

Predictors in Kindergarten and 1st Grade of Later Academic Achievement  
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**Reading Achievement:**

*Cognitive and Early Skill Predictors of Reading Achievement:*

Early language and reading skills have been shown, not surprisingly, to be a significant predictor of later reading achievement (Grissmer et al, 2010; Hooper et al, 2010) and some studies show that these predict the vast majority of achievement score variance in later years as well as gaps that never improve, regardless of amount or type of instruction (Sonnenschein et al, 2009). In a comprehensive 7 year study, Butler et al (1985) found that the most important predictor variable in kindergarten of later reading success in 6th grade was language skills. These were measured by asking students to do such tasks as repeat nonsense syllables, distinguish between word pairs, describe a story, repeat a short paragraph, retell a story, and comprehend text read aloud (p. 353). With that said, they did also find that although these characteristics had direct effects on reading in Grade 1, by Grade 6 the effects were significantly weaker. Hooper et al (2010) found that expressive language skills (gesture, vocal development, and social communication) were positively related to later reading achievement for both Caucasian and African American children. Lesaux, Rupp, and Siegel (2008) found that significant predictors in kindergarten of fourth grade reading comprehension and word reading were letter identification (reading out loud random letters on a page) rhyme detection, and "oral cloze" (identifying what word is missing from a sentence read out loud by experimenter). Butler et al (1985) also found "grammatical closure" and "auditory closure" to be significant, which sounds quite similar, although these measures were never clearly explained in their article. Above all, for both English Language Learners and native speakers, Lesaux, Rupp, and Siegel found that letter identification was the most significant predictor of both initial reading status as well as growth over time. This was corroborated in at least one other study (Sonnenschein et al, 2009). Other important skills that predict later achievement are associating letters with sounds at the beginning of words, recognizing common sight words, reading words in context, and associating letters with sounds at the ends of words (Sonnenschein et al, 2009).

Similar results have been found for working memory. One study in the UK found that the most important factor in early primary school related to later reading achievement in Grade 3 was retention in short term memory of both verbal and visual/spatial information (Bull, Espy & Wiebe, 2008). For verbal information, a series of numbers were spoken to the students, and they were required to repeat them back in the same order. For visual-spatial short-term memory, children were shown an arrangement of blocks and then the blocks were pointed to in a specific order. The student had to recreate the arrangement and point to the blocks in the same order. Students with the greatest ability to retain long digit spans (verbal short-term memory) were ahead of their peers in both reading and math for the entire observation period, indicating that this was perhaps the most important factor out of all that were measured (p. 216). Lesaux, Rupp, and Siegel (2008) also found that verbal working memory was significant in predicting later reading comprehension and word reading. Butler et al. (1985) found evidence for the positive benefits of visual/spatial memory retention in their finding that figure drawing (both copying geometric figures and drawing a human figure) predicted reading gains by grade 6.

Fine motor skills have been found to be a "very strong and consistent predictor" of later achievement by Grissmer et al (2010). They also found that early declarative knowledge of the external world led to later reading and science achievement.

Finally, in their groundbreaking study in 2007, Duncan et al. found that knowledge of numbers and ordinality was the most important predictor of later reading achievement, a counter-intuitive conclusion that challenges many findings cited above (see below for follow-up studies).

### *Behavioral Predictors of Reading Achievement:*

A child's early temperament seems to have some effect on later achievement, although more recent studies qualify this association. Magnuson, Duncan, & Kalil (2006) found that more sociable children at ages 4 and 5 had higher adolescent reading outcomes, and teacher ratings of social skills have been shown to be a significant predictor of achievement in multiple studies (Magnuson, Duncan, & Kalil, 2006; Hooper et al., 2010). Burchinal et al (2002) found that children rated by teachers in preschool as more socially extroverted were more successful in reading by 2nd grade. Entwistle et al (2005, as cited in Duncan et al, 2007) could predict adult educational attainment better with first-grade ratings of being cheerful and outgoing than with preschool or first-grade achievement scores.

But Duncan et al's landmark study in 2007 showed that there was little to no statistically significant prediction of later achievement for socio-emotional behaviors such as social skills and internalizing/externalizing behaviors. Grimm et al (2010), using a different approach but the same data, generally supported this finding, but noted that problems with social skills were related to significantly lower concurrent levels of math ability, and internalizing behaviors showed small to moderate associations with concurrent math and reading ability. Hooper et al (2010), Grissmer et al (2010), and to some extent, Hamre and Pianta (2001) also agree with the Duncan study's major findings that behavioral factors (both teacher-rated and otherwise) such as internalizing/externalizing and social skills have little effect on later achievement.

A different but related measure of behavior, deemed "school engagement," has been developed and assessed in a few studies. Ladd and Dinella (2009) found that a student's level of cooperative participation and "acceptance of the student role" in school was the strongest predictor of later achievement in 8th grade, with levels of school liking also strongly associated with both levels of cooperative participation and student achievement. Students with the highest levels of behavioral ("cooperative") and emotional ("approachers") engagement with school showed the highest levels of reading achievement by 8th grade. Luo et al (2009) found similar results in a sample of at-risk youth, with students classified in first grade as "cooperative" and/or "enthusiastic" scoring higher and growing faster by 4th grade reading scores than those labeled as "disaffected" and "resistive." They also found a large amount of concurrence between children's behavioral (cooperative-resistive) and psychological/emotional (enthusiastic-disaffected) relationship to school, which seems to indicate that increasing students' behavioral engagement in school early on could lead to increases in school liking.

What is known in the literature as "learning related skills" (including behaviors like self-control, staying on task, organizing work materials, working independently, listening attentively, and participating appropriately in groups) have been shown in multiple studies to predict later reading achievement. McClelland, Acock, & Morrison (2006) found "remarkable consistency" in this relationship from kindergarten through 6th grade, even after controlling for such historically robust predictors of achievement like child IQ, ethnicity, and maternal education level (p. 482). Matthews et al (2010) found learning related skills to be the most significant predictor, ahead of home environment and SES, in reading achievement. Perhaps even more important, students who score low on learning related skills in

kindergarten never catch up to their peers, with the gap in reading and math achievement widening over time (McClelland, Acock, & Morrison, 2006).

Similar findings in other studies show a strong link between attention skills (task persistence and self-regulation) and later achievement, independent of initial cognitive ability, prior reading ability and vocabulary level (Grimm et al, 2010; Grissmer et al, 2010; Duncan et al, 2007), although others have not found such correlations (Hooper et al., 2010).

## **Math Achievement**

### *Cognitive and Early Skill Predictors of Math Achievement:*

Bull, Espy & Wiebe (2008) found that the most important predictor of later math achievement by Grade 3 were visual-spatial short-term memory span, followed by less significant contributions made by verbal short-term memory and working memory (repeating back a series of numbers in identical, then reverse, order of what was spoken by experimenter), inhibition (only verbally identifying characters in a story who met a certain condition), and planning and monitoring (recreating a shape with balls on pegs in the smallest amount of moves after being told ahead of time the least amount of moves necessary).

Just like in reading, "learning related skills" (including behaviors like self-control, staying on task, organizing work materials, working independently, listening attentively, and participating appropriately in groups) have been shown in multiple studies to predict later math achievement (McClelland, Acock, & Morrison, 2006; Matthews et al, 2010;)

Hooper et al (2010) found that expressive language skills (gesture, vocal development, and social communication) were positively related to later math achievement for both Caucasian and African American children.

Early math skills are, not surprisingly, positively related to later math skills (Grissmer et al, 2010; Hooper et al, 2010), with knowledge of numbers and ordinality coming out on top as the most important predictor of later math achievement in at least one comprehensive study of six large data samples (Duncan et al, 2007). Jordan et al (2009) found similar results in a longitudinal study from kindergarten to third grade with their more complex measure of "number competence," which included items measuring "counting, number recognition, number comparisons, nonverbal calculation, story problems, and number combinations" (p. 852).

Fine motor skills have been found to be a "very strong and consistent predictor" of later achievement by Grissmer et al (2010). They also found that early declarative knowledge of the external world, along with early math skills, was a significant predictor of later math achievement.

### *Behavioral Predictors of Math Achievement:*

Much like in reading, more sociable or extroverted children (both by teacher ratings and other scale measures) at age 4 and 5 tend to have higher adolescent math outcomes (Burchinal et al, 2002; Magnuson, Duncan, & Kalil, 2006; McClelland, Acock, & Morrison, 2006).

Ladd and Dinella (2009) found that a student's level of cooperative participation and "acceptance of the student role" in school was the strongest predictor of later math achievement in 8th grade, with levels of school liking also strongly associated with both levels of cooperative participation and student achievement. Students with the highest levels of behavioral ("cooperative") and emotional ("approachers") engagement with school showed the highest levels of math achievement by 8th grade. Luo et al (2009) found similar results in a sample of at-risk youth, with students classified in first grade as

"cooperative" and/or "enthusiastic" scoring higher and growing faster by 4th grade in math scores than those labeled as "disaffected" and "resistive."

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### **Family and Environmental Predictors:**

There are mixed opinions about the effects of family structure and other background variables on later achievement. Burnett & Farkas (2009) claim that poverty may indeed affect younger children, but not adolescents. They also found that although it seems that poverty and family structure are factors related to lower achievement in math and reading than is predicted, once fixed factors related to the low-income experience are controlled for, this effect virtually disappears. This is consistent with other studies (Smith et al, 1997; Duncan et al, 1998, as cited in Burnett & Farkas, 2009), but contradicts another (Guo, 1998, as cited in Burnett & Farkas, 2009). Chatterji (2006) similarly concludes that it's much more about what happens once students are enrolled in school than what they bring from their background:

"...the proportion of reading variance explained by children's sociodemographic factors was relatively high with kindergarten entry as the reading outcome (56%). However, it dropped when end-of-kindergarten outcomes were used as the dependent variable (32%). With end-of-first grade reading outcomes, the explanatory power of these background variables dropped remarkably to just about 5%." p. 498

Burchinal et al (2002) found that maternal education level and parents' caregiving practices and attitudes were the strongest predictors of later achievement in both reading and math. Gregory and Rimm-Kaufman (2008) found similar results, noting that higher maternal education led to higher GPA by 9th grade and that supportive, respectful, encouraging, responsive, and "appropriately interdependent" mother-child interactions during problem-solving tasks increased the likelihood of graduation 12 years later, regardless of race/ethnicity, gender, SES, or IQ. Gutman, Sameroff, and Cole (2003) also showed that maternal education, level of rigidity in a mother's beliefs about her child's development, and whether or not a head of household was in an unskilled occupation were the three most important factors affecting GPA from grades 1 through 12. They also found that social risk factors such as these neutralized the effect of child IQ and child mental health on achievement, meaning that no matter what level of intelligence or mental health status high-social-risk students entered kindergarten with, their grades still suffered throughout their time in school due to these external factors. There also seems to be a timing issue with mothers' levels of education. Magnuson (2007) found that for children of lower-educated mothers, if the mothers went back to school early in their child's life (between ages 6-8 in this study), there were positive benefits to child math and reading outcomes, but not if the mother sought additional education later. But he does add that increasing maternal education also led to an increase in the quality of the home environment, which was found to be a mediating influence on child achievement.

Jimerson, Egeland, and Teo (1999) found in a sample of at-risk children that parent involvement in a child's education in first grade led to math scores above predicted levels in sixth grade and a more "stimulating, organized, and supportive" home environment led to increases in both math and reading scores (p. 120). Interestingly, however, the absence of these factors in children's lives did not lead to scores below expected levels. A similar study showed that the quality of the home environment and early caregiving prior to school entry are the most significant predictors of dropping out by age 19 (Jimerson, Egeland, & Stroufe, 2000). Another major finding was that "only achievement in sixth grade significantly

contributed to the prediction of dropping out when the early family and home variables (were) entered" (p. 539).

In a meta-analysis of literature on parental expectations for academic success, Yamamoto and Holloway (2010) found in 8 out of 21 studies that parental expectations had a positive effect on achievement, but differed widely across race and ethnicity, with the strongest link evident for European-American families. There was also a strong relationship between parent expectations and the child's own expectations, but this once again was strongest for European-Americans. The four processes that came out of the literature through which parental expectations influence child achievement are that they a) raise motivation, b) instill stronger beliefs within a child of his/her competency, c) lead to greater parent involvement in the child's education, and d) increase teacher expectations.

An interesting study by Dupere et al (2010) examined the influence of a child's neighborhood context and found that for children in less economically advantaged neighborhoods there was a strong link between the presence of educated, affluent professionals in the neighborhood and achievement. They did, however, find that this advantage leveled off by the early to mid-teen years to a moderate level. Regardless, for neighborhoods on the lower end of the spectrum in terms of economic and social advantage, the effect sizes on achievement were as powerful as other commonly recognized factors such as maternal education and family income (p. 1239).

There is some literature to support the benefits of physical activity on achievement. One study showed that while participation in physical education classes at school neither improves nor impairs math and reading achievement in elementary school children (K-5), other physical activity has a positive influence, even after controlling for prior academic achievement (Stevens et al, 2008). In this study, physical activity was measured by parent assessments and was defined as aerobic exercise of at least 20 minutes and/or sports participation not associated with physical education class. But SES in this study accounted for up to 27% of reported physical activity, so this seems to also be an issue of class rather than simple family and student choices.

### **School Factors:**

There is some evidence of teacher influence on achievement. One study showed that teacher-reported closeness with children whose parents reported less progressive parenting practices (characterized by teaching conformity to rules, respect for adults, and limited focus on encouraging curiosity) resulted in positive gains in reading scores over time (Burchinal et al, 2002). Another study showed that a child in kindergarten who had a relationship with a teacher marked by conflict and dependency (labeled "relational negativity") had lower levels of achievement through 8th grade, although this was most significant for children with concurrent behavior problems (Hamre & Pianta, 2001). The study showed that higher levels of dependency for boys in kindergarten led to higher levels of behavior problems in early elementary and middle school, while not for girls. It should be noted, however, that this study had a fairly small sample size of 179 children.

Han (2008) conducted a comprehensive study of children of immigrants and found that children of Latin American descent (especially Mexico) closed reading and math gaps between kindergarten and third grade in relation to their Caucasian peers as a result mainly of school factors such as level of school safety, school climate, and school resources.

The question of full-day vs. half-day kindergarten has received some attention in the literature, and the consensus seems to be that full-day kindergarten does lead to academic benefits, but these quickly fade by around third grade, although this has much to do with family, home environment, and SES-related

factors (Votruba-Drzal, Li-Grining, & Maldonado-Carreño, 2008). More research is necessary to isolate whether there is any actual benefit that is unaffected by environmental factors.

Finally, studies overwhelmingly illustrate that retaining a student in the early elementary grades only leads to short-term achievement gains relative to matched and promoted peers (Silberglitt et al, 2006; Jimerson, 2001, as cited in Silberglitt et al, 2006) and that these gains often fade as early as 8th grade.

### **Summary:**

Taken as a whole, the literature suggests that for both reading and math achievement, early language and number skills, verbal and spatial working memory, and attention/"learning related" skills are the key cognitive predictors of later achievement, and that little seems to be able to be done at a school and classroom level to close gaps in achievement across children with varying levels of these skills.

At home, students who experience progressive, supportive parenting practices, quality early caregiving, and are given consistent, appropriate, and encouraging expectations for their achievement tend to succeed.

Finally, students who enjoy school, are outgoing and cheerful, stay physically active, and have strong, positive relationships with teachers marked by appropriate interdependence also seem to do well.

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