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| Author(s)        | MORRISON, Fredrick J.                                                           |
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## MAKING THE CUT : EARLY SCHOOLING AND COGNITIVE GROWTH

Fredrick J. Morrison

*University of North Carolina at Greensboro*

### Abstract

The role of early education in cognitive growth was examined, by capitalizing on a natural experiment termed "school cutoff." Children who just made vs. missed the cutoff for grade one, were compared on growth of memory, language, and reading skills over a two year period. Findings revealed that early schooling produced a powerful and unique improvement in short-term memory skills and strategies, with no evidence of an age  $\times$  experience interaction. Further, growth of three levels phonological segmentation skill (syllabic, subsyllabic and phonemic) showed distinctly different developmental and schooling influences, conforming to a domain-specific view of early cognitive growth. Finally, the contribution of age alone to early academic success was found to be minimal. Together, results revealed the powerful and unique impact of early schooling on cognitive development. In addition, findings confirmed the usefulness of the school cutoff methodology in elucidating important sources of developmental change in young school-age children.

The nature-nurture controversy in research on human cognitive development settled into a complacent, middle-aged interactionism some time over the last two decades, lulled there, in part, by the dominance of classic Piagetian theory and by the almost exclusive reliance on cross-sectional methodology and laboratory-based experimentation (Morrison, Lord, and Keating, 1982). These dominant orienting attitudes and practices tended to create a view of the child as advancing intellectually and socially in readily predictable sequences (or even stages), with rather domain general skills emerging as a function of experience.

In reality, notwithstanding interactionist claims, this dominant perspective created a rather traditional maturationalist ethos in which the actual role of experience was simply not adequately addressed (Fischer, 1980). In practice, a kind of 'horticultural' metaphor of development emerged, in which children were viewed like flowers that grow and develop in an orderly, predictable fashion with the environment relegated to the status of soil, whose sole contribution was to provide richer or poorer nutrients and thus accelerate or retard the rate of development of a sequence of events coded in and

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Request for reprint should be addressed to Professor Frederick J. Morrison at Department of Psychology, The University of North Carolina-Greensboro, Greensboro, NC 27412-5001, U. S. A.

guided by genetic influences.

In recent years, however, a growing body of evidence has documented the dramatic impact that specific experiences related to schooling (Stevenson & Lee, 1990), literacy (Scribner & Cole, 1981), and specialized expertises (Ceci & Liker, 1986; 1988; Chi & Ceci, 1987) can have on growth of a wide array of important cognitive skills. In addition, accumulating evidence tends to view such feats of learning as predominantly domain-specific, at least initially (Keating & Crane, 1990.) As a result, this research has reawakened interest in the powerful and unique influence of specific experiences on psychological growth and concurrently raised questions about the adequacy of the horticultural metaphor and its dominant underlying maturationalist emphasis.

In recent years, we have been utilizing a 'natural experiment' termed 'school cutoff', to examine the roles played by early schooling experiences in the timing and nature of development of cognitive skills. With some notable exceptions, our research to date has documented that early schooling experiences produce dramatic and unique changes in selected cognitive skills. Further, some changes observed appear to be quite domain- or even sub-domain-specific and sensitive to changes in environmental demands of the schooling experience. Finally, within limits, the unique contribution of maturation- or age-related factors (at least as traditionally conceived) is much less evident.

### The Natural Experiment

These conclusions have been reached as a result of findings growing out of our study of children who just make vs. miss the cutoff for school entry. This natural experiment has permitted us to compare cognitive growth in two groups of children, almost identical in age and matched on background characteristics. One group of children, having just made the cutoff for grade one by virtue of birthdate, receive a formal grade one experience while another group of children, whose birthdate causes them to just miss the cutoff, go to Kindergarten. Comparison of changes in cognitive skills in the two groups using a pre-post design permits assessment of the impact of the grade one schooling experience on growth of cognitive skills.

### Schooling and Growth of Memory Skills

In one of our first studies (Morrison & Smith, in review) we examined the impact of schooling on changes in memory performance and memory strategies. Children were shown nine pictures of common objects for later recall and asked to overtly verbalize whatever strategies they might be using to help them remember. Results from that first study are shown in Figure 1, depicting a number of pictures recalled at pretest and post-test by children who had just made (Y1) vs. just missed (K) the cutoff—they were 41 days different in age and equated on IQ, SES and amount of daycare experience. The graph reveals first, that there were no group differences in memory at pretest, illustrating that little improvement in memory had occurred in the Y1 group during their previous Kindergarten year. This conclusion is reinforced by the finding that after a year of Kindergarten schooling, the K group at post-test showed no improvement in memory performance. In contrast, after a year in first grade, the Y1

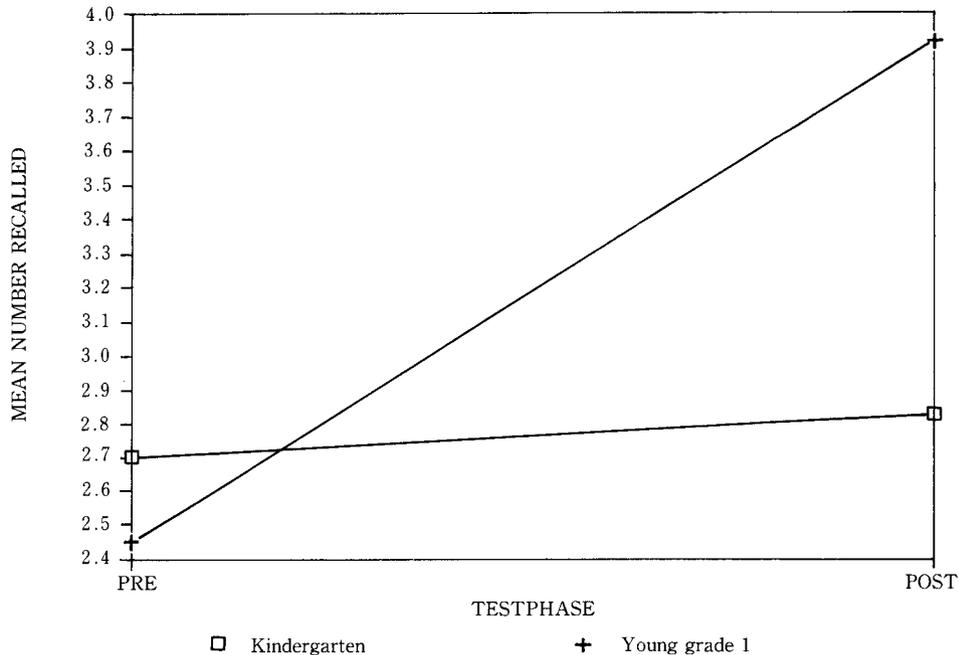


FIGURE 1 Mean number of pictures recalled by Y1 and K children at pretest and posttest 1.

children showed a dramatic rise in memory performance. Additional measures of strategic behavior revealed that the Y1 children had acquired more active, cumulative rehearsal strategies after a year in grade one, whereas Kindergarten children remained passive rehearsers throughout the same period in Kindergarten.

#### An Age $\times$ Experience Interaction

These initial findings constituted direct evidence for the powerful and unique influence of schooling on growth of short-term-memory performance and skills. The cutoff method also permitted assessment of possible age  $\times$  experience interactions, since the following year the original Kindergarten children went to grade one, but almost a year older than the original Y1 children, who now went to grade 2. Results from the second post-test are shown in Figure 2 together with the previous data. As depicted, the original Kindergarten children, following exposure to grade one, showed significant increases in memory performance. Nevertheless, the degree of increase for the K children was not greater than that shown by the original Y1 children a year earlier—hence there was no evidence that being older enhanced the impact of grade one schooling on growth of memory skills—no age  $\times$  experience interaction, in other words. Taken together, results from this first study demonstrated that growth of immediate memory skills was exclusively a product of the grade one schooling experience.

#### Early Schooling and Phonological Segmentation

A separate study (Morrison & Dow, in review) examined the role of aspects of

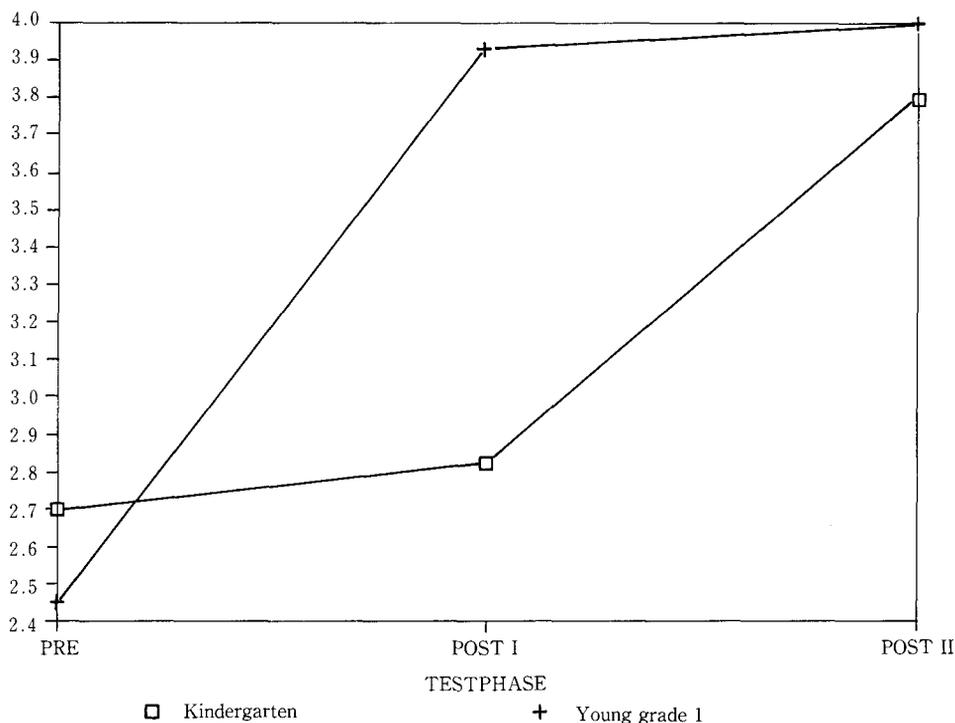


FIGURE 2 Mean number of pictures recalled by the two groups at pretest and posttest 1 and 2.

early schooling, especially exposure to formal reading instruction, on growth of phonological segmentation, highlighting growth of phonemic awareness. Some uncertainty has existed in the literature about the causal status of phonemic awareness in early reading acquisition. The cutoff methodology provided a unique test of the independent and reciprocal relations between phonemic awareness and reading acquisition (Perfetti, 1985). In addition, the study assessed growth of children's skill in segmenting two other phonological levels—the syllable and sub-syllable.

In this study, following training and practice, children were asked to say how many sounds a word contained, using a variant of the standard token task. As in the previous study, a pre-post<sub>1</sub> -post<sub>2</sub> design was utilized with Y1 and K children to assess the impact of early schooling as well as possible age  $\times$  experience interactions on growth of three levels of phonological segmentation.

Figure 3 depicts the results for phonemic awareness across the three testing intervals. As shown, the two groups children performed equivalently on the pretest. At first post-test, the K children showed a modest but reliable increase in phonemic segmentation scores following a year in Kindergarten. Nevertheless, the Y1 children manifested a much larger increase in phonemic awareness following exposure to more formal reading instruction in grade one. Finally, at second post-test, the original K children manifested a strong increase in phonemic segmentation scores, but no greater than the Y1 children had a year earlier, despite beginning at a higher level at the end of Kindergarten. These findings supported the view that the most significant changes in

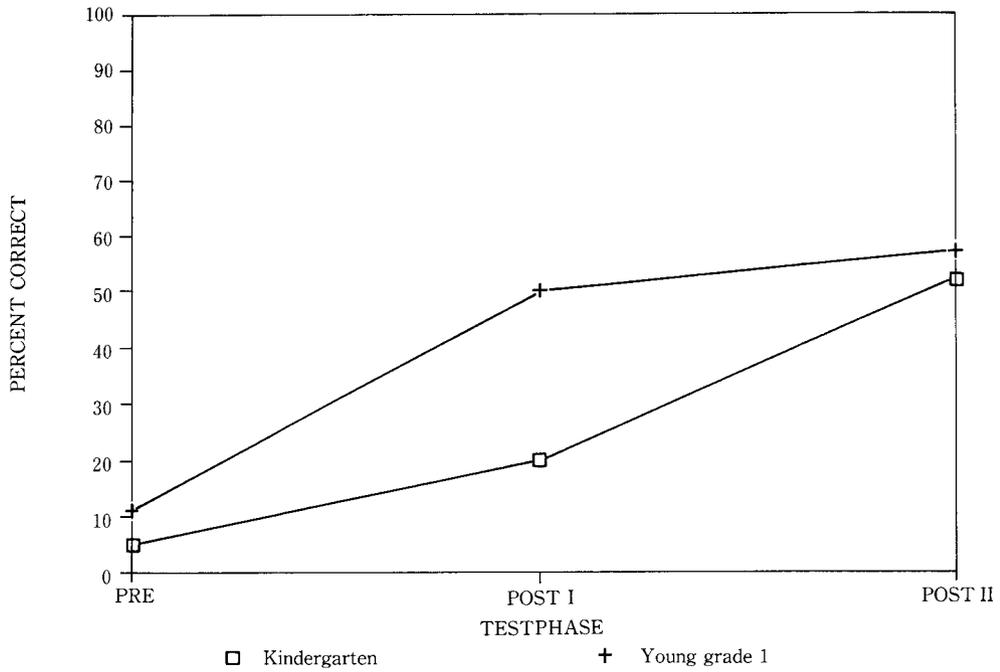


FIGURE 3 Level of performance in phonemic segmentation achieved by the two groups across the three testing intervals.

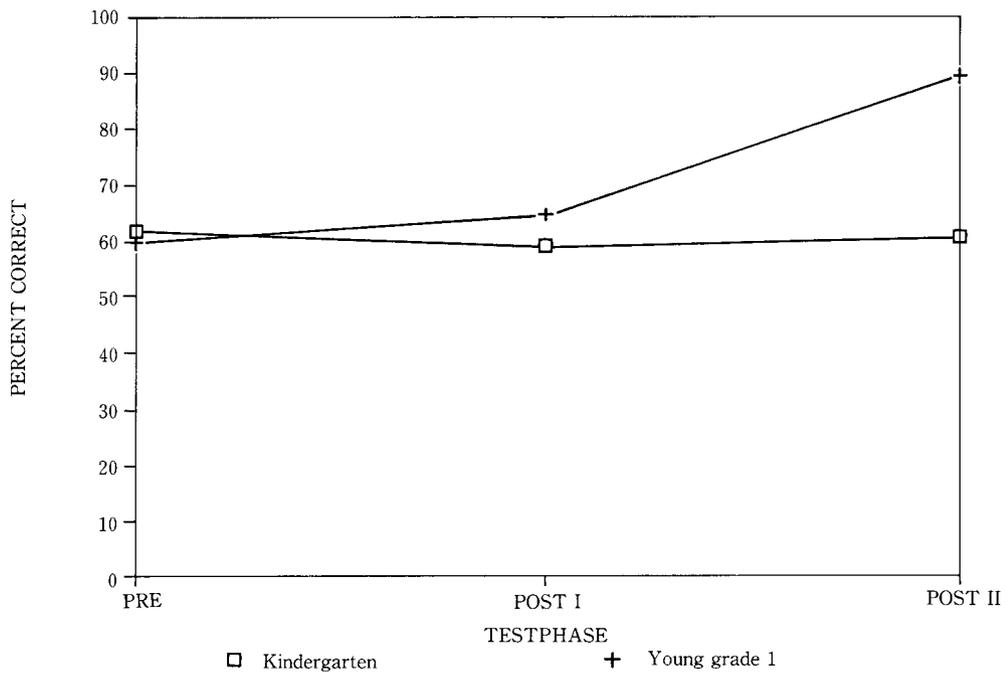


FIGURE 4 Level of performance in syllabic segmentation achieved by the two groups across the three testing intervals.

phonemic awareness were a result of exposure to formal reading instruction in grade 1.

Further examination of the change scores for syllabic and subsyllabic segmentation permitted assessment of whether children were learning a general segmentation skill that would cut across levels of phonological analysis or whether the newly acquired skill in phonemic segmentation would be limited to that sub-domain.

Figure 4, depicting growth of syllabic segmentation skill, reveals a very different pattern from that of phonemic awareness. First, performance at pretest was higher for syllabic than for phonemic awareness—preschool children are inherently better at segmenting syllables than phonemes. Second, almost no schooling or age effects emerged at first post-test. Yet at second post-test, there was a clear and very reliable “grade two effect”! The original Y1 children manifested a sharp unique increase in syllabic segmentation following grade 2. Examination of the curriculum and informal interviews with teachers confirmed the suspicion that, starting around grade two, more emphasis is placed on mastery of the idea of a syllable and of the skill of syllabic segmentation.

Results for sub-syllabic segmentation are shown in Figure 5. It is clear from the figure that sub-syllabic segmentation skill was intermediate between syllabic and phonemic segmentation and followed a unique developmental pattern. Essentially, sub-syllabic segmentation skill showed a modest improvement over time with no evidence for any unique impact of schooling. These findings are consistent with the notion that sub-syllabic segmentation may represent a somewhat later developmental or educational achievement, dependent upon acquiring higher-order linguistic knowledge of word stems and analogical word decoding processes in reading.

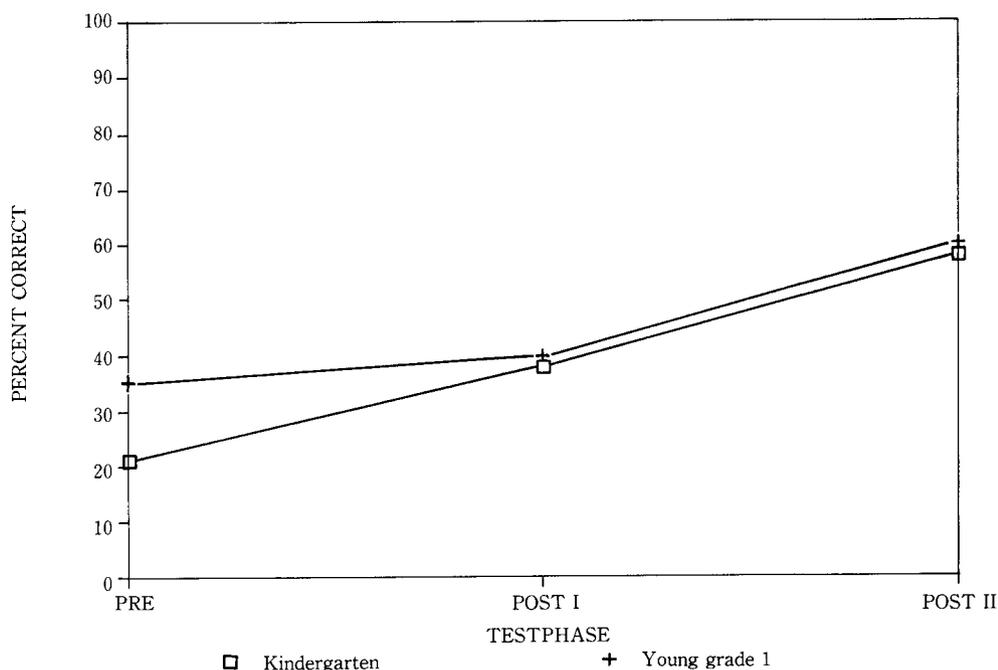


FIGURE 5 Level of performance in subsyllabic segmentation achieved by the two groups across the three testing intervals.

Taken together, results from the three tasks showed very different patterns of change and influence. As such the findings reinforced recent demonstrations that competence learned in one domain (or even sub-domain) does not automatically transfer to other domains requiring similar cognitive processes (Keating & Crane, 1990).

### The Influence of Age-Related Factors

Findings from the above two studies have impressed on us the power of specific experiences in shaping the timing and nature of development of selected cognitive skills. Partly as a consequence, we became concerned by claims in the popular and scientific literature about the importance of entrance age on school readiness, achievement and social adaptation. Specifically, claims have been made that children who are young when they enter grade one (essentially 5-year olds and especially boys) are not cognitively and/or socially *mature* enough to benefit from formal schooling. Hence local school officials and pediatricians routinely recommend that children close to the school cutoff date be held back prior to Kindergarten or retained an extra year in Kindergarten, in order to "buy the gift of time."

Parenthetically, if correct, this concern would have been particularly devastating in Edmonton, Alberta (the site of our original research) since the cutoff date for school entry in Edmonton is March 1, the latest cutoff date in North America. Edmonton thus has the youngest children on the continent receiving formal grade one instruction.

Since our own experimental studies revealed clear and unique benefits for these children in cognitive growth, and since the existing research suffered serious methodological and logical problems, we undertook to study directly whether young grade one children were at greater risk for academic failure. Stated another way, we endeavoured to assess whether age *per se* contributed significantly to the impact of early schooling or academic achievement.

As part of a large ongoing study on this topic, we assessed reading scores in three groups of children, matched on IQ, SES and daycare experience: young grade one students and Kindergarten students, selected as in the earlier studies; and old grade 1 students (O1) who had just missed the cutoff for grade one the previous year.

Results for reading achievement across the three testing intervals are shown in Figure 6. Here, grade level equivalent scores on the Wide Range Achievement Test are shown for the three groups of children. As shown, at pretest, there was small differences among groups favoring old grade one children. More striking, however, was the finding that the degree of progress made by Y1 children over the course of first grade was identical to that of older children and far greater than the almost-age-equivalent Kindergarten children. Thus, as a group, young grade one children learned as much as older grade one children, at least in elementary word reading skill, given their starting points. Moreover, the progress of the Y1 children was far greater than it would have been, if they had stayed in Kindergarten. Perhaps most striking, the small initial difference between O1 and Y1 children at pretest and end of grade one was completely eliminated by the end of second grade.

The overall pattern of changes in the three groups demonstrated rather dramati-

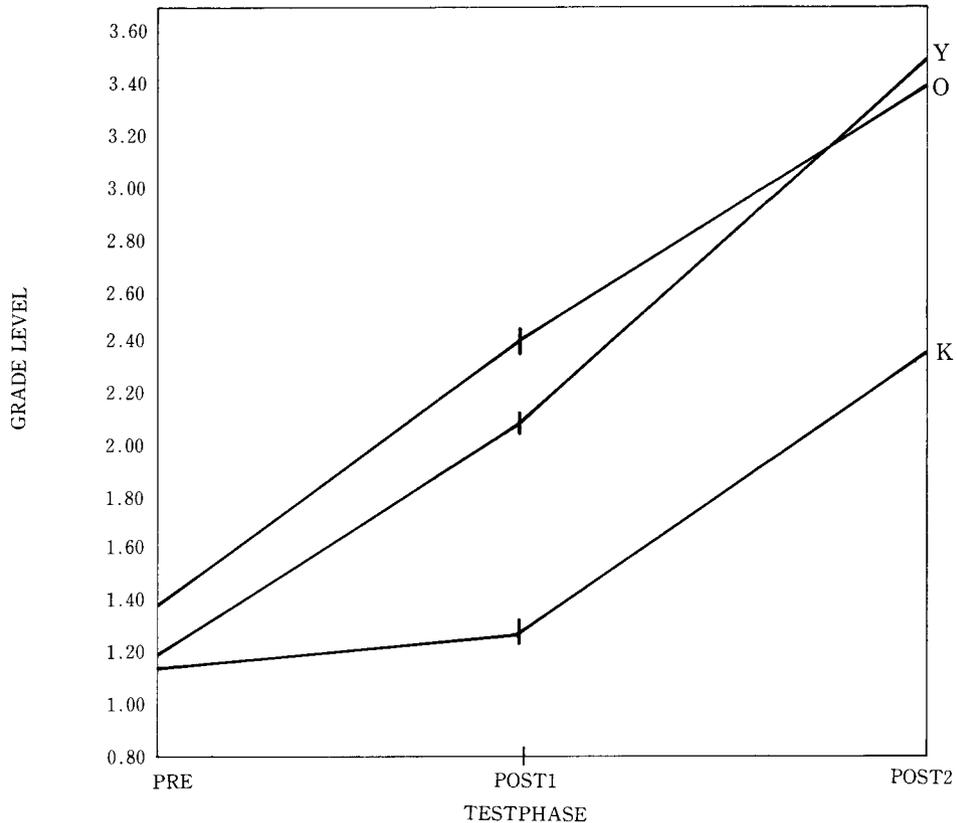


FIGURE 6 Grade-level equivalent reading scores on the WRAT-R for Y1, K, and O1 children cross the three testing intervals.

cally that, in and of itself, age was a poor predictor of learning to read. Coupled with our earlier failure to find significant age  $\times$  experience interactions in memory and language development, our research to date has consistently found that, within obvious limits, age-related factors (like maturation) do not contribute significantly to changes in cognitive, linguistic, and academic skills during the period under study.

In conclusion, findings to date utilizing the school cutoff procedure have demonstrated that exposure to early schooling produces measurable gains in cognitive, linguistic, and academic skills. The early schooling experience appears to emphasize growth of specific skills and sub-skills needed for functioning during a particular learning phase in the educational curriculum. As a result, children in school develop relatively isolated, domain-specific skills rather than general thinking strategies. Whether they might also learn general cognitive skills remains an open question. Finally, the school cutoff methodology revealed itself to be a sensitive and discriminating procedure for examining the nature and causes of important developmental changes during the early school years.

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