a requirement for the position. The Autism Special Interest Group in ABAI includes multiple references to BCBA and BCaBA credentials, and recommends that holding these certifications is a necessary requirement for providing behavior analytic interventions for people with autism. Florida specifies the BCBA as a funding category within its Medicaid waiver, and California does likewise with its community-based services program. State insurance laws that provide coverage for individuals with autism usually include applied behavior analysis as a covered service, and often specify BCBAs and BCaBAs as eligible service providers.

As noted earlier, the increased demand for certificants in the marketplace directly influences the demand for university-based certification training. This demand underlies a substantial increase in the number of colleges and universities offering training in applied behavior analysis. The fact that the continuing increase in academic training sites largely involves academic departments that historically have not offered systematic training in behavior analysis suggests that individual faculty, department chairs, and deans are able to use this demand for train-

ing to establish programs. This also means that the number of BACB-approved course sequences may continue to grow for some time.

Naturally, the continuing increase in applied behavior analysis training programs requires faculty members who can teach the required courses. There is considerable evidence that a number of faculty positions have been changed or created to accommodate this need.

The curricula offered by these university programs are based on the coursework requirements specified by the BACB. An important effect of the certification program has been to develop such a curriculum for the first time in the field's history. The elaborate job task analysis process (described earlier) ensures that the curriculum is based on a systematic and inclusive empirical process. Furthermore, the professional testing standards and case law underpinning this process ensure that the curriculum will continue to evolve with the field, as reflected in revisions incorporated in the most recent version of the job task analysis.

These curricula require training materials, and there is some evidence that the certification program is driving creation of new or revised textbooks. This effect is likely to appear with some delay, but a recently published volume by Bailey and Burch (2005) concerning training in the area of ethics specifically addresses this need. Other volumes have been revised with particular attention to BACB curricular requirements (e.g., Cooper, Heron, & Heward, 2007), such that the relevant BACB task list items covered in each chapter are listed at the beginning of each chapter, the pages covering content relevant to each task are given in an appendix, and the entire BACB task list is included in the text's inner covers.

Some effects of a certification program are more subtle than new programs and textbooks. For example, certification helps to create an identity for individuals trained in behavior analysis who provide such services to consumers. Individuals with this credential are members of a distinct field and profession defined in part by the certification program. They tend to be members of the Association for Behavior Analysis International, the Association of Professional Behavior Analysts, the European Association for Behavior Analysis, and state or regional behavior analysis organizations, and to attend their annual meetings to acquire the BACB-required continuing education. As a result, membership in these organizations has increased markedly in recent years.

Some effects of credentialing applied behavior analysts may be evident only in hindsight. As future behavior analysts look at the history of the field prior to and after BACB certification, changes that have not yet been recognized may become evident. It is already clear, however, that certification of applied behavior analyst practitioners has become one of the most important developments in the field's history.

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