

Effects of Day Care on the Development of Cognitive Abilities in 8-Year-Olds: A Longitudinal Study

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In Göteborg, Sweden, 146 children (72 girls) were enrolled in a longitudinal study when they averaged 16 months of age. None of the children had experienced regular out-of-home care yet, but within 3 months, 54 entered center care and 33 entered family day care. Quality of home and out-of-home care environments, child temperament, and the development of verbal abilities were assessed regularly during preschool years. When they were 8 years old (2nd grade), cognitive ability tests were administered to the 123 children (65 girls) still in the study. Tested ability was related to the number of months children had spent in center-based day care before 3.5 years of age. Child care quality predicted cognitive abilities among children who had spent at least 36 months in out-of-home care during their preschool years. Both tested and rated cognitive abilities in 2nd grade were related to earlier measures of verbal ability and to paternal involvement during preschool years.

Almost 20 years ago, Belsky and Steinberg (1978) concluded that "the overall picture of evidence, duly qualified, suggests that the day care experience has neither salutary nor adverse effects on the intellectual development . . . of most children" (p. 931). By 1978, however, no long-term studies had been conducted, and thus Belsky and Steinberg's review dealt only with immediate or short-term effects. The present study deals with the possible long-term effects of early entry into out-of-home care on cognitive abilities, with relevant characteristics of the child, the family, and the out-of-home care setting also taken into account.

In the last decade, a number of researchers have related elementary school performance to earlier child-care experiences. Most studies conducted outside the United States have found that early enrollment in day care has either positive or no effects on children's cognitive abilities in elementary school, once the effects of maternal education and family socioeconomic status are partialled out (Norway: Hartmann, 1991; New Zealand: Smith, Inder, & Ratcliff, 1993; Britain: Wadsworth, 1986). Within the United States, by contrast, results have been less consistent; some researchers have reported that early day-care experiences have positive effects, whereas others have reported no effects or even markedly negative effects of out-of-home-care

experiences on children's cognitive performance (e.g., Howes, 1988; Ramey, 1992; Thornburg, Pearl, Crompton, & Ispa, 1990; Vandell & Corasaniti, 1990). In addition to the inconsistent results, interpretation of the evidence is limited because most of the studies were retrospective in nature and controlled for only the most obvious aspect of the child's environment—family socioeconomic status—or else involved intensive intervention programs (Lamb, in press).

In Sweden, Andersson (1989, 1992) undertook a long-term longitudinal study in which positive effects of early out-of-home care on cognitive aptitude and teachers' ratings of school performance were discerned in follow-up assessments of the children at both 8 and 13 years of age. In both reports from the study, Andersson noted that children with early center-based day-care experiences later performed better on tests of cognitive abilities and got higher ratings of cognitive competence from their teachers than did children with less experience of early out-of-home care. Andersson's study is of special interest because it is one of the very few with a long-term longitudinal design and because his results differ substantially from those reported by North American researchers, thereby underlining the importance of ecological context. Andersson's study was also retrospective, however, in the sense that the first round of data collection started when the children averaged 3.5 years of age. As a result, preexisting differences between children on different child-care trajectories, as well as the quality of both home and out-of-home care, could not be taken into account. The present study was designed to avoid this problem by recruiting children between 12 and 24 months of age before they were launched on different child-care trajectories and by following them over a period of 7 years.

Many reviewers (e.g., Belfer et al., 1993; Lamb, in press; Lamb & Sternberg, 1990; Scarr & Eisenberg, 1993) have underscored the need for researchers to consider the effects of day

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care in broad context, thereby viewing nonparental care histories in the context of other formative factors pertaining to the child, the family, and the day-care setting. This study adds to a growing literature on the long-term effects of out-of-home care on children's development by studying a group of Swedish children prospectively over a 7-year period in relation to their diverse experiences of out-of-home care and other formative child and family factors. Specifically, we focus here on the children's cognitive development when they were 8 years old in the context of individual, family, and child-care factors likely to affect cognitive development.

First, we considered four characteristics of the children likely to be influential: gender, temperament, number of siblings, and prior cognitive abilities. Studies of gender differences and the effects of sibling status have yielded inconclusive results, though, in general, results favor girls (Butler, Marsh, Sheppard, & Sheppard, 1982, 1985; Tramontana, Hooper, & Selzer, 1988) and only or first-born children (Polit & Falbo, 1988). Meanwhile, poorer language (Engfer, 1993; Rubin, 1982; Slomkowski, Nelson, Dunn, & Plomin, 1992), communicative (Evans, 1993; Rubin, LeMare, & Lollis, 1990), and cognitive (Lamb, 1982) skills have been reported among shy-inhibited rather than among sociable-uninhibited children. Prior cognitive abilities, finally, are likely to be the most powerful predictors of later cognitive skills.

Second, socioeconomic status, quality of the home environment, and the extent of paternal involvement were included as indices of family background. As suggested by Desai, Chase-Lansdale, and Michael (1989), it is important to consider the level of resources available to the child, including material goods (books, records, learning equipment) as well as nonmaterial ones (emotional climate, parent-child communication, etc.). Measures of socioeconomic status and dynamic measures of home quality index these resources and have been shown to be correlated with measures of children's cognitive abilities (Caughy, DiPietro, & Strobino, 1994; Desai et al., 1989; Gottfried & Gottfried, 1984; Johnson et al., 1993; Satz & Friel, 1978). Radin (1981, 1982, 1994), meanwhile, has argued that paternal involvement is an important, although seldom studied, determinant of individual differences in cognitive and academic development.

Third, we assessed the effects of early child-care arrangements with measures of the type, amount, and quality of out-of-home care. As reported above, considerable uncertainty still exists regarding the effects of different types of out-of-home care on the development of children's cognitive abilities. Quality of out-of-home care has received a great deal of attention since the beginning of the "second wave of day-care research" (Belsky, 1984, p. 2). The positive effects of higher quality care on aspects of children's socioemotional development have been demonstrated in a number of studies (see Lamb, in press, for the most detailed review). Effects of day-care quality on children's cognitive abilities have not been documented as extensively, however, with most evidence derived from intervention studies (e.g., Infant Health and Development Program, 1990; Ramey, 1992). Kontos (1991) found child-care quality to be a significant predictor of social but not intellectual development in a sample of 100 children ages 3 to 5 years, whereas in a large study of children in four American states, toddlers had better

verbal abilities when they received care of higher quality (*Cost, Quality, and Child Outcome in Child Care Centers*, 1995). Clarke-Stewart, Gruber, and Fitzgerald (1994) reported that middle-class 2- to 4-year-olds performed better on many measures of cognitive development in centers of higher quality.

In previous reports from the Göteborg Child-Care Study, Broberg (1993; Broberg, Hwang, Lamb, & Bookstein, 1990) reported that verbal ability at 40 months of age was predicted by sociability, home-care quality, and earlier verbal ability scores, but not by the type or quality of out-of-home care. As a result, we expected verbal ability in elementary school to be predicted by the following: (a) Earlier measures of the children's verbal abilities, such that children with higher test scores at 40 and 86 months of age would also perform better in elementary school; (b) children's temperament, with inhibited children performing more poorly on tests of verbal ability; and (c) home quality, with children from more stimulating home environments with more involved fathers expected to do better than children with less stimulating home environments and less involved fathers. On the basis of our earlier results, socioeconomic status was not expected to predict verbal ability.

We expected that mathematical ability would be predicted by earlier measures of mathematical ability, child temperament, paternal involvement, and home quality, in the same ways as verbal abilities. On the basis of our own earlier results and in contrast to Andersson's (1989, 1992) findings, we did not expect either type of care or quality of out-of-home care to influence cognitive abilities.

Method

Participants

We recruited 146 children from the waiting lists for public child-care facilities in all areas of Göteborg, the second largest city in Sweden (approximately 500,000 inhabitants), in 1982 and 1983. Children were included in the study if they were (a) between 12 and 24 months old, (b) firstborn, or at least not living with a sibling under 12 years of age, (c) living with both parents (married or unmarried), and (d) not attending regular day care. Approximately 75% of the parents who were eligible for the study agreed to participate. By the time of the first assessment, the children (72 girls) averaged 15.9 months of age ($Mdn = 16$ months, $SD = 2.9$ months). The families came from a range of backgrounds. Mean Hollingshead scores for mothers and fathers were 41.1 ($Mdn = 44$, $SD = 12.5$) and 43.5 ($Mdn = 42$, $SD = 15.3$), respectively. Because of a shortage of places, not all children were assigned to public child-care facilities. Fifty-four of the children were enrolled in public day-care centers (center day-care or CDC group), 33 entered family day-care (FDC group) settings (8 public and 25 private), and 59 children remained in the exclusive care of their parents (home-care or HC group).

Children assigned to the different study groups did not differ with regard to parental age, but children in the FDC group had significantly higher paternal Hollingshead scores than did children in the HC group (49.6 vs. 40.0), with children in the CDC group having intermediate scores. This difference probably reflects the fact that a majority of FDC children were enrolled in private FDC homes (a relatively expensive option). There were no significant group differences on Caldwell's (1970) Home Observation for Measurement of the Environment (HOME) scale at the time of the initial assessment or in parental child-rearing attitudes as assessed with Block's (1965) Child Rearing Practices Report (CRPR), when the children averaged 40 months of age.

Children were followed for 7 years through four additional waves of data collection that took place when they averaged 28, 40, 80, and 101 months of age. Eight-four percent of the families participated in all five phases of data collection. Of the families who dropped out, 8 did so between Phases I and II, 2 between Phases II and III, 8 between Phases III and IV, and 5 between Phases IV and V. In Phase V, 123 families, 7 of which involved divorced or separated parents, were still involved. Attrition between Phases I and II was due mainly to serious illnesses or handicaps that were detected after the children were recruited. Later attrition was due mainly to families moving away from Göteborg. Attrition occurred in all groups; of the 24 dropouts, 12 were initially enrolled in center-based day care, 3 in family day care, and 9 had remained in exclusive home care. Children changed care groups mainly because vacancies opened in public day-care facilities or because new siblings were born. FDC children moved to the HC group when siblings were born and to the CDC group when places became available. HC children moved to the CDC group as placements were opened to them unless siblings were born. Parents in the HC group had second children significantly faster than parents in the CDC or FDC groups, although by Phase III (when the children averaged 40 months of age), there were no differences with regard to the number of siblings in the three study groups.

Procedure

All families were initially visited in their homes by members of the research staff. During this visit, information was collected about the parents' social and occupational background, social support, child-care arrangements, paternal involvement, and the children's temperament. During a second visit, the quality of the home environment was assessed. Children who were enrolled in out-of-home care began within 2 weeks of our initial assessment. Six weeks later, a member of the research staff visited these facilities, rated the quality of care, and conducted a short interview with the caregivers to obtain further information about the out-of-home-care settings.

One and 2 years after the initial interviews, the families and child-care facilities were visited again. During these visits, trained psychologists again assessed the quality of the home environments, the quality of the out-of-home-care facilities, and the children's verbal abilities. When children were 6.5 years old, on average, prior to enrollment in elementary school (at the time of this study, Swedish children began elementary school in the fall of the year in which they turned 7 years), as well as 2 years later, families were again visited in their homes. During these visits, professional psychologists who had not met the children during earlier phases tested the children's verbal and mathematical abilities and assessed again the quality of the home environment. In Phase IV, the quality of out-of-home care was assessed during a visit to the out-of-home care facility or part-time preschool. In Phase V, the elementary schools were visited, and the second-grade teachers' ratings of the children's cognitive abilities were obtained.

Measures

Verbal abilities. In Phases II, III and IV, verbal ability was assessed using objective tests. In Phases II and III, the Language subscale of the Griffiths Developmental Scales (Griffiths, 1954, 1970), one of the most widely used standardized measures of intellectual abilities in Europe, was used to test verbal ability. The Language subscale demands that children name a number of objects, name pictures of objects, name colors, explain the proper use of objects, describe the actions and activities portrayed in a picture, explain how to address an everyday problem, identify the media from which several items were made, and repeat sentences of increasing length. The scale has been translated and standardized in Swedish (Alin-Åkerman & Norberg, 1980) and is widely

used in research and clinical practice in Sweden. Test-retest and interrater reliability are both adequate ($rs > .75$).

Two verbal subscales (reading and vocabulary) of a standardized school readiness test (Ljungblad, 1967/1989) with adequate reliability (Spearman-Brown coefficient was .90 for the combined tests used here) were administered individually to children prior to their entry into elementary school. The subscale scores were summed to yield a total verbal ability score.

When the children were in second grade, a standardized test of reading abilities was used (Häggström & Lundberg, 1990; see also Elley, 1994; Jacobsson & Lundberg, 1995; Lundberg & Olofsson, 1980; Lundberg, Olofsson, & Wall, 1990). Two subscales required children to recognize words and sentences. Reading comprehension was tested by letting children read a story and then answer a number of questions related to its content. The word and sentence recognition subtests were administered individually to the children by the research assistants. The reading comprehension test, however, was administered in the classroom by the teachers and mailed to the research assistant who scored it. The three subtests were z transformed and summed to yield total verbal ability scores ($\alpha = .79$).

Mathematical abilities. The Numerical subscales of the Standardized School Readiness Test (Ljungblad, 1967/1989) were administered individually to children prior to their entry into elementary school. Reported reliability for the combined tests used was .90 in the standardization sample. The subscale scores were summed to yield total mathematical ability scores.

When the children were in second grade, a standardized test of mathematical ability was used (Ljung & Pettersson, 1990). One subscale required the children to write in figures a number given in letters. Two subscales required children to perform simple arithmetic (addition and subtraction), and the last subtest required children to solve mathematical problems (e.g., Write the missing number: $10 = 3 + \quad$; $\quad - 8 = 6$). In the Swedish standardization sample, the four subscales had internal reliability coefficients of .71, .72, .81, and .75, whereas the internal reliability of the total scores was .87. In our sample, the correlations between the total mathematical ability score and the subtest scores were .50, .82, .72, and .81, respectively. The four subtest scores were z transformed and summed to yield a total mathematical ability score. Cronbach's alpha for the combined scale was .68.

Siblings. In Phases II, III, IV, and V, we coded whether siblings had been born since our last visit. The total number of siblings born by Phase V, as well as an index of when the siblings arrived, were used as scores in the analyses.

Inhibition. We measured inhibition in two different ways. In Phase III, when children averaged 40 months of age, mothers' ratings of eight items from Block and Block's (1980) California Child Q-Set (CCQ; 19 [reversed score], 23, 35, 45, 46, 60, 82 [reversed score], and 98) and observers' ratings of the children's lack of sociability with a strange adult and lack of involvement in a peer-play situation were combined into an index of inhibition (Cronbach's $\alpha = .70$). Inhibition was also measured by preschool teachers' ratings in Phases III and IV on seven items from Baumrind's (1968) Preschool Behavior Q-Sort (10, 13, 30, 34, 50, 57, and 60). Cronbach's alphas of this measure were .83 and .84 at 40 and 86 months, respectively. Further details are provided by Broberg, Lamb, and Hwang (1990).

Family background. We used Hollingshead scores (weighted sums of the mothers' and fathers' education and occupation scores) to index family background, computed as instructed by Hollingshead (1975). The possible range is from 8 to 66, with higher scores denoting higher social status.

Quality of home care. We used age-appropriate versions of Caldwell's HOME inventory (Caldwell, 1970; Caldwell & Bradley, 1984) to assess quality of home care in all phases. In the first two assessments, the infant version was used, whereas four subscales (IV, VI, VII, and

VIII) of the preschool version were used in Phases III and IV. In Phase V, the full elementary school version of the HOME was used. In all phases, the available information was combined into a single score with z -transformed values used in the analyses (alphas ranged from .59 to .77). To reduce the number of independent variables used in the analyses, HOME scores for Phases I, II, and III were summed to yield a total HOME score for the first three phases ($\alpha = .68$). The Belsky and Walker (1980) Spot Observation Checklist was also used in the first three phases to measure the quality of home care. This checklist includes 13 positive and 7 negative events, with an observer noting whether each occurred during 3-min-long spot-sample units. The environment was sampled three or four times per occasion, and the numbers of positive and negative items observed were then averaged. A single index of early childhood home-care quality was constructed by combining the standardized average of the positive scores from the 16-, 28-, and 40-month assessments into a single score ($\alpha = .63$). The negative Belsky and Walker scores from the home observation were not sufficiently reliable and were consequently not used in the analyses.

Paternal involvement. We assessed paternal involvement in all phases, using ratings by the parents on the Parental Responsibility Questionnaire (PRQ; Lamb et al., 1988). The PRQ refers to different child-related chores (e.g., taking the child to the doctor for health checkups, buying clothes, buying toys, putting the child to bed at night.) On each item, the parent indicated which parent was mostly responsible, from 1 (*almost always mother*) to 5 (*almost always father*), and these scores were summed to yield two summary measures of paternal involvement in each phase, one based on the mothers' reports and one on the fathers'. Latent class analysis (LCA) for ordinal data (Rost, 1988a, 1988b) revealed groups of "minimally involved" and "moderately involved" fathers in all phases except Phase V, when maternal responses distinguished three classes of fathers. A second-order LCA on these classifications revealed two groups, one comprising fathers who were consistently in the moderate or higher group and the other comprising fathers whose classification varied over time. From the second-order LCA, a summary index of paternal responsibility was derived by taking the logit of the two class memberships, with high scores indicating a greater likelihood of being consistently more involved.

Time in day care. We indexed the child's time in day care by the total number of months (whether full time or part time) he or she had spent in (a) center-based day care, (b) family-based day care, and (c) exclusive home care up to and including Phase III (i.e., when the child averaged 40 months of age).

Quality of alternative care. Both structural and dynamic measures were used to assess quality of alternative care. Structural aspects were assessed with information obtained in a short interview with caregivers regarding the number of children in the group, the number of caregivers, the average number of hours the target child spent in out-of-home care each day, the "longest" regular day the child spent in day care, and the total number of caregivers who had been working in the group within the last 12 months. This information was then combined into an index on which higher values indicated that the child spent more hours in day care and had longer "longest days," more children were in the group, and more caregivers were present. A summary measure for the early childhood period was constructed by averaging scores from the assessments at 16, 28, and 40 months.

To tap dynamic aspects of the alternative care setting, the Belsky and Walker (1980) Spot Observation Checklist was used in the first three phases of data collection. Scores from the first three assessments were then summed for analytic purposes. Cronbach's alphas for the combined positive and negative scores were .71 and .66, respectively.

Interobserver reliability. All observations (inhibition, quality of home, and alternative care) were conducted by assistants who trained together with videotapes and pilot participants until achieving critical degrees of reliability. For the HOME, criterion was set at 80% exact

Table 1

Pearson Correlation Matrix of Cognitive Abilities in Phases III and IV in Relation to Cognitive Abilities in Phase V

Cognitive abilities	Verbal (101 months)	Math (101 months)
101 months		
Verbal	1.00	
Mathematical	0.52**	1.00
86 months		
Verbal	0.43**	0.30**
Mathematical	0.36**	0.29**
40 months		
Verbal	0.47**	0.25*

Note. N varied from 108 to 122 for the different pairs of scores. * $p < .01$. ** $p < .001$.

agreement; for inhibition and the Belsky and Walker (1980) items, criterion was set at 90%. Once data collection began, 15% of the sessions were conducted by two of the observers working simultaneously but independently. Reliability coefficients in the subsequent reliability assessments were within 5% of the criterion levels. It was impossible to keep observers blind with respect to the child-care-group status of the children, but they were not aware of the explanatory model guiding the research or of the specific hypotheses. Observers were changed between Phases III and IV.

Results

First-Order Analyses

Earlier measures of cognitive abilities and cognitive abilities in second grade. As shown in Table 1, verbal abilities in second grade were correlated with indices of the children's verbal abilities when they averaged 40 and 86 months of age. Verbal abilities in second grade were also moderately correlated with mathematical test scores at 86 months of age, and mathematical abilities in second grade were correlated with earlier verbal (at 40 and 86 months) and mathematical (at 86 months) test scores.

Inhibition and cognitive abilities in second grade. Neither the inhibition scores based on the mothers' and observers' ratings when the children were 40 months old nor those based on the preschool teachers' ratings when the children averaged 40 and 86 months of age predicted verbal or mathematical test scores when the children were in second grade.

Gender, sibling status, and cognitive abilities in second grade. The effects of gender on the children's cognitive abilities were investigated using t tests. No significant differences emerged. The effects of sibling status were investigated (a) by comparing children without siblings with children who had siblings in Phase V and children whose siblings were born before Phase II or before Phase III, and (b) by correlating the number of siblings with test scores and teachers' ratings. There were no significant differences related to sibling status.

Home-care quality and cognitive abilities in second grade. As anticipated, measures of socioeconomic status were unrelated to measures of the children's cognitive abilities in second grade. Only the correlation between the fathers' level of education and the children's mathematical abilities approached significance ($r = .18, p = .06$). Home-care quality, which had

Table 2
Standardized Cognitive Ability Scores for
Six Groups of Children

Group	N	Scores			
		Verbal		Mathematical	
		M	SD	M	SD
Consistent HC	37	55.32	17.12	19.97	5.90
Consistent FDC	12	51.31	15.78	19.67	6.96
Consistent CDC	32	62.66	19.95	23.67	4.06
HC at 40 months, other care at 16 or 28 months	20	53.82	14.32	21.90	3.60
FDC at 40 months, other care at 16 or 28 months	3	57.00	14.68	16.33	5.03
CDC at 40 months, other care at 16 or 28 months	17	61.64	20.01	22.67	5.25

Note. HC = home care; FDC = family day care; CDC = center day care.

been a significant predictor of verbal abilities in Phase III, did not predict the children's cognitive abilities in Phase V. Home scores in Phase IV and V were unrelated to scores on both measures of cognitive ability, whereas the HOME score in Phase III was related to verbal abilities in Phase V ($r = .20$, $p = .026$).

Type and quality of child-care experiences and cognitive abilities in second grade. The effects of type of care on children's cognitive abilities were investigated in a series of one-way analyses of variance (ANOVAs) on three levels: HC, FDC, and CDC; the two dependent variables (tested verbal and mathematical abilities) in Phase V were analyzed against the type of care received in earlier phases. In each phase, we considered which type of care the children were currently receiving, regardless of prior care. Descriptive statistics on the measures of cognitive abilities for the different groups, in relation to child-care status when the children were 40 months old, are shown in Table 2.

Significant effects for type of care consistently favored children who had been in center-based day care. These children were typically followed by those who had been in HC, and then by children in FDC, although the small size of the FDC group (Phase I: 30; Phase II: 25; Phase III: 15; Phase IV: 15) compared with the other two groups made interpretation of these results difficult. Children who had been in CDC in Phases I and II had the highest tested levels of verbal ability when 8 years old, $F(2, 119) = 3.64$, $p = .03$; $F(2, 118) = 3.78$, $p = .03$, respectively. Tukey post hoc tests of mean differences showed that the children who had been in center day care in Phase I ($p = .04$) and Phase II ($p = .05$) scored higher on the verbal ability tests at 101 months of age than children who had remained home at these ages. Children who had attended center day care in the previous assessments also had the highest tested levels of mathematical ability at 8 years of age: Phase I, $F(2, 118) = 4.09$, $p = .02$; Phase II, $F(2, 117) = 3.76$, $p = .03$; Phase III, $F(2, 117) = 5.69$, $p = .01$; and Phase IV, $F(2, 101) = 3.30$, $p = .04$). Tukey post hoc tests of mean differences showed that the

CDC children scored higher than the HC children when they had been in center day care in Phases I and II (Phase I: $p = .01$; Phase II: $p = .04$) and higher than both HC and FDC children when they had been in center day care in Phase III (CDC vs. HC: $p = .02$; CDC vs. FDC: $p = .01$). Scores on the structural indices of out-of-home-care quality at 40 and 80 months of age were correlated with the tested mathematical abilities in second grade ($r = .30$, $p = .019$ at 40 months; $r = .22$, $p = .014$ at 80 months of age), but not with tested verbal ability.

Second-Order Analyses

To identify those variables that explained unique amounts of variance in cognitive ability, we conducted stepwise regression analyses with the variables described in the previous section as predictors (previous verbal and mathematical abilities, the summary scores for inhibition, the quality of home care and the quality of alternative care, the number of months in each type of care, the children's gender, and their sibling status). The tested verbal and mathematical abilities at 101 months of age were used as the dependent variables. In addition, the final models were tested with structural equation modeling to assess their overall fit. Such models do not fit the data adequately when significant interpredictor relationships are present. Hence, they can be interpreted as simple tests of the presence of such correlations among the predictors.

Verbal ability. As seen in Table 3, verbal ability was positively predicted by the tested verbal abilities in the two previous phases (at 40 and 80 months of age), consistently higher paternal involvement as rated by the mothers, and the total number of months the child had spent in center-based day care. The four variables accounted for a squared multiple correlation of .36 in the dependent variable, with the verbal abilities at 40 months of age contributing the highest change in R^2 (.219), followed by the verbal abilities at 80 months (.071), the number of months spent in day care (.042), and higher levels of paternal involvement as perceived by the mothers (.037). When we used them simultaneously, these variables revealed a model fit of $\chi^2(5, N = 122) = 4.89$, $p = .429$.

Mathematical ability. As seen in Table 4, mathematical ability was positively predicted by previously tested mathematical abilities, the structural measures of day-care quality in the first three phases, inhibition, and the negative Belsky and Walker (1980) scores in early childhood. Together, these predictors accounted for a squared multiple correlation of .210 in tested mathematical abilities, with mathematical abilities at 80 months contributing the highest change in R^2 (.086), followed by the structural quality of alternative care (.061), the children's inhibition (.035), and the negative Belsky and Walker scores (.028). The goodness of fit for the model when these four variables were considered simultaneously was $\chi^2(5, N = 121) = 3.46$, $p = .629$.

Discussion

By following these Swedish children for over 7 years, we have been able to identify aspects of their personal background that have significantly affected their cognitive development. Not

Table 3
Stepwise Regression Analysis for Children's Verbal Abilities in Second Grade

Predictors	R^2 change	F	p	β	t	p
Verbal ability at 40 months	.219	33.30	.000	.3696	4.59	.000
Verbal ability at 80 months	.071	11.82	.000	.2950	3.67	.000
Months in day care	.042	7.36	.008	.2099	2.84	.005
Paternal involvement (according to mothers)	.037	6.74	.011	.1933	2.60	.011

Note. β , t , and p (t) are assessed in the final step.

surprisingly, earlier measures of cognitive ability were the best predictors of cognitive performance at 8 years of age, but, quite unexpectedly, the type of early child care experienced proved to be predictively important as well.

On the basis of our own earlier results (Broberg et al., 1990), neither type of care nor quality of out-of-home care was expected to influence cognitive ability. Contrary to this expectation, however, our results showed that day care had positive " sleeper effects " on cognitive development, just as Andersson (1989) found in an independent study of Swedish 8-year-olds. The longitudinal design of our study, the fact that we controlled for later group experience (all home-care children spent at least 1 year in part-time preschool before starting elementary school), and the fact that we studied children receiving both center- and family-based day care enabled us to isolate the effect of the day-care experience with respect to both time and type. Children who had spent more months in center-based day care before they were 40 months old obtained higher scores on tests of cognitive ability than did other children. For children who had spent 3 or more preschool years in out-of-home care, quality of alternative care was also predictive. Dynamic measures of quality (quality of adult-child interaction) predicted verbal abilities, whereas structural measures of quality (child-staff ratio, group size, age range) predicted mathematical ability.

Overall, the results reported here add to the growing number of reports that high quality out-of-home care has positive effects on children's cognitive development in several cultures, including the United States (see Clarke-Stewart, 1991, and Lamb, in press, for reviews). Furthermore, because of its longitudinal design, our study enabled us to explore patterns of influence more thoroughly than has hitherto been possible. Given comparable levels of quality, the mechanisms proposed here should operate in a variety of industrialized cultures, not simply Sweden.

It is noteworthy, however, that some of our results were not

consistent with previous research on the development of cognitive abilities. For example, we found that the correlations between measures obtained when the children were 40 and 101 months of age were unexpectedly higher than those between scores obtained when the children were 80 and 101 months old. Examination of the means and standard deviations in Table 2 suggests that ceiling effects are unlikely to account for our findings. Perhaps, instead, the problem lies in the fact that the measurement at 80 months of age took place shortly after most of the children experienced a major life event—entry into kindergarten. Conceivably, this change temporarily affected the children's test performance as they adjusted to their new environments, whereas these adjustments had long been made by the time of assessment in second grade. This interpretation is consistent with the fact that the unusual pattern of correlations was evident in the subgroups of children in the home-care and family-day-care groups (who experienced the biggest transitions from home-based to institutional settings), whereas it was inverted for the children in center-based day care (who entered kindergarten facilities much like their centers along with the other children from their centers).

We had also not expected that measures of the home environment, which predicted verbal abilities in earlier phases, would no longer be predictive when the children were in second grade. Similar results were reported by Luster and Dubow (1992), who found that measures of the home environment were better predictors of intelligence in preschool than in school-aged children. One interpretation of these results is that later development is more driven than earlier development by the child's ability to choose her or his own environment, a process known as *niche-picking* (Scarr & McCartney, 1983). Genetic differences among children account for only 15% to 25% of the variance in IQ-test scores at 3 and 4 years of age compared with more than 50% in adulthood (DeFries, Plomin, & LaBuda, 1992), and, as a result, Cardon, Fulker, DeFries, and Plomin (1992) have

Table 4
Stepwise Regression Analysis for Children's Mathematical Abilities in Second Grade

Predictors	R^2 change	F	p	β	t	p
Mathematical abilities at 80 months	.086	11.04	.001	.3059	3.63	.000
Quality of alternative care (structural)	.061	8.36	.005	.2409	2.88	.005
Inhibition	.035	4.93	.028	.2000	2.39	.018
Belsky & Walker (1980) (negative)	.028	4.10	.045	.1717	2.03	0.45

Note. β , t and p (t) are assessed in the final step.

suggested that observed continuities in cognitive ability levels arise from age-specific genetic and nonshared environmental effects. On the other hand, the quality of early alternative care became more predictive of verbal abilities as the children aged—a finding that is inconsistent with the explanation in terms of niche-picking as well as with the expectation that treatment effects should decrease as the time between treatment and assessment increases. Likewise, the fact that measures of family socioeconomic status (indexed by maternal and paternal occupational levels) did not predict performance on our measures of cognitive ability in second grade is somewhat puzzling because it is typically a strong predictor (Sattler, 1988). This may be because troubled families with very low socioeconomic status scores were not included in our study, resulting in a rather narrow sampling of social class variation, or because socioeconomic status is of less predictive importance in Sweden, with a narrower range of social class differences than in the United States or in the United Kingdom.

Our earlier results also led us to predict that the children's temperament would influence cognitive ability, but this too was not the case. Inhibited children did just as well on tests of verbal ability as uninhibited children. Because such associations are quite often found in studies of younger children (Engfer, 1993; Evans, 1993; Rubin, 1982; Rubin et al., 1990; Slomkowski et al., 1992), our results suggest that shyness affects vocal and verbal production but not the written measures of linguistic ability used in our assessments of the children at 8 years of age. As in the United States, however, cognitive abilities were enhanced by increased paternal involvement (Radin, 1981, 1994). The small size of the effect undoubtedly reflects the number of potential influences considered simultaneously in this study.

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