

Editor's Note. *This article and the next are a continuation of the special series on responsiveness to intervention (RTI) that began in JLD Volume 38, Number 6, and was guest-edited by D. F. Mellard, D. D. Deshler, S. E. Byrd, D. L. Compton, E. Fuchs, L. S. Fuchs, and D. J. Reschly.*

Response to Intervention as a Vehicle for Distinguishing Between Children With and Without Reading Disabilities: Evidence for the Role of Kindergarten and First-Grade Interventions

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Abstract

Children at risk for early reading difficulties were identified on entry into kindergarten, and half of these children received small-group intervention two to three times a week during their kindergarten year. The other half received whatever remedial assistance was offered by their home schools. These children were again assessed at the beginning of first grade, and those who continued to have difficulties in reading received either one-to-one daily tutoring offered by project teachers from the beginning to the end of first grade or whatever remedial assistance was offered by their home schools over the same time period. All target children were periodically assessed through the end of third grade. Results suggest that either kindergarten intervention alone or kindergarten intervention combined with first-grade intervention are both useful vehicles for preventing early and long-term reading difficulties in most at-risk children.

In several recent papers focusing on the causes and correlates of specific reading disability (dyslexia), we and our colleagues expressed serious concerns over current psychometric/exclusionary approaches to classifying children as disabled readers (Vellutino, Scanlon, & Lyon, 2000; Vellutino et al., 1996). Documentation that an impaired reader is afflicted by specific reading disability typically entails psychometric assessment having the IQ-achievement discrepancy as the central defining criterion, along with exclusionary criteria such as uncorrected sensory deficits, emotional disorder, socioeconomic disadvantage, general learning problems, and like factors. Such approaches can be criticized on several grounds.

First, because they do not control for the child's preschool and educa-

tional history, they do not adequately distinguish between reading difficulties caused primarily by experiential and instructional deficits and reading difficulties caused primarily by biologically based deficits in reading-related cognitive abilities. Second, they often classify children as disabled readers on the basis of assessment instruments that have little or no diagnostic validity, in terms of their relationship to reading ability (e.g., figure copying tests). Third, they give undue weight to the IQ-achievement discrepancy in classifying children as disabled readers (Fletcher et al., 1994; Gresham, 2002; Siegel, 1989; Stanovich & Siegel, 1994; Vellutino et al., 2000). Fourth, they tend to inflate the number of children classified as disabled readers: Current estimates range from 10% to 20% of the population of school-age children (Lyon,

Fletcher, & Barnes, 2002). Fifth, they create low expectations for children so classified, as do most diagnostic labels. Sixth, they provide no direction for remedial or classroom instruction. These concerns motivated us to embark on a program of intervention research to begin to develop the means for distinguishing between cognitive and experiential/instructional deficits as primary causes of early and protracted reading difficulties, and for identifying children at risk for reading difficulties before exposure to formal reading instruction.

The First-Grade Intervention Study

In the first major study pursuing these objectives (Vellutino et al., 1996), we

tracked literacy development in middle- to upper-middle-class children, who were identified in mid-first grade as either struggling readers or normally achieving readers, for a period extending from their entry into kindergarten (before reader group membership was determined) through the end of fourth grade. These two groups represented subsamples from the larger population of children we initially assessed ($N = 1,407$) at the beginning of their kindergarten year. To evaluate the possible contribution of home and preschool literacy experiences to early reading achievement, foundational literacy skills such as knowledge of the alphabet, knowledge of print concepts, print awareness, and phonological awareness were assessed at or shortly before the children entered kindergarten. Cognitive abilities underlying reading ability were also assessed in kindergarten and again in first and third grade. The possibility that early reading difficulties in some children may be the result of deficiencies in kindergarten literacy instruction was assessed through systematic observations of the kindergarten language arts programs in all participating schools (Scanlon & Vellutino, 1996). Finally, daily one-to-one tutoring was provided for most of the reading-impaired children for up to two school terms (mid-first grade to mid-second grade), depending on the child's progress. Several important findings emerged from this study.

First, the number of children who might have been classified as disabled readers prior to implementation of the intervention program represented approximately 9% of the first-grade population from which our sample was selected ($n = 1,284$ after attrition). However, the number of such children was appreciably reduced after only one semester of remediation and represented approximately 1.5% of the population when all children scoring below the 15th percentile on measures of basic word level skills were included in the count. And although there were substantial reductions in the percentage of tutored children who scored at

least within the average range on measures of basic word level skills after tutoring was discontinued, such reductions occurred primarily among children who showed the least amount of initial growth in response to remediation (Vellutino & Scanlon, 2002; Vellutino, Scanlon, & Jaccard, 2003). Second, the children who were found to be the most difficult to remediate generally performed below the level of both the normally achieving readers and the children who were found to be readily remediated on tests of phonologically based skills such as phonological awareness, verbal memory, and fluency in name retrieval. In contrast, the readily remediated children, in many cases, performed at levels comparable to those of the normal readers on the same measures and could no longer be classified as disabled readers. Third, all children identified as problem readers in mid-first grade were deficient in emergent literacy skills such as letter identification and phonological awareness at the beginning of kindergarten. Moreover, a child was less likely to be identified as a poor reader if he or she had been exposed to a comprehensive and balanced language arts program in kindergarten that included both word level and text processing activities in the instructional program (Scanlon & Vellutino, 1996).

Finally, we found that the tests of intelligence did not differentiate the impaired readers who were difficult to remediate and the impaired readers who were readily remediated, nor did they differentiate children in the tutored groups and normal readers of average intelligence. At the same time, normal readers of average intelligence and normal readers of above-average intelligence did not differ appreciably on measures of basic word level skills (i.e., word identification and phonological decoding). In addition, IQ-achievement discrepancy scores were not significantly correlated with growth in reading (Vellutino et al., 2000).

We concluded, from the results obtained in this study, that early reading difficulties in most impaired read-

ers can be successfully remediated and that experiential and instructional deficits are more likely to be the primary cause of such difficulties than are basic cognitive deficits of biological origin. However, results from the kindergarten assessment and classroom observation components of our study also led us to conclude that children's pre-first grade literacy experiences and instruction may be critically important determinants of early reading achievement. Thus, it seemed that a logical and potentially useful extension of our first-grade intervention study would be to evaluate the utility of identifying children at risk for early reading difficulties on entry into kindergarten and implementing intervention in kindergarten to prevent long-term reading difficulties. We discuss selected findings from this study in the remainder of this paper.

The Kindergarten and First-Grade Intervention Projects

Kindergarten Screening

This was a 5-year longitudinal study that was initiated in late spring 1997 and terminated in late spring 2002. Participants in this study were children from lower-middle- to upper-middle-class backgrounds in suburban and rural schools in upstate New York. The initial sample consisted of 1,373 children assessed at the beginning of kindergarten. There were two cohorts of these children consisting of comparable percentages of males and females in each cohort (54% males in Cohort 1 and 50% males in Cohort 2). All children in both cohorts were given a test of letter-name knowledge when they entered kindergarten, and approximately 30% were identified as being at risk for early reading difficulties on the basis of their performance on this test alone. However, to further document their at-risk status, these children were also given tests evaluating phonological awareness (sensitivity to rhyme

and alliteration), rapid automatized naming of objects, counting by ones, and number identification.

Table 1 presents results on all of these tests for both the at-risk and the not-at-risk groups. It can be seen that children in the at-risk group performed at levels well below children in the not-at-risk group on all of the screening measures.

Kindergarten Intervention

In the next phase of the project, approximately half of the at-risk children were randomly assigned to a project treatment group, and the other half were assigned to a school-based comparison group. The school-based comparison group was initially slated to be our control group, but because several of the participating schools chose to offer their own intervention, we report results only for contrasts between children in the project treatment and school-based comparison groups from schools where no kindergarten intervention was provided. Table 2 presents results for these two groups on the tests included in our initial screening battery. The groups were not appreciably different on any of these measures at the outset.

The children assigned to the project treatment group were provided with a small-group early literacy intervention program (2 to 3 children per group) throughout kindergarten. Those in each group met with a certified teacher (trained by project staff) twice each week for 30 min each session in a room outside of their classrooms. Remedial activities focused on emergent literacy skills such as knowledge of print concepts, print awareness, letter recognition, letter identification, phonological awareness, letter-sound mapping, sight word learning, shared and guided reading, and listening to and reading stories.

To evaluate the short-term effects of our kindergarten intervention program, we readministered the letter identification and phonological awareness tests from our screening battery in

December, March, and June of the children's kindergarten year. We also administered experimental tests evaluating print concepts, word identification (primary word identification), knowledge of letter sounds, letter-sound decoding (primary decoding), and two additional phonological awareness skills: phoneme blending and phoneme segmentation (see Note 1). For present purposes, we present data only for our June assessment. Considering an effect size of 0.50 as a moderately high group difference (in accord with accepted statistical criteria), it can be seen that the project treatment group performed appreciably better than the school-based comparison group on most of the measures. Group differences were statistically meaningful on tests evaluating phonologically based literacy skills, in particular, phoneme segmentation, knowledge of letter names, knowledge of letter sounds, word identification, spelling, and letter-sound decoding. In contrast, group differences were either marginal or below statistically ac-

ceptable standards on tests evaluating print concepts, detection of rhyme, detection of alliteration, and phoneme blending. However, all effect sizes favor the project treatment group (see Table 3). Thus, it seems reasonable to suggest, from these results, that early intervention on behalf of at-risk children identified at the beginning of kindergarten can significantly improve the foundational literacy skills of such children and help prepare them for reading instruction in first grade.

First-Grade Intervention

To distinguish between at-risk children who continued to need remedial services in first grade and those who did not (ostensibly) need these services, the full sample of at-risk children who had been assigned to the project treatment and school-based comparison groups in kindergarten were reevaluated at the beginning of their first-grade year, using the Letter Identification, Word Identification, and Word

TABLE 1
Performance Levels for the At-Risk and Not-at-Risk Groups on the Kindergarten Screening Battery (Both Cohorts)

Selection measure	At risk ^a	Not at risk ^b
WRMT-R Letter Identification (51) ^c		
<i>M</i>	5.75	25.26
<i>SD</i>	4.21	5.82
Rhyme Detection (12) ^c		
<i>M</i>	6.71	8.93
<i>SD</i>	2.76	2.86
Alliteration Detection (12) ^c		
<i>M</i>	4.16	6.02
<i>SD</i>	1.46	2.70
Rapid Automatized Naming Time (in seconds)		
<i>M</i>	83.36	73.00
<i>SD</i>	21.29	17.48
Counting by ones (highest number) (40) ^c		
<i>M</i>	23.49	32.94
<i>SD</i>	9.58	8.48
Number Identification (12) ^c		
<i>M</i>	4.97	8.67
<i>SD</i>	2.80	1.69

Note. WRMT-R = Woodcock Reading Tests-Revised (Woodcock, 1987).

^a*n* = 475. ^b*n* = 898. ^cNumber in parentheses indicates maximum possible score on the measure.

TABLE 2

Performance Levels for the Project Treatment and School-Based Comparison Groups on the Kindergarten Screening Battery (Both Cohorts)

Selection measure	Project treatment ^a	School-based comparison ^b
WRMT-R Letter Identification (51) ^c		
M	5.81	5.60
SD	4.49	4.23
Rhyme Detection (12) ^c		
M	6.32	6.91
SD	2.90	2.80
Alliteration Detection (12) ^c		
M	4.15	4.22
SD	1.39	1.45
Rapid Automatized Naming Time (in seconds)		
M	79.89	82.90
SD	16.36	17.55
Counting by ones (highest number) (40) ^c		
M	23.15	23.97
SD	10.41	9.97
Number Identification (12) ^c		
M	4.57	4.62
SD	3.10	3.01

Note. WRMT-R = *Woodcock Reading Mastery Tests-Revised* (Woodcock, 1987).

^a*n* = 53. ^b(no school-based treatment) *n* = 68. ^cNumber in parentheses indicates maximum possible score on the measure.

Attack subtests from the *Woodcock Reading Mastery Tests-Revised* (WRMT-R; Woodcock, 1987), as well as measures of letter-sound knowledge (letter sounds), word identification (primary word identification), and letter-sound decoding skills (primary decoding) administered in kindergarten. A composite of these measures based on summed *z* scores from each of the tests was computed for each child, and this score was used to identify children we designated as *poor readers*. Because a major objective of the first-grade intervention project was to compare two different approaches to remedial instruction (i.e., code emphasis vs. text emphasis) and because we wanted to ensure that there was an adequate number of poor readers in each of these treatment groups, we adopted a relatively lenient cutoff score for distinguishing children who continued to be at risk for reading difficulties from children who were no longer at risk for reading difficulties. Accordingly, we

operationally defined a *poor reader* as a child whose summed *z* score was at or below the midpoint of the *z*-score distribution for the at-risk children who had been in our project treatment group in kindergarten. Thus, by definition, 50% of the kindergarten project treatment group qualified as poor readers. However, 60% of the children from the kindergarten school-based comparison group qualified as poor readers when the entire group was considered and 80% qualified when we considered only children from schools that did not offer their own kindergarten intervention program.

These results indicate that our kindergarten intervention program was reasonably successful in reducing the number of children who qualified as poor readers in first grade. However, to further evaluate the utility of kindergarten intervention for preventing early and long-term reading difficulties, we followed the progress of the at-risk children who received kinder-

garten intervention offered by our project and who did not qualify as poor readers at the beginning of first grade. These children were designated as the "no longer at risk" (NLAR) group. To provide a normative standard, we also identified a group of normally achieving readers at the beginning of first grade. This group consisted of children who were not identified as being at risk in kindergarten and whose summed *z* scores on the screening measures administered at the beginning of first grade were at or above zero. To further evaluate the influence of intelligence in acquiring skill in reading, the normal reader group was dichotomized into average IQ (AvIQNorm) and above-average IQ (AbAvIQNorm) groups (see Note 2).

Finally, we also followed the progress of the children who were identified as poor readers at the beginning of first grade. Some of these children received daily one-to-one tutoring in first grade implemented by project teachers, and the remainder received the remedial services offered by their home schools. However, here we focus on the poor readers who received both kindergarten and first-grade intervention implemented by project teachers. For purposes of comparison, we divided this group into two groups: one consisting of children who were found to be difficult to remediate, and a second consisting of children who were found to be less difficult to remediate relative to the children in the NLAR and normal reader groups (see Note 3). Children in the difficult-to-remediate (DR) group were those who performed below average on measures of reading skills at the end of third grade (when the project terminated), despite having received remedial intervention services offered by project teachers in both kindergarten and first grade. Children in the less-difficult-to-remediate (LDR) group were those who performed at least in the average range on measures of reading skills at the end of third grade, after receiving the same remedial intervention services. Average or above-average per-

formance was defined as a standard score of 90 or above on the Basic Skills Cluster of the WRMT-R. Below-average performance was defined as a standard score below 90 on the same measure.

The first-grade intervention component of the project entailed random assignment of the children identified as poor readers at the beginning of first grade to one of three experimental conditions, two that involved one-to-one remedial intervention administered by project teachers and one in which children received the intervention normally available to them at their home schools (we do not discuss results from the latter group in this paper). The two experimental conditions that involved remediation offered by project teachers differed with respect to the amount of time spent on remedial activities. One of these conditions allotted the majority of time in each lesson to activities designed to facilitate development of phonological skills (e.g., phonological awareness, letter-sound decoding, etc.), and the other allotted the majority of time in each lesson to activities designed to facilitate development of text processing skills (e.g., conjoint use of code and meaning-based strategies for word identification, comprehension monitoring, etc.). However, each treatment condition included both types of activities as well as equivalent amounts of time spent on sight word identification and writing activities (Scanlon, Vellutino, Small, Fanuele, & Sweeney, 2003). We should also point out that because the two treatment conditions produced statistically equivalent results on measures of basic word level skills across grade levels, the DR and LDR groups were dichotomized on the basis of scores on the Basic Skills Cluster collapsed across the two conditions.

Results on First-Grade Screening Measures

The performance levels for the various reader groups on the screening measures administered at the beginning of

TABLE 3
Performance Levels for Project Treatment and School-Based Comparison Groups on the Kindergarten June Follow-up Battery

Kindergarten follow-up measure	Project treatment ^a	School-based comparison ^b	ES
WRMT-R Letter Identification (51) ^c			
<i>M</i>	28.52	24.37	0.51
<i>SD</i>	3.86	8.14	
Letter Sounds (35) ^c			
<i>M</i>	24.69	15.23	0.99
<i>SD</i>	7.17	9.54	
Primary Word Identification (25) ^c			
<i>M</i>	4.38	2.06	1.07
<i>SD</i>	3.30	2.16	
Primary Decoding (30) ^c			
<i>M</i>	6.81	2.36	1.30
<i>SD</i>	7.51	3.42	
Print Concepts (12) ^c			
<i>M</i>	10.96	10.48	0.25
<i>SD</i>	1.13	1.92	
Rhyme Detection (12) ^c			
<i>M</i>	8.13	7.88	0.09
<i>SD</i>	2.78	2.93	
Alliteration Detection (12) ^c			
<i>M</i>	7.75	6.65	0.36
<i>SD</i>	3.36	3.04	
Phoneme Blending (20) ^c			
<i>M</i>	14.29	12.44	0.47
<i>SD</i>	3.49	3.91	
Phoneme Segmentation (22) ^c			
<i>M</i>	6.25	1.05	1.66
<i>SD</i>	7.50	3.13	

Note. WRMT-R = Woodcock Reading Mastery Tests-Revised (Woodcock, 1987).

^a*n* = 48. ^b(no school-based treatment) *n* = 65. ^cNumber in parentheses indicates maximum possible score on the measure.

first grade are presented in Table 4. It can be seen that there is a linear trend across groups such that the children in the DR and LDR groups performed at the lowest levels on almost all of the tests administered, the children in the AvIQNorm and AbAvIQNorm groups performed at the highest levels, and the children in the NLAR group performed at levels intermediate to the former and latter groups. However, of special interest is the finding that the children in the NLAR group performed solidly in the average range (relative to the normal readers) on all measures and were much closer to the normal readers on these measures than

the children who continued to be at-risk. Thus, it seems reasonable to suggest, based on both of these findings, that providing early intervention for at-risk kindergartners is a useful first step in preventing long-term reading difficulties. It also appears to be a useful means of distinguishing between children who need only a slight "boost" in kindergarten in order meet grade-level expectations (and who are, thus, no longer at risk) and more severely impaired children who will continue to need remedial services in first grade and perhaps beyond first grade. Results on measures of reading achievement administered at the end

of first, second, and third grade provide additional support for these suggestions.

Results on Reading Outcome Measures

Table 5 presents results from these grades on the Word Identification and Word Attack subtests from the WRMT-R and on the Reading Comprehension subtest from the *Wechsler Individual Achievement Test* (WIAT; Wechsler, 1992) in standard score units. For pur-

poses of comparison, we also graph results for these measures across grades in raw score units (see Figure 1). The data are derived only from children who were available at the end of third grade.

Once again we see a linear trend such that the DR children performed at the lowest levels on all measures of reading achievement, the *AviQNorm* and *AbAviQNorm* children performed at the highest levels, and the LDR and NLAR children performed at levels that are intermediate to the DR and

the normal reader groups. Moreover, achievement levels in the LDR and NLAR groups are solidly in the average range. Also of interest is the fact that performance levels in both the LDR and NLAR groups approach those of the normal readers on the literacy measures by the end of third grade. Thus, of the total sample of available at-risk children who received only kindergarten intervention or both kindergarten and first-grade intervention provided by our project ($n = 117$), 84% (98/117) performed within the av-

TABLE 4
Performance Levels for the Poor, No-Longer-at-Risk, and Control Groups on the First-Grade Screening Battery

First-grade screening measure	Difficult to remediate ($n = 19$)	Less difficult to remediate ($n = 26$)	No longer at risk ($n = 81$)	Average IQ controls ($n = 27$)	Above average IQ controls ($n = 27$)
WRMT-R Letter Identification (51) ^a					
<i>M</i>	23.16	23.73	32.20	33.12	34.74
<i>SD</i>	6.80	4.83	2.76	2.28	3.08
Letter Sounds (35) ^a					
<i>M</i>	13.05	17.54	28.51	28.08	29.63
<i>SD</i>	5.62	6.59	3.02	4.17	4.46
Primary Word Identification (25) ^a					
<i>M</i>	4.00	2.81	9.22	13.70	16.56
<i>SD</i>	3.73	2.67	5.49	7.46	6.43
WRMT-R Word Identification (106) ^a					
<i>M</i>	2.00	1.12	5.70	13.68	19.78
<i>SD</i>	2.45	1.80	4.98	9.87	13.43
WRMT-R Word Attack (45) ^a					
<i>M</i>	.00	.23	2.72	4.19	6.96
<i>SD</i>	.00	.59	3.37	4.80	5.29
Primary Decoding (30) ^a					
<i>M</i>	1.79	2.58	9.80	10.24	14.89
<i>SD</i>	1.84	1.90	6.01	5.38	8.26
Rhyme Detection (12) ^a					
<i>M</i>	5.32	7.27	9.31	9.96	10.37
<i>SD</i>	2.52	3.21	2.30	2.46	1.52
Alliteration Detection (12) ^a					
<i>M</i>	6.11	7.54	10.43	10.26	10.89
<i>SD</i>	2.56	2.67	1.91	1.89	1.74
Phoneme Blending (20) ^a					
<i>M</i>	11.89	12.69	16.74	16.26	16.89
<i>SD</i>	2.40	2.11	2.56	3.29	3.26
Phoneme Segmentation (22) ^a					
<i>M</i>	2.84	1.96	11.65	9.00	11.33
<i>SD</i>	5.51	4.31	6.74	7.29	7.45

Note. WRMT-R = *Woodcock Reading Mastery Tests-Revised* (Woodcock, 1987).

^aNumber in parentheses indicates maximum possible score on the measure.

TABLE 5
Performance Levels for the Poor, No-Longer-at-Risk, and Control Groups on the
First-, Second-, and Third-Grade Achievement Measures

Grade level	Poor reader: Difficult to remediate (n = 19)	Poor reader: Less difficult to remediate (n = 26)	No longer at risk (n = 72)	Average IQ controls (n = 27)	Above-average IQ controls (n = 27)
Word Identification^a					
Grade 1					
M	94.63	105.73	109.24	118.89	127.33
SD	8.50	5.72	11.71	13.05	14.69
Grade 2					
M	83.94	102.73	107.47	117.67	125.78
SD	11.46	8.37	12.19	14.68	12.21
Grade 3					
M	79.16	99.50	103.44	109.74	114.81
SD	11.58	6.63	9.70	11.37	8.13
Word Attack^a					
Grade 1					
M	93.32	102.23	102.15	109.19	114.52
SD	7.87	8.80	9.70	10.66	13.08
Grade 2					
M	84.68	101.54	102.26	110.11	114.96
SD	10.49	7.61	12.81	11.98	13.34
Grade 3					
M	79.95	101.62	101.38	107.74	109.56
SD	6.69	9.61	11.37	10.54	11.39
Reading Comprehension^b					
Grade 1					
M	86.63	96.27	100.61	107.85	117.15
SD	5.92	7.16	8.95	11.64	12.68
Grade 2					
M	86.37	99.65	102.85	108.44	114.81
SD	9.36	7.81	10.14	10.74	11.64
Grade 3					
M	88.47	98.23	105.99	109.30	120.11
SD	7.24	7.00	9.86	9.75	12.73

^aWoodcock Reading Mastery Test—Revised standard scores (Woodcock, 1987). ^bWechsler Individual Achievement Test standard scores (Wechsler, 1991).

erage range on all literacy measures by the end of third grade (NLAR and LDR groups). Note also that 73% (72/98) of the at-risk children who had average level reading skills at the end of third grade received only kindergarten intervention (62% of the total sample).

These findings suggest that early and long-term literacy difficulties can be prevented in most children at risk for such difficulties if they are identified at the beginning of kindergarten (if not sooner) and if appropriate inter-

vention to establish foundational literacy skills is undertaken at the outset. They also suggest that most at-risk kindergartners will require less intensive (e.g., small-group) and less protracted intervention to prepare them for first-grade literacy instruction than will the smaller number of children who are found to be more difficult to remediate in kindergarten. Children of the latter description will, quite likely, require additional remedial assistance in first grade to prevent them from ex-

periencing long-term reading difficulties. Yet, it is of some significance that over half (58%) of the kindergarten project treatment children who continued to need and received remedial assistance in first grade performed at solidly average levels on all measures of reading achievement at the end of first, second, and third grade. We may therefore conclude, from this pattern of results, that either kindergarten intervention alone or kindergarten and first-grade intervention combined can pre-

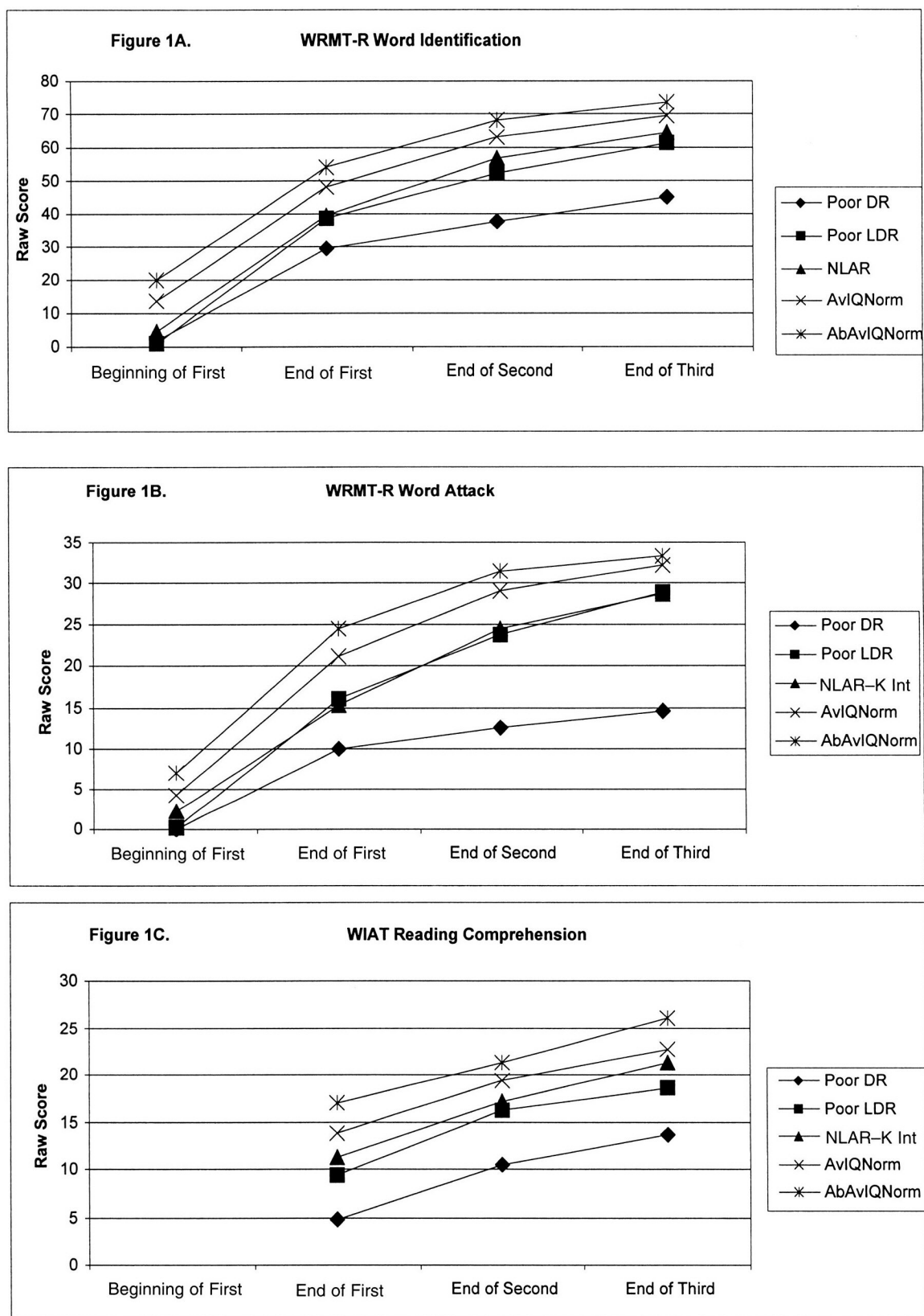


FIGURE 1. Performance levels across grades for poor, no-longer-at-risk, and normal reader groups on the reading measures.

vent long-term reading difficulties in the majority of children identified as at risk for such difficulties at the beginning of kindergarten.

Note, however, that the mean score for the children in the DR group was also within the average range on all of the literacy measures at the end of first grade (albeit in the low average range on the reading comprehension measure). Yet, at the end of second and third grade, these children performed well below average on the word-level measures and only in the low average range on the reading comprehension measure. Thus, although most of the DR children were able to profit from the additional intervention they received in first grade, they obviously required more remedial assistance to

consolidate and maintain their gains to become independent readers beyond first grade.

Finally, in contrast to results obtained in our first intervention study (Vellutino et al., 1996), children in the AvIQNorm group generally performed below children in the AbAvIQNorm group on the tests of word level skills as well as on the test of reading comprehension skills (see Table 5).

Cognitive Profiles of Reader Groups

In the previous intervention study we conducted, we found that normally developing readers generally outperformed children identified as poor readers in mid-first grade on measures of

reading-related cognitive abilities that were administered in kindergarten and in first and third grades (Vellutino et al., 2003; Vellutino et al., 1996). However, we also found that children who were readily remediated often performed better than children who were difficult to remediate on such measures. Moreover, their cognitive profiles were closer to those of an average IQ normal reader group than were the cognitive profiles of the difficult-to-remediate children. Findings from the more recent study, in essence, replicate the previous findings. Table 6 presents results contrasting the DR, LDR, NLAR, AvIQNorm, and AbAvIQNorm groups on selected measures evaluating reading-related cognitive abilities administered in third grade. These in-

TABLE 6
Performance Levels for Poor, No-Longer-at-Risk, and Control Groups on the Third-Grade Cognitive Measures

Third-grade cognitive measure	Poor reader: Difficult to remediate (n = 19)	Poor reader: Less difficult to remediate (n = 26)	No longer at risk (n = 72)	Average IQ controls (n = 27)	Above-average IQ controls (n = 27)
Rapid Naming Letters (time in seconds)					
M	33.89	30.35	28.42	25.67	26.65
SD	6.86	8.39	5.82	5.31	5.25
Rapid Naming Objects (time in seconds)					
M	52.42	51.15 ^a	47.65	42.81	42.27
SD	12.61	17.31	9.43	8.14	8.04
Phonological Memory Raw Score (48) ^b					
M	18.89	20.62	24.19	25.07	28.04
SD	3.89	4.77	5.34	4.87	5.83
PPVT Standard Score					
M	97.95	99.73	103.53	102.70	115.33
SD	9.49	9.22	11.19	9.71	10.37
WISC-III Verbal IQ Score					
M	93.89	97.15	105.51	107.19	120.56
SD	8.84	11.84	9.02	8.17	7.75
WISC-III Performance IQ Score					
M	98.68	96.04	105.89	99.93	120.67
SD	10.66	11.49	11.78	8.46	7.42
WISC-III Full IQ Score					
M	95.63	95.92	106.03	103.81	122.59
SD	6.06	10.31	9.41	7.62	5.10

Note. WISC-III = Wechsler Intelligence Scale for Children—Third Edition (Wechsler, 1991); PPVT = Peabody Picture Vocabulary Test (Dunn & Dunn, 1997).

^aNote that one less-difficult-to-remediate (LDR) child's naming speed on the Object Naming task was atypical (107 seconds). When this child's score was removed from the distribution, the mean LDR score for object naming was 48.92 and the standard deviation was 13.30. ^bNumber in parentheses indicates maximum possible score on the measure.

clude tests evaluating rapid automatized naming, phonological memory (memory for nonsense words), receptive vocabulary, and verbal and non-verbal intelligence.

With the exception of the test evaluating nonverbal intelligence (on which the DR, LDR, NLAR, and AvIQNorm groups performed at comparable levels), we again see a linear trend such that the DR and LDR groups performed at the lowest levels, the AvIQNorm and AbAvIQNorm groups performed at the highest levels, and the NLAR group performed at levels intermediate to the poor and normal reader groups. However, the NLAR group performed at levels that were equivalent to those of the AvIQNorm group on all of the cognitive measures. These findings are consistent with the possibility that the cognitive abilities underlying reading ability can be placed on a continuum that determines the ease with which a child acquires functional literacy skills, relative to the amount and quality of the literacy experiences and the literacy instruction to which that child has been exposed. Thus, whereas a child with an optimum or near-optimum mix of reading-related cognitive abilities is likely to acquire functional literacy skills with little or no difficulty, even under less-than-optimum experiential and instructional circumstances, the child with a less-than-optimum mix of reading-related cognitive abilities will find literacy acquisition more challenging and will require more optimum literacy experiences and instruction to become functionally literate and to avoid early reading difficulties. By the same analysis, the child with significant deficiencies in cognitive abilities that underlie reading ability (e.g., phonological coding, phonological awareness, verbal memory, etc.) may have extraordinary difficulty learning to read and may experience early reading difficulties even under the most optimal experiential and instructional circumstances. Such children are likely to require more intensive and more protracted compensa-

tory instruction to become functionally literate. Thus, there is what some scholars have called a "gradation of risk" for becoming "reading disabled," depending on an interaction of one's natural endowment with the amount and quality of one's environmental and instructional experiences (Vellutino, Fletcher, Snowling, & Scanlon, 2004).

Implications of the Present Findings for Distinguishing Between Children With and Without Reading Disabilities

The present results extend earlier findings from our own research (Vellutino et al., 1996) insofar as they document that children at risk for early and long-term reading difficulties can be efficiently and economically identified on entry into kindergarten and that such difficulties can be prevented in most of these children with relatively low-cost (small-group) remedial intervention implemented during their kindergarten year. Moreover, the data suggest that although some at-risk children who receive kindergarten intervention will require additional remedial assistance at the beginning of first grade, many if not most of these children will no longer require such assistance by the end of first grade.

Second, our results provide additional support for the assertion (Vellutino et al., 1996) that early and long-term difficulties in the majority of impaired readers are caused primarily by experiential and instructional inadequacies rather than biologically based cognitive deficits. Support for this assertion is provided by the finding that early literacy difficulties were remediated in most of the at-risk children by the end of kindergarten and by the finding that performance levels in many of these children on several of the cognitive measures were comparable to those of the normal readers and stronger than those of the poor readers

who continued to need remedial assistance in first grade. However, the finding that the cognitive profiles of the poor readers who received additional remedial instruction in first grade were generally weaker than those of both the normal readers and the NLAR children suggests that reading difficulties in some poor readers are caused primarily by cognitive deficits of biological origin. Yet, it is noteworthy that the children in the LDR group were able to profit from the additional instruction they received in first grade and maintain their gains over time, despite the fact that their performance levels on most of the cognitive measures were not appreciably different from those of the children in the DR group who were unable to maintain the gains they demonstrated (relative to the normative group) at the end of first grade.

Collectively, these results imply that an at-risk child's initial response to remedial intervention can be a reasonably good barometer of whether that child will be readily remediated or more difficult to remediate, and that the profile developed from this and subsequent work with the child can aid as a "first-cut diagnostic" in determining whether his or her reading difficulties are caused primarily by experiential and instructional inadequacies or by cognitive deficits of biological origin. Although children in both the DR and LDR groups performed within the average range on all of the literacy measures at the end of first grade, indicating that those in both groups had clearly profited from the additional remedial assistance they received in first grade, the children in the LDR group performed at levels that were much closer to those of the children in the NLAR and normal reader groups on all measures, and this pattern was maintained in second and third grade. In contrast, the children in the DR group performed considerably below children in the LDR, NLAR, and normal reader groups on all measures at the end of first grade, especially on the reading comprehension measure where performance in the DR group

tended to be marginal. Thus, whereas the reading skills the LDR children had acquired by the end of first grade were strong and reasonably well integrated, the reading skills the DR children had acquired were tenuous and less well integrated, as seems verified by their below-average levels of performance on the reading measures in second and third grade. Therefore, it would appear, from observed group differences in level of response to remedial intervention, that at least some of the children in the DR group would be more defensibly classified as "reading disabled" (for whatever official purposes such classifications are needed) than either children in the NLAR group or children in the LDR group.

Of course, using response to intervention as the initial means of making the distinction between experiential/instructional and cognitive inadequacies as primary causes of a child's early reading difficulties does not rule out the use of appropriate psychometric tests with well-established measurement properties to cross validate impressions gained from remedial work with the child (e.g., tests evaluating phonological awareness, verbal memory, name retrieval, etc.), as we have suggested elsewhere (Vellutino & Scanlon, 2002). But our finding, in the present study, that the DR and LDR poor readers were not appreciably different on such measures suggests that response to intervention would be a more reliable criterion, not to mention its utility for developing the remedial strategies and activities that may be needed to facilitate literacy acquisition in children who prove to be more difficult to remediate.

A third implication of the results from this study is inherent in the patterns of performance that emerged on the intelligence measures. First, these measures did not reliably distinguish between children who were difficult to remediate and children who were less difficult to remediate, suggesting, once again, that intelligence does not predict response to intervention (Vellutino et al., 1996). Second, none of the intel-

ligence tests distinguished between children in the NLAR group and children in the AvIQNorm group. Moreover, the nonverbal intelligence test did not distinguish between children in each of the three remedial groups (DR, LDR, and NLAR) on the one hand, and the normal readers of average intelligence (AvIQNorm) on the other, and the combined results suggest that intelligence does not distinguish between at-risk and normally developing readers. These findings essentially replicate those obtained in the Vellutino et al. (1996) study discussed earlier and further undermine the use of intelligence test scores to diagnose reading disability (Fletcher et al., 1994; Siegel, 1989; Stanovich & Siegel, 1994; Vellutino et al., 2000; Vellutino et al., 1996).

Note, however, that both the DR and LDR groups performed substantially below the NLAR and the AvIQNorm groups on the test of verbal intelligence. This finding is of interest because in the Vellutino et al. (1996) study, the poor and normal reader groups were administered tests of verbal and nonverbal intelligence in both first and third grade and there were no significant differences among the poor reader groups nor between each of these groups and an average-IQ normal reader group on either of these measures in first grade. However, in accord with the present results, significant differences were found between children in the most difficult to remediate group and children in the average-IQ normal reader group on the test of verbal intelligence administered in third grade but not on the test of nonverbal intelligence administered in that grade. This disparity is no doubt attributable to the fact that nonverbal measures of intelligence are less vulnerable to Matthew effects than are verbal measures of intelligence (Stanovich, 1986). Indeed, it is possible that many of the observed differences between poor and normal readers on tests of intelligence are attributable to Matthew effects, especially those observed in older reader groups, which

again underscores the importance of using response to intervention in lieu of measures of intelligence to diagnose reading disability.

Finally, in keeping with similar results from previous intervention studies (Foorman, 2003; Torgesen, 2000; Vellutino et al., 1996), the present findings make it clear that some impaired readers will require continued and protracted remedial assistance, beyond that provided in the interventions evaluated in the present and previous studies, if they are to eventually acquire functional literacy skills. This raises the question of how such remedial assistance should be implemented. Obviously, the question can only be answered through additional research. But, given the finding that the children in the present study, who proved to be the most difficult to remediate, were unable to maintain the considerable gains they made after receiving both kindergarten and first-grade intervention, one can also raise questions about the adequacy of the classroom and remedial instruction they received after the project intervention ended. It is quite possible that many of these children were subsequently exposed to instruction that did not facilitate application of the skills and strategies they had acquired through exposure to our intervention program. Thus, research addressing the quality of both classroom and remedial instruction and the relationship between these two enterprises, in preventing and remediating early reading difficulties, is of critical importance (Gresham, 2002).

Summary

Results from the present study extend results from the first-grade intervention study conducted by Vellutino et al. (1996) and provide additional support for their contention that early and long-term reading difficulties in most children are caused primarily by experiential and instructional deficits rather than biologically based cognitive deficits. In the present study, children at

risk for early reading difficulties were identified at the beginning of kindergarten and received either kindergarten (small-group) intervention alone or both kindergarten and first-grade (one-to-one) intervention for most of each school year. Because the majority of children who received some form of kindergarten intervention generally performed better than children who did not receive any kindergarten intervention on measures of emergent literacy skills and because most of these children were found to be no longer at risk in first grade and beyond, we suggest that early identification of at-risk children in kindergarten and early intervention to institute foundational literacy skills in such children is an efficient strategy for making a "first cut" distinction between experientially and biologically based causes of early reading difficulties. This suggestion is supported by the finding that children who received both kindergarten and first-grade intervention and who, by definition, were difficult to remediate, were also found to have weaker cognitive profiles than either normally achieving readers or children whose emergent literacy difficulties were remediated in kindergarten and who were no longer at risk in first grade.

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AUTHORS' NOTES

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NOTES

1. The primary word identification and primary decoding tests are experimental tests that were constructed and normed in our laboratory to avoid the "floor effects" typically observed with kindergarten and first-grade children on most commercially available standardized tests.
2. The normal reader group was dichotomized on the basis of the mean score of the normal reader distribution on the Wechsler Intelligence Scale for Children—Third Edition (WISC-III) Full Scale IQ (Wechsler, 1991). This test was administered to all target children in third grade.
3. We refer to these children as "less difficult to remediate" in comparing them with the children we characterize as "difficult to remediate" because although they responded more positively to first-grade intervention than did the difficult-to-remediate children, they did not respond as positively to the kindergarten intervention as the children in the no-longer-at-risk groups and were therefore more difficult to remediate than the children in the latter groups.

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