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Maternal Education and Children's Academic Achievement During Middle Childhood

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Despite much evidence that links mothers' educational attainment to children's academic outcomes, studies have not established whether increases in mothers' education will improve their children's academic achievement. Using data from the National Longitudinal Survey of Youth on children between the ages of 6 and 12, this study examined whether increases in mothers' educational attainment are associated with changes in children's academic achievement and the quality of their home environments. Results suggest that children of young mothers with low levels of education perform better on tests of academic skills and have higher quality home environments when their mothers complete additional schooling, whereas increased maternal education does not predict improvements in the achievement or home environments of children with older and more highly educated mothers. The estimated effects of additional maternal schooling for children of these younger mothers appear to be more pronounced for children's reading than math skills.

Keywords: maternal education, child achievement, teen parents

Family characteristics, such as socioeconomic status and parental education, are important predictors of children's school success. Disadvantaged students enter school already academically far behind and continue to perform less well than their more advantaged peers (Entwisle & Alexander, 1993; Lee & Burkam, 2002; Stipek & Ryan, 1997). Programs to improve achievement typically intervene directly with children at risk of school failure, for example, by providing enriching preschool experiences or compensatory instruction. However, another potential route of intervention targets parents' socioeconomic resources. Recent research has considered the benefits that accrue to children from increases in their parents' employment and income (Clark-Kauffman, Duncan, & Morris, 2004; Dearing, McCartney, & Taylor, 2001). Less attention, however, has been given to understanding how raising parental education may improve children's academic outcomes (Magnuson & Duncan, 2004).

Positive correlations between mothers' educational attainment and children's test scores, academic outcomes, and cognitive development are among the most replicated results from developmental studies (Davis-Kean, 2005; Haveman & Wolfe, 1995; Sirin, 2005) although more contested in economic studies (Behrman & Rosenzweig, 2002; Black, Devereux, & Salvanes, 2003; Oreopaulos, Page, & Stevens, 2006). Yet most developmental studies consider mothers' education as a fixed characteristic, and thus measure it at only one time. Consequently, despite accumulated evidence linking mothers' educational attainment to children's academic outcomes, research has not established whether increases in maternal education that occur after the birth of her children will improve their academic outcomes.

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Understanding the effects of changes in mothers' education during childhood is important because research suggests that educational credentials are increasingly acquired in a discontinuous fashion, with education accumulating over several distinct spells of schooling (Astone, Schoen, Ensminger, & Rothert, 2000). A substantial proportion of mothers, particularly economically disadvantaged young mothers, now continue to pursue education well after the birth of their children (Astone et al., 2000; Rich & Kim, 1999). For example, studies of disadvantaged families find that about 50% of mothers with young children participate in some type of educational activity (Love et al., 2002; McGroder, Zaslow, Moore, & LeMenestrel, 2000).

This article considers whether increases in mothers' completed schooling are associated with improvements in their children's reading and math achievement and whether children of young, less-educated mothers benefit more from their mothers' completion of additional schooling than children of older and more highly educated mothers. These research questions follow from ecological and life course theories that argue that changes in parents' socioeconomic circumstances affect children because they shape children's proximal environments and their interactions with these environments (Bronfenbrenner, 1986; Elder, 1994). Theories of academic socialization provide a framework to understand how changes in socioeconomic standing, and particularly mothers' schooling, may shape their children's achievement (Eccles, 1992; Taylor, Clayton, & Rowley, 2004).

Life course theory's idea of "linked lives" emphasizes the interconnection between the experiences of parents and their children and argues that proximal environments and interactions that facilitate the intergenerational transmission of achievement and behavior patterns are dynamic and changeable (Elder, 1994; Macmillan, McMorris, & Kruttschnitt, 2004). To date, studies have primarily focused on links between changes in parents' economic resources and children's outcomes (e.g., Macmillan, McMorris, &

Kruttschnitt, 2004). Just as changes in a family's financial resources predict changes in children's well-being, so too might changes in their parents' education (Bornstein, Hahn, Suwalsky, & Haynes, 2003; Furstenberg, Brooks-Gunn, & Morgan, 1987).

Academic socialization is a term used to refer to the set of processes by which parents shape children's behaviors, beliefs, skills, and attitudes to promote successful school experiences (Taylor, Clayton, & Rowley, 2004). Parents' socioeconomic status (SES) and school experiences are identified as important influences on children's achievement because each influences parents' cognitions, including their beliefs and values, about their children's school achievement and the opportunities it provides (Davis-Kean, 2005; Eccles, 1992; Kaplan, Liu, & Kaplan, 2004; Taylor, Clayton, & Rowley, 2004). For example, parents with higher levels of education are likely to value education more and have higher expectations of their children's achievement than other parents (Davis-Kean, 2005; Halle, Kurtz-Costes, & Mahoney, 1997; Kaplan, Liu, & Kaplan, 2004). Parents' values and expectations as well as their own academic abilities, in turn, are thought to shape children's home learning environments and thereby foster children's own academic interests, beliefs, and skills (Davis-Kean, 2005; Eccles, 1992; Taylor, Clayton, & Rowley, 2004).

On average, more highly educated parents provide more stimulating learning environments in several key ways (Davis-Kean, 2005). Mothers with higher levels of education typically create enriching language and literacy environments by exposing children to complex language and vocabulary, bringing books and print material into their homes, engaging children in learning activities such as reading, and seeking out structured learning opportunities (Davis-Kean, 2005; Hart & Risley, 1995; Hoff-Ginsberg & Tardiff, 1995; Kohl, Lengua, & McMahon, 2000). In addition, often more highly educated mothers are skilled at using communication and teaching styles that foster independent thinking and problem solving (Harris, Terrel, & Allen, 1999; Laosa, 1980). Finally, another important dimension of the home environment that may be influenced by parents' education is their involvement in their children's schooling and support of school-related activities at home (Fan & Chen, 2001; Hill et al., 2004; Stevenson & Baker, 1987).

Taken together, these theories suggest that improvements in maternal education may lead to improvements in academic socialization strategies and children's achievement. Such positive effects, however, are only likely to occur if additional education affects parents' socialization strategies or perhaps improves parents' socioeconomic standing. Consequently, it is likely that completing additional education will have larger benefits for the children of mothers who have lower levels of education, do not already have positive views about schooling, or do not engage in successful academic socialization strategies. Improvements in maternal education may be particularly consequential during early and middle childhood, when children's own achievement-related skills, interests, and beliefs are still forming (Eccles, 1992).

Although increases in maternal education may improve academic socialization among all children, those born to adolescent mothers may benefit more than other children from improvements in their mothers' schooling. There is considerable heterogeneity in the achievement of children of adolescent mothers, yet on average these children's academic skills lag behind their peers (Coley & Chase-Lansdale, 1998). Because low educational aspirations and academic aptitude as well as negative interactions with teachers predict early childbearing (Driscoll, Sugland, Manlove, & Papillo, 2005; Manlove, 1998), it is not surprising that on average adolescent mothers are less likely to create home environments that support their children's academic success (Coley & Chase-Lansdale, 1998; Luster, Bates, Fitzgerald, Vandenbelt, & Key, 2000; Vandenbelt, Luster, & Bates, 2001). Viewed through the lens of academic socialization theory, young mothers' typically low levels of education and negative school experiences may result in less successful academic socialization and lower levels of child achievement.

Mothers' educational attainment and their cognitions about school, however, may change if they return to school (or persist in school). Again, changes may be most pronounced among young mothers. A recent qualitative study of young mothers participating in an educational program indicated that these mothers' orientation to schooling changed over time (Zachry, 2005). Whereas before adolescent mothers saw little point in attending school, after having a child and returning to school, they believed education was critical to their future success. These findings suggest that completing additional school may not only improve mothers' skills but also change young mothers' beliefs about achievement, which may, in turn, improve their parenting practices and children's outcomes (Luster et al., 2000).

The transformative potential of additional maternal schooling on children's lives was suggested by Furstenberg, Brooks-Gunn, and Morgan's (1987) research with poor urban adolescent mothers. More than half of their sample of teen mothers returned to school at some point after the birth of their children, and a substantial proportion of these mothers completed several additional years of education. Furstenberg and colleagues noted that there was considerable heterogeneity in the children's outcomes and found that mothers' completion of additional schooling or perseverance in school (after the birth of a child) was linked to positive outcomes among their adolescents, including higher levels of educational attainment. Their study, however, did not attempt to isolate further education per se as the cause of positive outcomes.

Identifying causal associations between mothers' educational attainment and children's outcomes is difficult because mothers who have higher levels of educational attainment or return to school are likely to differ from mothers who do not. Mothers who continue in their schooling after the birth of their children are more likely to have higher levels of academic achievement and aspirations, fewer stressful life events, better mental health, and more social support than mothers who do not obtain additional education (Brooks-Gunn, Guo, & Furstenberg, 1993; Felmlee, 1988; Leadbeater, 1996; Way & Leadbeater, 1999). These characteristics, rather than the mothers' schooling, may explain why children whose mothers return to school may fare better than other children.

In theory, experimental studies offer the best way to directly test whether increases in maternal education boosts children's development, as random assignment assures that the mothers differ only in their educational attainment. To date, two programs have been designed to increase teen mothers' education, New Chance (Quint, Bos, & Polit, 1997) and the Teen Parent Demonstration (Kisker, Rangarajan, & Boller, 1998), and a third, the National Evaluation of Welfare-to-Work Strategies (NEWWS), has been designed to promote education among welfare recipients of all ages, many of

whom were teen mothers (McGroder, Zaslow, Moore, & LeMenestrel, 2000). Unfortunately, none of these programs were successful in substantially increasing mothers' education beyond the relatively high rates of educational participation in the control group. Consequently, it is not surprising that differences in children's cognitive development and achievement were not detected.

Further analysis of the NEWWS data suggests that improvements in preschooler's school readiness was linked to their mothers' educational participation and that improvements in their home learning environments might explain this association (Magnuson, 2003). An increase of about 1 year of school predicted an increase of about 0.25 of a standard deviation in children's academic school readiness and 0.15 of a standard deviation in the quality of home learning environments.

The current study provides the first consideration of whether increases in mothers' education predict improvements in their children's academic achievement during middle childhood. In doing so, it provides a better understanding of the extent to which maternal education may shape children's learning and shifts in mothers' educational pathways may be linked to the development of their children. This study tests three hypotheses:

Hypothesis 1: Increases in maternal education improve children's reading and math achievement trajectories.

Because maternal education shapes mothers' life courses and academic socialization strategies, improvements in maternal education are expected to be positively associated with children's reading and math trajectories during middle childhood. This study focuses on changes in achievement, because it is expected that academic skills of children whose mothers' education increases will not differ before their mothers complete additional schooling. Thus, increases in maternal education are expected to predict concurrent changes in achievement, rather than initial levels of achievement or prior changes in achievement. Associations between increased maternal education and both math and reading are expected to be similar because levels of maternal education have been found to predict both skills sets (Sirin, 2005), and math and reading trajectories display common patterns (Kowaleski-Jones & Duncan, 1999).

Hypothesis 2: The estimated effects of increases in maternal education are larger for children born to young mothers with low levels of educational achievement than for older or more highly educated mothers.

Young mothers are particularly likely to have low levels of achievement, to be of a lower SES, and to be less able to support their children's achievement. As described earlier, these characterizations may lead young educationally disadvantaged mothers to provide their children with lower quality home environments, which in turn may contribute to their children's lower levels of academic achievement. For this reason, it is expected that improvements in their education will have larger associations with children's reading and math skills, as their home environments may be more likely to be improved by their mothers' schooling or they may have more to gain from such improvements.

In testing these hypotheses, particular attention is given to the specific timing of associations between increases in maternal education and changes in children's achievement during middle childhood (6–12 years old). This focus serves two functions. First, it enables an exploratory analysis of whether the estimated effects of increased maternal education differ by child age. Levels of maternal educational attainment have been associated with higher levels of children's achievement across middle childhood and adolescence (Haveman & Wolfe, 1995). Prior research, however, has not considered whether increases in maternal education are associated with changes in achievement during middle childhood, and thus, it is not clear whether associations should be expected to differ across middle childhood. Second, as noted above, it enables an exploration of whether prior differences in children's achievement may explain links between mothers' increased schooling and children's achievement.

Hypothesis 3: Increases in maternal education improve the quality of children's home environments.

Prior research and theory suggest that the quality of the home environment is one of the key processes by which mothers' education affects children. If improvements in maternal education are associated with improvements in children's achievement, then improvements in the quality of children's home environments may be a likely explanation for these associations. Finding that improvements in maternal education are linked to improvements in children's home environments, however, does not identify the quality of the home environment as the intervening process, nor rule out other possible processes as explanations. An alternative explanation, that increases in maternal education bring about improvements in family income, which in turn mediate effects of mothers' education on children, is also considered. Nevertheless, both of these analyses are intended to be exploratory.

Method

Sample

Data for this study comes from the maternal and child supplement to the National Longitudinal Survey of Youth (NLSY), a longitudinal panel study run by the Bureau of Labor Statistics. In 1979 a national cohort of 12,686 young men and women between the ages of 14–21 were selected to participate in annual interviews about training, employment, and fertility. In 1986 a maternal and child supplement was added to the panel study, in which female participants were asked questions about their children every 2 years and child assessments were administered. Data used in this study are taken from the 1986–2004 supplements (Center for Human Resource Research, 2004**)**, and rates of retention have remained close to 90%.

For the present study, the full sample consists of some 1,748 children who were born to mothers less than 26 years old. Restricting the sample to children born to mothers 25 years old or younger provides some homogeneity to the sample with respect to mothers' age; however, removing this restriction does not change reported results. Although national in scope, the sample in this study is not nationally representative. About 80% of the sample has siblings who are also in the sample. Restricting the sample to one randomly selected child in each family (about 60%) of the full sample yields results similar to those reported for the full sample, which includes all siblings.

Table 1
Descriptive Statistics for Sample Characteristics at Age 6

Variable	Full sample (N = 1,748)			Young mothers (n = 425)			Older mothers (n = 1,323)		
	M	*SD*	%	*M*	*SD*	%	*M*	*SD*	%
Mother's academic aptitude (AFQT percentile)[a]	31.01	24.98		18.21	12.91		35.12	26.49	
Maternal educational attainment[a]	12.08	1.80		11.19	1.37		12.37	1.82	
Age of mother at child's birth (years)[a]	21.66	2.38		18.69	1.32		22.61	1.78	
Mother's hours worked per year[a]	1010	965		889	902		1045	98	
Number of children in household	2.42	1.10		2.20	1.05		2.50	1.10	
Number of adults in household	1.95	0.81		1.92	1.04		1.93	0.75	
Average income-to-needs ratio from birth to age 6[a]	1.88	1.18		1.38	0.85		2.04	1.23	
Birth order of child[a]	1.71	0.90		1.36	0.62		1.83	0.94	
Self-esteem[a]	3.17	0.38		3.09	0.04		3.20	0.39	
Mother's expected educational attainment[a]	13.24	2.13		12.55	1.92		13.46	2.14	
Mother's desired educational attainment[a]	13.94	2.13		13.37	2.04		14.12	2.13	
Spouse's educational attainment[a]	12.25	2.28		11.50	2.12		12.43	2.28	
Grandmother's educational attainment[a]	9.97	3.20		9.21	3.02		10.21	3.22	
Grandfather's educational attainment[a]	9.79	3.83		8.72	3.72		10.09	3.81	
Hispanic			23			24			22
Black[a]			37			46			32
Mother resided with two biological parents at age 14[a]			62			65			52
Urban residency[a]			76			72			77
Father present in the household[a]			54			41			58
Boy			51			53			49
Missing urban residence[a]			2			4			3
Missing father in the household			2			2			2
Missing hours worked			2			1			2
Missing number of children in household[a]			0			0			0
Missing number of adults in household			1			1			0
Missing household income-to-needs ratio[a]			11			12			10
Missing grandmother education			7			7			6
Missing grandfather education			17			26			14
Missing spouse education			35			48			31
Missing self-esteem			2			2			2

Notes. *T* tests were used to test for differences in continuous measures and chi-square tests for categorical variables. The Armed Forces Qualifying Test (AFQT) is a measure of mothers' academic aptitude. All measures of educational attainment are scaled in years. Young mothers were 20 years old or younger when their children were born, had a high school degree or less education when the child was age 6, and scored below the 50th percentile on the AFQT. Older mothers were either older than 20 when the child was born, had completed at least some college when the child was age 6, or had scored above the 50th percentile on the AFQT test.
[a] The difference between younger, less-educated mothers and older mothers is statistically significant, $p < .05$.

The main reason children were excluded from the sample was missing data on one or more of the achievement tests between ages 5 and 12 (n = 855). The NLSY reports that the primary reason for missing data on these assessments was interviewers inadvertently skipping eligible children and incorrectly administering the assessments (Baker, Keck, Mott, & Quilan, 1993). Children were also excluded for the following reasons: they did not reside with their mother (n = 280), and data was missing on mothers' academic aptitude (n = 140) or mothers' educational attainment (n = 225).

Children excluded from the sample differed from included children. On average, they had slightly lower reading comprehension and math scores, and their mothers as well as their mothers' spouses had lower levels of education. Characteristics of the final sample of children and mothers are presented in Table 1.

The subsample of children of less-educated, young mothers is about a quarter of the full sample (n = 425). Mothers of these children were 20 years old or younger when their children were born, had a high school degree or less education when the child was age 6, and had scored below the 50th percentile on the Armed Forces Qualifying Test (AFQT), a test of the academic aptitude.[1] Mothers' educational attainment and academic aptitude were used to identify "low-educated" mothers because both are important indicators of mothers' education and academic achievement. The subsample of older, more-educated mothers thus includes mothers who were either older than 20, had completed at least some college, or had scored above the 50th percentile on the AFQT.

By creation, the resulting subgroup of children of young, low-educated mothers is characterized primarily by their mothers' age because many young mothers had completed high school when their child was 6 years old (60%), whereas few had completed any college (15%) or had scored above the 50th percent on the AFQT assessment (10%). Consequently, about 80% of children born to young mothers were coded in the young, low-education mother category, which is referred to as the "young mother" sample. In

[1] Restricting this subgroup to mothers who were either younger than 20 years old (n = 300) or 19 years old (n = 181) results in a similar pattern of findings as presented in Table 5; however, the smaller sample sizes decrease the statistical power and thus increase standard errors slightly.

comparison, about 40% of older and more educated mothers had attended at least 1 year of college when their child was 6 years old and 30% scored above the 50th percentile on the AFQT.

There are some expected differences between the characteristics of young, less-educated mothers and other mothers, indicating that their children are more generally disadvantaged. Compared with more highly educated mothers, young mothers with low levels of education had lower family income-to-needs ratios, were employed for fewer hours per year, and were less likely to be living with the child's father (see Table 1).

Measures

Reading and math achievement. Three measures of children's academic achievement were used as outcomes: the Peabody Individual Achievement Tests (PIATs) for Math, Reading Recognition, and Reading Comprehension (Dunn & Markwardt, 1970). When first assessed, children were between 5 and 7 years old (on average 6 years old); subsequent assessments were completed 2 (8 years old), 4 (10 years old) and 6 years (12 years old) later.

The reading recognition test consists of 84 items that assess children's oral reading skills such as word recognition and pronunciation ability. The reading comprehension scale consists of 64 items that measure children's practical reading ability. Only children who answered more than 19 questions correct on the reading recognition test were given the reading comprehension test. Children who scored less than 20 were assigned their reading recognition score as a reading comprehension score. At age 6 about 86% of children answered fewer than 20 reading recognition questions correctly, but by age 8 this had declined to 12%, and it was less than 2% for older children. The math subscale consists of 84 multiple-choice items created to measure mathematic concepts taught in mainstream classrooms. For all three measures, age-standardized scores were created from raw scores (number of correct answers provided) using 3-month age-increments and all available observations in the NLSY. The standardized scores have a full sample mean of 0 and standard deviation of 1. Children's average ages, as well as the means and standard deviations for each of the PIAT measures are presented in Table 2.

Standardized scores on the three PIAT tests are highly correlated. As expected, the correlation between the two reading tests ($r = .80$, $p < .01$, results not shown) is somewhat higher than the correlation between the reading and the math subtests ($r = .55$ for reading comprehension and .56 for reading recognition, $p < .01$, results not shown). The tests have adequate test–retest reliability across middle childhood (.81–.94 for reading recognition; .61–.78 for reading comprehension; .52–.74 for math). Additional details about the test content, validity, and reliability are found in Dunn and Markwardt (1970).

Home environment. The quality of children's home environment was assessed by the total scores on the Home Observation for the Measurement of the Environment–Short Form (HOME-SF; Baker et al., 1993). This measure uses observer ratings and maternal reports to assess multiple dimensions of the caregiving environment that are linked to children's learning and development. Items are scored dichotomously to denote the presence of a supportive environment, and then summed. The total HOME-SF is comprised of emotional support and cognitive stimulation subscales. The emotional support scale includes items such as whether

Table 2
Mean of Children's Age, Quality of the Home Environment, Reading Recognition, Reading Comprehension, and Math Test Scores

Sample and variable	*M*, age 6	*M*, age 8	*M*, age 10	*M*, age 12
Full sample ($N = 1{,}748$)				
Child's age	5.97	8.04	10.01	11.97
PIAT reading recognition	−0.04	−0.05	−0.04	−0.01
PIAT reading comprehension	0.00	−0.06	−0.03	−0.02
PIAT math	−0.05	−0.08	−0.11	−0.05
Home environment (HOME-SF)	−0.16	−0.13	−0.10	−0.04
Household income-to-needs ratio	2.06	2.08	2.19	2.36
Children of young, low-educated mothers ($n = 425$)				
Child's age	6.02	8.23	10.22	12.17
PIAT reading recognition	−0.13	−0.21	−0.19	−0.19
PIAT reading comprehension	−0.10	−0.25	−0.19	−0.20
PIAT math	−0.22	−0.29	−0.34	−0.24
Home environment (HOME-SF)	−0.51	−0.51	−0.36	−0.32
Household income-to-needs ratio	1.54	1.61	1.67	1.84
Children of older and more educated mothers ($n = 1{,}323$)				
Child's age	5.94	7.98	9.94	11.90
PIAT reading recognition	−0.01	0.01	0.01	0.05
PIAT reading comprehension	0.03	0.01	0.02	0.03
PIAT math	0.00	−0.01	−0.04	0.01
Home environment (HOME-SF)	−0.04	−0.01	−0.02	0.05
Household income-to-needs ratio	2.22	2.23	2.35	2.52

Note. The full sample standard deviations for achievement and the Home Observation for the Measurement of the Environment–Short Form (HOME-SF) measures are approximately 1. Standard deviations for income-to-needs ratio are 1.4 to 1.6 for the full sample and older mothers and 1.1 to 1.3 for young mothers. Young mothers were 20 years old or younger when their children were born, had a high school degree or less education when the child was age 6, and scored below the 50th percentile on the Armed Forces Qualifying Test (AFQT). Older mothers were either older than 20 when the child was born, had completed at least some college when the child was age 6, or had scored above the 50th percentile on the AFQT. Sample sizes for income-to-needs ratios and the home environment are reduced due to missing data. PIAT = Peabody Individual Achievement Test.

the mother encouraged the child to speak during the interview and information about how the child is disciplined. The cognitive stimulation scale includes measures such as the number of books in the home, whether the child is encouraged to pursue hobbies, and whether the family receives a newspaper.

The number of items and questions in the HOME-SF differ slightly according to children's ages (separate scales for children under age 3, 3–5, 6–10, 10 and older; Baker et al., 1993). Consequently, the raw scores have been age-standardized based on 3-month age increments and all available observations in the NLSY (mean of 0 and standard deviation of 1). This age standardization facilitates the comparison of the measure across middle childhood and presents associations as effect sizes. The HOME-SF has been used extensively in previous research and demonstrates adequate reliability and validity, particularly during middle childhood (Cronbach's $\alpha = .68–.73$; for additional details see Baker et al., 1993; Mott, 2004). Means for the HOME-SF are provided in Table 2. The sample size for analyses of the HOME-SF is reduced slightly due to missing data ($n = 1{,}553$).

Family income. Data on mothers' family income was collected annually until 1994 and biennially thereafter. As a consequence, through 1994, information is available on income during the year of the child assessment, but after 1994, income in the year prior to the assessment is available. To make measures comparable overtime, incomes were converted into 2004 dollars using the inflation figures from the Consumer Price Index. Next, to create the family income-to-needs ratio, incomes were divided by the 2004 federal poverty thresholds for families of a specified size. Means for the resulting ratios are presented in Table 2. Unfortunately, rates of missing data for family income range between 14–16% each year. Consequently, the sample for analyses in which income-to-needs is the dependent variable is reduced to only 1,027 children, about 60% of the full sample.

Maternal education. During each annual interview mothers were asked the highest year of education that they had completed. Response values ranged from 8 to 25 corresponding to grade levels. For example, a value of 12 corresponded with having completed high school or a high school equivalency degree. Responses contained obvious measurement error in that some mothers' educational attainment decreased over time. The NLSY handled these and other problems by creating a set of revised educational attainment variables. If inconsistencies could not be reconciled based on mothers' full educational history, variables were coded as missing. These revised attainment measures are used in this study.

In analyses, children's initial levels of academic achievement were predicted by the number of years of education that mothers had completed. Changes in children's achievement were predicted by an increase in the number of years of additional schooling that mothers reported having completed in consecutive interviews. For example, a mother who had a high school degree (12 years) when her child was 6 years old and reported having completed 1 year of college when her child was 8 years old (13 years) would be coded as having a 1-year increase in education. Years of education completed, rather than degrees completed, was chosen to be the key independent variable because many mothers who finished an additional year or two of education did not complete a degree. Yet such schooling, even in the absence of a new degree, may have consequences for mothers' parenting and children's achievement (Magnuson, 2003).

About 8% of mothers' responses indicated that they had completed 3 or more years of school over a 2-year interval (in most cases a change from 9 to 12 years of school due to the completion of a High School General Equivalency Degree [GED]). Because it is uncertain how many years of school such a change represents, these values were recoded to 2 years. Whether such increments actually reflect 2 years of schooling is unclear. However, such measurement error will likely attenuate associations, leading to results that may understate associations between children's achievement and increases in mothers' completed schooling. Years of completed additional schooling were measured in 1-year increments and ranged from zero to 2, with the sample means for the full sample ranging from .07 to .10 across time (see Table 3).

Mothers were asked additional questions about their educational activities, such as whether they had obtained a high school degree or a GED as well as whether they attended a college or university.

Table 3
Means and Standard Deviations of Family Characteristics at Age 6, Changes in Family Characteristics, and Missing Data, Full Sample (N = 1,748)

	Age 6		Change, ages 6–8[a]			Change, ages 8–10[a]			Change, ages 10–12[a]		
Family characteristic	*M*	%	*M*	*SD*	%	*M*	*SD*	%	*M*	*SD*	%
Additional years of completed schooling	12.04		.09	.29		.08	.34		.06	.29	
Number of children in household	2.46		.19	.52		.09	.49		.05	.43	
Mother's hours worked per year	994		111	837		127	851		110	891	
Number of adults in household	1.88		−.03	−.75		−.02	−.70		.00	.64	
Urban residence		76			−1			−1			−1
Father in household		53			−2			−3			−2
Missing data[b]											
Missing urban residence		3			3			2			1
Missing number of children in household		2			4			4			2
Missing father in household		1			1			1			0
Missing mother's hours worked		2			3			2			4
Missing number of adults in household		3			6			5			4

[a] Values for family characteristics ages 6–8, 8–10, and 10–12 reflect changes in measures over the specified time periods. [b] Values for the missing data do not reflect changes but levels of missing data for the change measures.

Although responses are missing for 13% of mothers who completed additional education, these data are used to describe mothers' school experiences.

Covariates. Measures of maternal and child characteristics were included in analyses as covariates to isolate the estimated effects of increased maternal education from potential confounding factors that may bias estimates. Descriptive statistics for these variables are presented in Table 1.

Measured at age 6, the following continuous variables were used to predict children's age 6 test scores and home environment (intercept): the mother's yearly work hours (scaled in thousands of hours), the number of children in the household, the number of adults in the household, and the spouse's highest grade of school completed. Dichotomous control measures entered into analyses also measured at age 6 included whether the child's residence is urban (urban = 1; rural = 0), the child's father lives in the household (father in household = 1; father not in household = 0), the child is Black (Black = 1; non-Black = 0), and the child is Hispanic (Hispanic = 1; non-Hispanic = 0).

Data from earlier waves of the NLSY were used to create additional control variables to predict children's age 6 test scores and home environment, including the following: continuous measures for total family income-to-needs ratio (family income divided by the poverty threshold) averaged from birth to age 5, the mothers' age at the child's birth, the mother's academic aptitude (AFQT percentile rank), mothers' self-esteem (measured in 1980, scores ranging from 1 to 4 with a higher score reflecting more self-esteem; Baker et al., 1993), and the child's birth order, as well as the highest grade of school completed by the child's maternal grandmother and grandfather. In 1979, mothers were asked the highest grade of school they wished to complete and expected to complete, and both of these measures were also used as controls. Finally, an indicator was also included for whether the mother resided with both biological parents at age 14 (reside with both parents = 1; not reside with both parents = 0).

Increases in children's tests scores between ages 6 and 8, 8 and 10, and 10 and 12 were predicted by several time invariant measures: the child's gender, the mother's educational attainment at the first observation, her spouse's education at the first observation, the maternal grandmother's and grandfather's education, the family income-to-needs ratio averaged from birth to age 5, mothers' expected level of education, mothers' desired level of education, mothers' self-esteem, whether the child is Black, whether the child is Hispanic, and the mother's academic aptitude (AFQT percentile rank). These analyses also included measures of changes in several time-varying household characteristics: whether the child's father lives in the household, whether the child's residence is urban, the number of children in the household, the number of adults in the household, and the mother's yearly work hours. Descriptive statistics for these variables are presented in Table 3.

Missing-data dummy variables were used to retain cases even if values were lacking for control variables (Allison, 2001). If data were missing, a dummy variable indicator was created and set equal to 1 for cases with missing values. Then, the corresponding control variable was assigned a value of zero.[2] For example, when data were missing for urban residence, the urban residence variable was coded as having a value of zero, and a dummy variable indicating missing urban residence data (1 = yes; 0 = no) was created.

When children were on average 6 years old, there was little missing data for most variables, 7% or less with the exception of family income, spouse's education, and grandfather's education (see Table 1). Rates of missing data for covariates during subsequent intervals were also low (4% or lower, see Table 3). The higher rates of missing data for spouse's and grandfather's education were expected given the rates of single-parent families in this sample.

Analytic Models

Children's academic achievement and the quality of their home environments between ages 6 and 12 were modeled by piecewise hierarchical linear models (HLM) using SAS's PROC MIXED procedure (Bryk & Raudenbush, 1992; Raudenbush, 2001; Singer, 1998). In this multilevel model, time (Level 1) is nested within children (Level 2). Whereas many HLM models consider time to be a continuous measure, this approach measures time in discrete 2-year intervals, which correspond to intervals between the child assessments at ages 6, 8, 10, and 12. This method allows for the consideration of whether increases in mothers' education predicted changes in children's test scores during concurrent intervals and whether improvements in children's achievement preceded mothers' completion of additional education.

The within-subject (Level 1) trajectory model for children's achievement outcomes can be represented as:

$$\text{Achievement}_{ti} = P_{0i} + P_{1i}(\text{Age } 8_{ti}) + P_{2i}(\text{Age } 10_{ti}) + P_{3i}(\text{Age } 12_{ti}) + e_i. \quad (1)$$

Child i's academic achievement at time t is a function of the initial level of achievement at age 6, P_{0i}, as well as growth in the child's achievement score during the subsequent 2-year increments and an error term. For example, Age 8_{ti} has the value of zero at the first observation, when children were on average age 6, and 1 at each subsequent observation. Consequently, the increase in child i's achievement between ages 6 and 8 is P_{1i}. Likewise, the estimated increase in tests scores between assessments at ages 8 and 10 years old (Interval 2) is $P_{2i,}$ and the increase between ages 10 and 12 (Interval 3) is P_{3i}.

Next, the intercept and growth parameters are taken as dependent outcomes, and entered into the between-subjects (Level 2) model. The initial level of children's achievement and changes in age-standardized achievement are predicted by both persistent and time-varying family and child characteristics:

[2] As explained by Allison (2001) the choice of what value is used to replace the missing data is arbitrary and matters only for interpreting the missing data dummy variable. This approach to missing data is found to work sufficiently well when relatively small amounts of data are missing and the variables are moderately correlated with the key dependent variable and independent variable (Allison, 2001).

$$P_{0i} = B_{00} + B_{01}Med_{1i} + B_{00}Fchar_{1i} + Cchar_{1i} + u_{0i}.$$

$$P_{1i} = B_{10} + B_{11}(Med_{2i} - Med_{1i}) + B_{12}(Fchar_{2i} - Fchar_{1i}) + B_{13}Fchar_{1i} + B_{14}Cchar_{1i} + u_{1i}.$$

$$P_{2i} = B_{20} + B_{21}(Med_{3i} - Med_{2i}) + B_{22}(Fchar_{3i} - Fchar_{2i}) + B_{23}Fchar_{1i} + B_{24}Cchar_{1i} + u_{2i}.$$

$$P_{3i} = B_{20} + B_{31}(Med_{4i} - Med_{3i}) + B_{32}(Fchar_{4i} - Fchar_{3i}) + B_{33}Fchar_{1i} + B_{34}Cchar_{1i}. \quad (2)$$

Child *i*'s academic achievement at age 6, P_{0i}, is modeled as a function of the mother's educational attainment (Med_{1i}) and family ($Fchar_{1i}$) and child characteristics ($Cchar_{1i}$), as well as an individual error term (u_{0i}). Each increment to child *i*'s achievement over the 2-year intervals are predicted by stable family and child characteristics as well as increases in a mother's completed schooling (e.g., $Med_{ti} - Med_{t-1i}$) and changes in time-varying family characteristics (e.g., $Fchar_{ti} - Fchar_{t-1i}$). For example, increases in children's age-standardized achievement scores between ages 6 and 8, P_{1i}, are predicted by mother's educational attainment when the child was age 6 and increases in the mother's completed schooling between ages 6 and 8, as well as the set of covariates described earlier. All of the continuous variables are centered on the sample mean, so the estimated intercept reflects the initial test score for a child with average values for continuous variables and zeros for all dichotomous indicators (Singer, 1998).[3]

Minimizing omitted variable biases is a concern in this study, as it is for all observational studies in which the treatment (increased maternal education) is not randomly assigned. Although it is impossible to be certain that bias has been fully removed, two important analytic strategies are employed to minimize such biases. First, theoretically derived covariates were chosen to control for mother and child characteristics that might be correlated with increases in maternal education and changes in children's achievement or the quality of their home environments. These include measures of mothers' academic aptitude, grandparents' education, and mothers' educational aspirations and expectations as well as self-esteem (Brooks-Gunn, Guo, & Furstenberg, 1993; Felmlee, 1988; Leadbeater, 1996; Way & Leadbeater, 1999). This ensures that differences in outcomes are not due to preexisting differences in mothers' academic abilities, expectations, aspirations, and other family members' education.

Second, by predicting changes in achievement and home environments this approach implicitly differences out disparities in levels of the outcomes between children of mothers who complete additional schooling and children of mothers who do not (Raudenbush, 2001; Rutter, 2003; Sobel, 1998). Consequently, if the effects of unobserved maternal and child characteristics are constant over time this approach will ensure they do not bias associations between increases in maternal education and children's achievement or home environments.

Associations may still be biased by the omission of time-varying characteristics or persistent characteristics that have time-varying effects. Consequently, the analyses include several covariates that may be associated with changes in age-standardized achievement. Prior research has suggested that children's race/ethnicity and gender may have differential effects on test scores as children age (Pungello, Kupersmidt, Burchinal, & Patterson, 1996). Therefore, these measures are included as predictors of changes in outcomes during each interval. The Level-2 models also include the following measures of changes in family and child characteristics that prior research suggests may be associated with mothers' increases in education: maternal work hours, the number of children in the household, the number of adults in the household, whether the residence was urban, and whether the child's father resided in the household (Brooks-Gunn, Guo, & Furstenberg, 1993; Felmlee, 1988; Leadbeater, 1996; Way & Leadbeater, 1999).[4]

To test the hypothesis that increases in maternal education predict improvements in children's achievement, HLM analyses were conducted with the full sample of children. Results from this analysis indicate whether increases in maternal education predict concurrent growth in children's achievement, holding constant a rich array of maternal and family characteristics.

To determine whether associations are more pronounced for children of young, less-educated mothers, analyses were conducted among this subgroup of children. Next, interaction terms (an indicator of young mother by the number of years of additional schooling completed) were included as predictors in the Level-2 models to test whether the estimated effects of increased schooling for younger mothers were significantly different than the effects

[3] The Level-2 model predicting increases in achievement between ages 8 and 10 does not include an error term because, with only four observations, at most three Level-2 error terms can be identified. Examination of the model fit statistics (AIC) suggested that excluding an error term for the Level-2 equation predicting P_{3i} resulted in the best fit of the data. Results from analyses that treated either P_{1i} or P_{2i} as fixed did not differ substantively from the results reported in the tables. There are two alternative models that could be estimated. First, children's trajectories over the total 6 years could be modeled as a function of mothers' increases in education, without regard for the specific timing of the increases. This type of analysis is not preferred because it does not allow for the examination of whether changes in children's trajectories preceded mothers' increases in education or differed depending on children's ages. However, results from such analyses do suggest positive effects of increases in young, less-skilled mothers' education on children's reading recognition (.07, $p < .05$) and reading comprehension (.06, $p < .05$) but not significant effects on children's math trajectories and no effects for children of older, more educated mothers. Second, a child fixed-effect model or a sibling fixed-effect model, both of which are common in economic studies, could be estimated. The child fixed-effect models differ from HLM models in that they do not estimate random errors for the slope parameters and use only within-child variation in achievement to identify effects. When accounting for the timing of changes in education, a simple child fixed-effect model with few covariates yields quite similar pattern of results to those reported in Tables 4 and 5. The sibling fixed-effect models compare children of the same mother at the same age. These models only use variation between siblings to identify effects (and thus children without siblings are excluded from analyses). Sibling models also yield similar findings for reading recognition and math outcomes, although results appeared to differ slightly for reading comprehension.

[4] Changes in the family income-to-needs ratio were not included as covariates in the Level-2 models. However, including a measure of changes in income-to-needs over each interval does not change presented results. Results were also not sensitive to including the following measures as predictors of children's initial level of achievement: children's home learning environment at ages 5 or 6, children's temperament at ages 4 or 5, and mothers' marital status.

for older mothers, holding constant all covariates. Additional models were estimated in which future increases in maternal education predicted the prior level and growth in children's achievement. This analysis is important because it provides a test of whether children's achievement might have differed in absence of their mothers' increased education. Finally, HLM models were also estimated with the HOME-SF and family income-to-needs ratio as outcomes in exploratory analyses.

Results

Descriptive Statistics

Overall, 16% of mothers completed additional schooling, with 5–7% of mothers completing additional schooling over each 2-year interval. Nearly 20% of the mothers who completed additional years of education reported that their education had increased during more than one of the intervals between assessments. Among mothers with increased educational attainment, the average number of additional years of school ranged from 1.25 to 1.28 over a 2-year period and about 1.56 over the 6 years of the study. Rates and patterns of maternal schooling were similar among the sample of young, less-educated mothers and older and more highly educated mothers.

About 30% of the mothers who completed additional schooling had less than a high school degree when their children were age 6. About 74% of these mothers subsequently completed a high school diploma or GED, most often a GED (60%). High school graduates who completed additional schooling attended a college or university. These mothers were more likely to attend 2-year than 4-year institutions (65% vs. 49%), although some mothers reported attending both over the course of the study (30%). In addition, more mothers reported attending as a full-time student than a part-time student (66% vs. 46%), although again some mothers reported having been enrolled both full- and part-time over the course of the study (16%). The diversity in schooling mothers experienced in this sample reflects national patterns of adult educational participation (National Center for Education Statistics, 2005).

Do mothers who completed additional education differ from those who did not? To answer this question, differences in all baseline characteristics were tested (*t* tests for continuous variables and chi-square tests for categorical variables, results not shown). Among the full sample, several salient differences emerged. Mothers who completed additional schooling had higher levels of academic aptitude (AFQT, 34 vs. 30, $p < .05$), higher levels of self-esteem (3.23 vs. 3.16, $p < .05$), higher aspirations for their own education (14.40 vs. 13.85, $p < .05$), and higher expectations for their own education (13.63 vs. 13.16, $p < .05$) than other mothers. In addition to these differences, among the subgroup of older mothers, mothers who completed additional schooling were younger than mothers who did not (22.3 vs. 22.6, $p < .05$). Among the younger, less-educated mothers only two differences were apparent. Compared with mothers whose education remained the same, mothers who completed additional education had higher educational aspirations (13.58 vs. 13.04, $p < .05$) and their children had higher average family income-to-needs ratios from birth to age 5 (1.4 vs. 1.2, $p < .05$). In sum, mothers who completed additional education differed in some ways from other mothers, suggesting that adjusting for these initial differences may be important. Yet, it is also notable that along many dimensions these mothers did not differ from other mothers.

Associations Between Maternal Education and Children's Achievement

The first step in determining whether increases in mothers' education predict children's achievement trajectories was to estimate only the Level-1 HLM model. These basic models are useful because they provided estimates of variance for the age 6 achievement (intercept) and changes in achievement (slopes) during each 2-year interval. Results suggested that sufficient variation exists across children such that individual characteristics might explain differences in children's achievement (results not shown).

Next, maternal and child characteristics were entered into the estimation model (at Level-2) to predict children's achievement at age 6 and changes in achievement over each of the subsequent 2-year intervals. Results from these models are presented in Table 4 with predictors of age 6 test scores summarized in the first panel and predictors of test score slopes summarized in the second panel.

Associations between child and family characteristics and children's age 6 achievement (intercept) were similar for children's reading and math skills and, for the most part, in the expected directions (see Table 4, panel 1). Results suggest that a year of completed maternal education was not associated with children's achievement; however, an additional year of spouse's education was associated with a higher level of reading and math skills (an effect size of .06–.07, $p < .01$). Other significant predictors of children's academic skills include maternal academic aptitude, the number of children in the household, family income-to-needs ratio, and children's gender and birth order.

For brevity, only the estimated slopes for each interval as well as the association between mothers' educational attainment, increases in education, and AFQT scores and these slopes are presented (see Table 4, panel 2). Because the scores were age-standardized, on average, children did not experience any consistent improvements or declines in their relative levels of achievement. If increases in maternal education were linked with improvements in children's achievement, then number of additional years of school mothers' completed would predict the slopes of children's reading and math achievement. Contrary to expectations, increases in mothers' completed schooling were not associated with concurrent improvements in achievement slopes. In addition, mothers' educational attainment (at age 6) and academic aptitude (AFQT scores) did not consistently predict gains in children's achievement relative to their peers.

Are Associations Larger for Children of Disadvantaged Mothers?

Are the associations between increases in mothers' education and children's achievement more consistent and positive for children of young mothers with lower levels of education? To explore this question, a second set of HLM analyses was conducted with the subgroup of children whose mothers were less than 20 years old when they gave birth to the child, had a high school degree or less education, and had scored lower than the 50th percentile on the AFQT. By conducting analyses within this subgroup, children of mothers who completed additional education were compared with children of mothers of a similar age, education, and aptitude who did not increase their schooling.

Only the findings related to the independent variable of interest, increases in mothers' educational attainment, are discussed in

Table 4
Summary of Predictors of Children's PIAT Reading Recognition, Reading Comprehension, and Math Achievement From Hierarchical Linear Modeling HLM Analyses, Full Sample (N = 1,748)

Variable	Reading recognition		Reading comprehension		Math	
	b	*SE*	*b*	*SE*	*b*	*SE*
Panel 1: Intercept—age 6						
Intercept	.09	.08	.14	.08	.13	.08
Mother's years of completed education	.02	.02	.02	.02	.01	.02
Black	.27***	.06	.31***	.06	−.07*	.06
Hispanic	.01	.07	−.01	.06	−.18***	.07
Boy	−.16***	.04	−.18***	.04	−.08*	.04
Maternal academic aptitude (AFQT)	.10***	.01	.09***	.01	.09***	.01
Urban residence	.01	.04	.00	.04	−.01	.04
Household income-to-needs ratio (birth to age 5)	.05***	.02	.05**	.02	.02	.02
Hours of work per year	.00	.02	.00	.02	.00	.02
Number of adults in household	−.05*	.02	−.05**	.02	−.05**	.02
Number of children in the household	−.07**	.02	−.09**	.02	−.11***	.02
Father in the household	−.08	.05	−.04	.04	−.08	.05
Birth order	−.06**	.03	−.05*	.02	.03	.03
Age of mother at birth	.00	.01	.01	.01	−.01	.01
Mother's self-esteem	−.04	.06	−.02	.06	−.06	.06
Mother's desired years of completed education	−.02	.02	−.01	.02	−.02	.02
Mother's expected years of completed education	.03*	.02	.03*	.02	.03*	.02
Spouse's years of completed education	.07***	.01	.06***	.01	.06***	.01
Grandmother's years of completed education	.00	.01	.00	.01	.00	.01
Grandfather's years of completed education	.01	.01	.01	.01	.00	.01
Mother resided with both parents (age 14)	−.04	.04	−.02	.03	−.03	.04
Panel 2: Slopes ages 6–12						
Slope ages 6–8						
Average score increase	.10**	.05	.08	.05	.02	.05
Increase in mother's years of completed school (ages 6–8)	.06	.05	.02	.05	−.01	.05
Mother's educational attainment (age 6)	.01	.02	.01	.02	.04**	.02
Maternal academic aptitude (AFQT)	−.01	.01	.02	.01	.01	.01
Slope ages 8–10						
Average score increase	−.03	.03	−.02	.05	−.07	.04
Increase in mother's years of completed school (ages 8–10)	.02	.04	.05	.04	−.04	.04
Mother's educational attainment (age 6)	.00	.01	.03	.02	−.01	.01
Maternal academic aptitude (AFQT)	.01	.01	−.01	.01	.00	.01
Slope ages 10–12						
Average score increase	.01	.03	.02	.04	.03	.04
Increase in mother's years of completed school (ages 10–12)	.03	.04	−.14***	.06	.07	.05
Mother's educational attainment (age 6)	.01	.01	−.01	.01	−.01	.01
Maternal academic aptitude (AFQT)	.00	.01	.02*	.01	.01	.01

Notes. The following time invariant maternal and family characteristics are included as predictors of the slopes: self-esteem, desired educational attainment, expected educational attainment, income-to-needs ratio at birth to age 5, spouse's education as well as child's gender, National Longitudinal Survey of Youth cohort, and race and ethnicity. Measures of changes in the following time varying measures are also included as predictors of slopes: the number of children in the household, the number of adults in the household, father presence in household, urban residence, and mother's work hours. Missing data dummy variables are also included in analyses. The Armed Forces Qualifying Test (AFQT) is a measure of mothers' academic aptitude. PIAT = Peabody Individual Achievement Test.
* $p < .10$. ** $p < .05$. *** $p < .01$.

detail. In contrast to the full sample analyses, results from analyses with the subgroup of children born to young mothers indicate substantial and consistent associations between increases in maternal education and children's reading skills but fewer associations with math skills (see Table 5, panel 2). Significant positive associations between increases in mothers' completed schooling and concurrent improvements in the growth of children's reading recognition and reading comprehension were found for children between ages 6 and 8 as well as 8 and 10. For example, between ages 8 and 10, an additional year of maternal educational attainment was associated with a 0.16 standard deviation ($p < .05$) increase in reading recognition and a 0.21 standard deviation ($p < .05$) increase in reading comprehension. Associations between improved math skills and mothers' additional education were only apparent between ages 6 and 8 (effect size of .30, $p < .01$).

With findings suggesting that additional schooling may be associated with improvements in the achievement of children born to young, less-educated mothers, but perhaps not older or more-

Table 5
Summary of Predictors of Children's PIAT Reading Recognition, Reading Comprehension, and Math Achievement From Hierarchical Linear Modeling Analyses, Young Mother Sample (n = 425)

Variable	Reading recognition		Reading comprehension		Math	
	b	*SE*	*b*	*SE*	*b*	*SE*
Panel 1: Intercept—age 6						
Intercept	.38**	.15	.48***	.14	.24	.15
Mother's years of completed education	.04	.03	.06	.03	.02	.04
Black	.17	.11	.09	.11	−.21*	.12
Hispanic	−.30***	.12	−.36***	.12	−.37***	.13
Boy	−.29***	.08	−.32***	.07	−.13	.08
Maternal academic aptitude (AFQT)	.09**	.04	.05	.04	.10***	.04
Urban residence	−.06	.08	−.05	.08	−.06	.08
Household income-to-needs ratio (birth to age 5)	.17**	.06	.19**	.06	.06	.06
Hours of work per year	−.03	.04	−.05	.04	−.02	.04
Number of adults in household	−.09	.04	−.09	.03	−.05	.04
Number of children in the household	−.05	.04	−.08**	.04	−.08**	.04
Father in the household	−.15	.10	−.17*	.09	−.10	.09
Birth order	−.11	.07	−.10	.06	−.06	.06
Age of mother at birth	.04	.03	.03	.03	.02	.03
Mother's self-esteem	−.15	.12	−.21*	.12	−.26**	.12
Mother's desired years of completed education	−.05*	.03	−.04	.03	.03	.03
Mother's expected years of completed education	.05	.03	.05*	.03	.02	.03
Spouse's years of completed education	.07***	.03	.07**	.03	.06	.03
Grandmother's years of completed education	.00	.01	−.01	.03	−.00	.01
Grandfather's years of completed education	.00	.01	.00	.01	.00	.01
Mother resided with both parents (age 14)	−.19	.07	−.17**	.07	−.06	.07
Panel 2: Slopes ages 6–12						
Slope ages 6–8						
Average score increase	−.05	.10	−.17***	.11	−.31**	.11
Increase in mother's years of completed school (ages 6–8)	.36***	.11	.32***	.11	.30***	.11
Mother's educational attainment (age 6)	−.01	.03	−.02	.04	.01	.04
AFQT	.06*	.04	.12**	.04	.03*	.04
Slope ages 8–10						
Average score increase	−.01	.07	−.03	.11	.05	.10
Increase in mother's years of completed school (ages 8–10)	.16**	.07	.21**	.10	−.04	.08
Mother's educational attainment (age 6)	.04*	.03	.04	.03	.07*	.03
AFQT	.01	.03	−.01	.04	.01	.03
Slope ages 10–12						
Average score increase	.08	.06	.12	.10	.02	.09
Increase in mother's years of completed school (ages 10–12)	.12	.08	−.17	.12	.02	.11
Mother's educational attainment (age 6)	−.01	.02	−.03	.03	.07**	.03
AFQT	−.01	.02	−.02	.04	−.02	.03

Note. Young mothers were 20 years old or younger when their children were born, had a high school degree or less education when the child was age 6, and scored below the 50th percentile on the Armed Forces Qualifying Test (AFQT), a measure of mothers' academic aptitude. The following time-invariant maternal and family characteristics are included as predictors of the slopes: self-esteem, desired educational attainment, expected educational attainment, income-to-needs ratio at birth to age 5, spouse's education as well as child's gender, National Longitudinal Survey of Youth cohort, and race and ethnicity. Measures of changes in the following time-varying measures are also included as predictors of slopes: the number of children in the houshold, the number of adults in the household, father presence in household, urban residence, and mother's work hours. Missing data dummy variables are also included in analyses. PIAT = Peabody Individual Achievement Test.
* $p < .10$. ** $p < .05$. *** $p < .01$.

educated mothers, interaction terms (an indicator for having a young mother interacted with the number of years of additional schooling completed) were entered as Level-2 predictors. Results (not shown) suggest that effects of changes in maternal education are significantly larger among the children of younger mothers than among children of older mothers. The coefficients for the interaction terms (Young Mother × Change in Education) ranged from .36 to .38 ($p < .01$) for changes in math and reading skills between 6 and 8 years old. Interaction terms also predicted improvements in reading skills for children between 8 and 10 years old (.16, $p < .10$, for reading recognition and .23, $p < .05$, for reading comprehension). For children between the ages of 10 and 12, differences in associations between additional schooling completed and children's test score slopes were not found when comparing older and younger mothers.

Again, children whose mothers completed their schooling toward the end of middle childhood do not appear to benefit from their mothers' additional education.

Do Children's Trajectories Differ Before Mothers Complete Additional Education?

Having found associations between increases in mothers' completed schooling and reading achievement among children of young, less-educated mothers, one concern might be that these children's reading achievement differed before their mothers' obtained additional education. That is, the improvements in children's scores might be better attributed to some previous characteristic or experience, such that children's achievement would have risen whether their mothers obtained more schooling or not. To explore this possibility, HLM analyses were estimated in which increases in young, low-educated mothers' education during each interval predicted children's test scores at age 6 as well as test score slopes for each of the intervals. Consequently, future increases in mothers' education predicted earlier, concurrent, and later achievement slopes. This approach explicitly tests for prior differences in children's achievement before mothers completed additional schooling and in doing so also controls for any initial differences.

Results, presented in Table 6, indicate that increases in children's achievement corresponded to, but did not precede, their mothers' increases in completed education. At age 6, reading and math test scores of children whose mothers returned to school did not differ significantly from reading scores of other children (see Table 6). Moreover, controlling for initial achievement differences (nonsignificant ones) did not change the pattern or magnitude of the estimated associations; increases in mothers' completed schooling were still linked with concurrent improvements in children's achievement.

Of most interest is the achievement of children whose mothers improved their education when their children were between 8 and 10 years old. For these children, differences both in achievement levels and slopes can be observed before their mothers' education improved. Again, results suggest that increases in the slopes of reading skills corresponded to, but did not precede, improvements in mothers' education. Furthermore, controlling for differences before age 8 and after age 10 resulted in slightly larger associations between years of completed schooling and reading recognition (effect size of .22, $p < .05$, as compared with .16, $p < .05$) and reading comprehension (effect size of .34, $p < .05$, as compared with .21, $p < .05$) between ages 8 and 10.

Findings also confirm that increases in mothers' education during the first interval corresponded to increases in math test scores, even after controlling for initial differences in math achievement (0.24, $p < .10$, see Table 6). As expected, increases in math during later intervals did not correspond to increases in mothers' education, even holding constant earlier levels of math achievement.

Finally, the lack of associations between mothers' improvements in education and later changes in children's achievement are also noteworthy. Improvements in maternal education are not linked to further gains in achievement during subsequent intervals. For example, improvement in completed maternal education between ages 6 and 8 does not predict changes in achievement between ages 8 and 10. Nevertheless, the earlier gains in achievement (ages 6–8) are largely maintained through age 12.

Table 6
Summary of Hierarchical Linear Modeling Analyses With Increases in Education Predicting Intercepts and Slopes of Children's Reading Recognition, Reading Comprehension, and Math Achievement, Young Mother Sample (n = 425)

Increases in maternal education	Reading recognition		Reading comprehension		Math	
	b	*SE*	*b*	*SE*	*b*	*SE*
Intercept age 6						
Ages 6–8	.04	.13	−.01	.13	.24*	.14
Ages 8–10	.08	.12	.04	.12	−.06	.13
Ages 10–12	.04	.14	.09	.14	.14	.15
Slope ages 6–8						
Ages 6–8	.32**	.14	.35**	.15	.23	.15
Ages 8–10	−.13	.13	−.14	.14	.08	.14
Ages 10–12	−.09	.15	−.10	.17	−.14	.17
Slope ages 8–10						
Ages 6–8	−.03	.10	−.10	.15	−.08	.13
Ages 8–10	.22**	.09	.34**	.13	−.02	.12
Ages 10–12	.00	.11	−.01	.16	.14	.13
Slope ages 10–12						
Ages 6–8	.13	.09	.10	.14	−.15	.12
Ages 8–10	−.10	.08	−.15	.12	−.08	.11
Ages 10–12	.13	.09	−.15	.15	−.05	.13

Note. Analyses include a full set of covariates (see notes to Tables 4 and 5). Young mothers were 20 years old or younger when their children were born, had a high school degree or less education when the child was age 6, and scored below the 50th percentile on the Armed Forces Qualifying Test.
*$p < .10$. **$p < .05$.

Sensitivity of Estimates to Covariates

One way to explore the extent to which estimates may be biased by omitted variables is to consider how sensitive they are to the inclusion of controls. If entering controls into the analyses reduces the estimates, it is likely that results would also be sensitive to the inclusion of unmeasured variables (Altonji, Elder, & Taber, 2005). Consequently, a set of HLM models with interactions between increases in education and an indicator for young, less-educated mothers was estimated. Just a few controls were included to predict the intercept (mother's educational attainment at age 6 and dummy indicators for NLSY cohort membership). Resulting associations followed a remarkably similar pattern to estimates from models with a complete set of controls. Indeed, the estimates resulting from analyses without controls were within .08 of the full model estimates.

Quality of the Home Environment as a Possible Mechanism of Influence

One possible way in which maternal education may improve children's achievement is by improving the quality of children's

home environments. Exploratory analyses considered whether this pathway is a plausible explanation for links between children's improved achievement and their mothers' improved schooling. In a piecewise HLM model, measures of the quality of the home environment were taken as outcomes and predicted by mothers' additional years of completed school interacted with an indicator for young, less-educated mothers as well as a full set of controls. If increases in the quality of children's home environments explain the associations between additional schooling and achievement among children of young mothers, associations between additional education and the quality of children's home environments would also be expected. However, it is important to caution that finding that improvements in young mother's education are linked to improvements in the quality of home environments does not establish that this process causes improvements in achievement.

The pattern of associations between additional maternal education and home environment quality mirror those found for mothers' schooling and children's reading achievement quite closely. Among older and more educated mothers, improvements in mothers' education were not associated with the quality of their children's home environments. In contrast, such associations were apparent among children of young, less-educated mothers. An additional year of completed schooling is associated with an effect size increase of .31 ($p < .01$, result not shown) in the quality of children's home environments between ages 6 and 8, .26 ($p < .05$, result not shown) between ages 8 and 10, and .12 (*ns*, result not shown) between ages 10 and 12. Just as was the case for children's reading achievement, adding controls for earlier and later time periods or including a reduced set of covariates does not substantively change the pattern of associations.

One alternative explanation for links between maternal education and children's achievement is family income. If improvements in maternal education are linked to higher family incomes, then this may explain both the increases in the quality of home environments and children's achievement. To explore this possibility, an additional piecewise HLM model was estimated in which family income-to-needs ratios were predicted by increases in mothers' education as well as interaction terms (young mother sample interacted with increases in education). Results from this analysis suggest little consistent association between increases in mothers' education and income-to-needs ratios. Among older mothers, changes in education were associated with improved income-to-needs ratio between ages 8 and 10 (.21, $p < .10$), but associations for the earlier and later time period were not significant (−.02 and .11, respectively, *ns*). Among the younger mothers, estimated associations between concurrent increases in education and changes in family income-to-needs ratios ranged from .03 to −.22 (*ns*). Again, estimates derived from models with fewer covariates and models that controlled for earlier and later time periods yielded similar findings. Such neutral to negative (nonsignificant) associations among the younger mothers suggest that improved family incomes may not explain the associations between increased maternal education and children's achievement. These analyses, however, are limited in several very important ways. First, due to missing income data only about 60% of the sample is included in these analyses. Second, the timing of the income measurement does not directly correspond to the timing of the increases in maternal education and achievement slopes in the later years of study. For these reasons, the income analyses are likely to be at best a rough approximation of associations and should be interpreted with caution.

Discussion

Life course theories and academic socialization theories suggest that increases in mothers' education may improve their children's achievement trajectories. Substantial proportions of mothers return to school after their children are born, and this study explored whether additional education may improve their children's achievement during middle childhood. Results suggest that children of older or more highly educated mothers did not benefit when their mothers completed additional education. However, increases in completed education among young, less-educated mothers predicted improvements in their children's reading achievement between ages 6 and 10, and these effects persisted through age 12. Furthermore, analyses confirmed that improvements in disadvantaged children's reading did not precede their mothers' increases in education, thus ruling out the possibility that children's achievement differed before their mothers' education increased.

The associations between improvements in mothers' education and changes in children's achievement slopes are less likely to be biased than analyses that estimate associations between levels of maternal education and levels of children's achievement for two reasons. First, the associations between reading and math slopes and mothers' additional years of completed schooling were isolated from associations with mothers' academic aptitude as well as their educational aspirations and expectations. In most nonexperimental analyses, parsing out these characteristics from educational attainment is difficult because these characteristics typically covary. Second, because the estimation strategy linked changes in children's achievement with changes in their mothers' education, resulting estimates are less likely to be biased by omitted variables (Raudenbush, 2001).

Academic socialization theories provide one explanation for how mothers' educational attainment and school experiences may shape children's achievement outcomes during middle childhood (Taylor, Clayton, & Rowley, 2004). Several prior studies have found that changes in the amount and quality of children's home learning environment are linked to improvements in maternal education (Magnuson, 2003; Votruba-Drzal, 2003). Exploratory analyses of the quality of children's home environment in this study confirmed that improvements in mothers' education are linked to improvements in the home environment between ages 6 and 10 for children residing with young, less-educated mothers (effect sizes = .31–.26). Moreover, the patterns of associations closely followed those found for reading achievement, suggesting that this is likely a mediating mechanism. In contrast, little evidence was found to suggest that improvements in household income mediated associations between concurrent increases in mothers' education and children's achievement. Limitations of the income data, however, suggest that these findings should be interpreted with caution. This study does not rule out the possibility that other processes may also be operating and does not directly link changes in children's home environments to changes in children's achievement. Additional research, including qualitative research, on children's home and school experiences both while their mothers are in school and after their mothers leave school is necessary

to more clearly identify the specific processes that explain the associations between increases in mothers' completed schooling on children's achievement trajectories.

Why might mothers' completion of additional years of schooling have a larger association with achievement among children of young mothers with low levels of education than with older and more highly educated mothers? Any explanations are necessarily speculative. First, it may be that additional years of schooling beyond some college may not have the same positive effects on home environment and academic socialization as completing a high school degree or some college. These more educated mothers may already be providing positive home environments for their children, as suggested by the higher initial quality of home environments and the lack of association between improved schooling and the quality of the home environment for this group. Alternatively, children of young mothers are likely to be disadvantaged by their mothers' low levels of education, which are associated with contexts that may place children at risk for academic failure (Jaffee, 2002). Improvements in academic socialization that may result from increased maternal education, such as higher quality home environments, may be particularly important for children who face multiple sources of disadvantage and lag behind their more advantaged peers (Luster et al., 2000).

Why would children's reading achievement be more consistently influenced by improvements in their mothers' education than their math achievement? Young children's calculation skills may not be sensitive to variations in their social background including parental education (Entwisle & Alexander, 1990; Ginsberg & Russell, 1981). Jordan and colleagues (1992) argued that class differences in young children's math achievement are often the result of the verbal skills rather than math skills. They demonstrated that children's performance on calculation tasks did not differ by social class when test questions rely on visual rather than verbal questions. In addition, some research has suggested that social class differences in verbal and literacy learning opportunities may be greater than differences in math learning opportunities (Jordan et al., 1992; Kellaghan, 1997; Saxe, Guberman, & Gearhart, 1987). An alternative explanation is that math achievement may not be influenced by parental education because math skills and concepts are primarily learned through formal instruction in school (Entwisle & Alexander, 1992). If children's classroom experiences play a compensating role in children's math achievement, then the advantages bestowed by an additional year or two of mothers' education may not matter much.

These findings point to the important role that maternal education plays in the achievement of their children. If these findings are replicated, then providing young mothers with opportunities to further their schooling will have potentially important benefits for their children's later school success. Whether interventions can improve children's achievement by increasing young mothers' education, however, is less certain. Previous interventions to improve mothers' education have not been effective (Quint, Bos, & Polit, 1997). Thus, more research is necessary to better understand the types of policies and interventions that promote young mothers' further schooling because it may offer an important avenue to improving their children's achievement.

Although additional maternal education was consistently linked with improvements in 6- to 10-year-olds' reading achievement, the effect sizes of the estimated associations are in the small to medium range (.16–.36). The average educational increase among mothers who went to school was about 1.5 years, so the cumulative effects on children's reading recognition might be slightly larger. The magnitudes of these estimated effects are considerably larger than effects found for antipoverty programs that increase disadvantaged children's family income by a few thousand dollars during middle childhood, although also possibly more costly (Dahl & Lochner, 2005; Morris, Duncan, & Kaufman, 2005). The estimated effects of increases in maternal education are more comparable to successful school-based interventions such as class size reduction or literacy-based school reforms (Borman et al., 2005; Finn & Achilles, 1990). Intensive early education programs, however, result in improvements in young disadvantaged children's achievement that are considerably larger, closer to three-quarters to a full standard deviation (for a review see Shonkoff & Phillips, 2000).

Some limitations of this study should be noted. First, the hierarchical linear models could not control for all of the potential differences in time-varying characteristics between mothers who returned to school and those who did not. For example, if improvements in maternal mental health lead mothers to obtain more education and their children to perform better in school, then these models may misattribute the effects of positive mental health to maternal education. Likewise, resulting associations may reflect changes that occur when mothers attend school rather then school attendance per se. For example, a mother who completes additional education may send her children to an after-school program or relocate, which may result in higher quality schooling for her children. Future studies should seek to rule out these alternative explanations.

Second, these models could not control for unobserved persistent differences that have differential effects on children's achievement over time. Important characteristics that could not be measured in this study include fathers' academic aptitude and mothers' access to social support and child-care assistance. Both of these characteristics have been found to be related to mothers' educational attainment and aspects of children's achievement or well-being (Behrman & Rosenzweig, 2002; Stevens, 1988).

This research points to several important topics for future research. First, the type of education that mothers pursued in this study varied considerably. Although such variation in educational participation coupled with the national scope of this study improves the external validity of the findings, it also suggests that future research should more carefully consider whether particular types of education (GED, vocational, and college) or school attendance (part- or full-time) are differentially associated with children's achievement. Likewise, it is also important to better understand whether obtaining an educational credential and completing an additional year of school are differentially associated with children's achievement. One might expect both that vocational training and completing a degree might influence children's achievement by improving mothers' subsequent employment opportunities, whereas additional schooling that does not lead to a degree and academic schooling affect achievement by shaping the quality of children's home environments. A study conducted with a larger sample of mothers attending diverse types of educational institutions is an important next step.

Second, although children's academic achievement is an important outcome, it represents only one dimension of children's aca-

demic achievement. Future research should consider whether increases in maternal education predict other indicators of school success such as grade retention, disciplinary actions, and later educational attainment. Finally, this analysis focuses on maternal education, but enhancements to fathers' education may also shape children's achievement and should be considered in future studies.

In conclusion, this study provides evidence that when young mothers with low levels of education complete additional years of schooling the quality of their children's home environment and children's achievement increases. In contrast, additional education among older mothers with higher levels of academic aptitude did not consistently predict improvements in children's academic achievement. Compared with reading achievement, children's math achievement did not seem to be as strongly influenced by increases in maternal education. These findings suggest that young, low-educated mothers' pursuit of additional education is linked to better achievement outcomes for their children and may help to explain why some children of young mothers fare better than others.

References

Allison, P. D. (2001). *Missing data.* Thousand Oaks, CA: Sage.

Altonji, J., Elder, T. E., & Taber, C. R. (2005). Selection on observed and unobserved variables: Assessing the effectiveness of Catholic school. *Journal of Political Economy, 113,* 151–184.

Astone, N. M., Schoen, R., Ensminger, M., & Rothert, K. (2000). School reentry in early adulthood: The case of inner-city African Americans. *Sociology of Education, 73,* 133–154.

Baker, P. C., Keck, C. K., Mott, F. L., & Quinlan, S. V. (1993). *NLSY Child Handbook, Revised Edition.* Columbus, OH: The Ohio State University, Center for Human Resources Research.

Behrman, J. R., & Rosenzweig, M. R. (2002). Does increasing women's schooling raise the schooling of the next generation? *American Economic Review,* 323–334.

Black, S., Devereux, P. J., & Salvanes, K. J. (2003). Why the apple doesn't fall far: Understanding the intergenerational transmission of human capital. *American Economic Review, 95,* 437–439.

Borman, G., Slavin, R. E., Cheung, A. C. K., Chamberlain, A. M., Madden, N. A., & Chambers, B. (2005). The national randomized field trial of Success for All: Second year outcomes. *American Educational Research Journal, 42,* 673–696.

Bornstein, M. H., Hahn, C. S., Suwalsky, J. T. D., & Haynes, O. M. (2003). Socioeconomic status, parenting and child development: The Hollingshead Four Factor Index of Social Status and the Socioeconomic Index of Occupations. In M. H. Bornstein & R. H. Bradley (Eds.), *Socioeconomic Status, Parenting, and Child Development* (pp. 29–82). Mahwah, NJ: Lawrence Erlbaum.

Brooks-Gunn, J., Guo, G., & Furstenberg, F. F. (1993). Who drops out and who continues beyond high school? A 20-year follow-up of Black urban youth. *Journal of Research on Adolescence, 3,* 271–294.

Bronfenbrenner, U. (1986). Ecology of the family as a context for human development: Research perspectives. *Developmental Psychology, 22,* 723–742.

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models: Applications and data analysis methods.* Newbury Park, CA: Sage.

Center for Human Resource Research. (2004). *NLSY79 Child and Young Adult users guide.* Columbus, OH: The Ohio State University.

Clark-Kauffman, E., Duncan, G., & Morris, P. (2004). How welfare policies affect child and adolescent achievement. *American Economic Review, 93,* 299–303.

Coley, R. L., & Chase-Lansdale, P. L. (1998). Adolescent pregnancy and parenthood: Recent evidence and future directions. *American Psychologist, 53,* 152–166.

Dahl, G., & Lochner, L. (2005). *The impact of family income on child achievement* (Working Paper No. 11279). Cambridge, MA: National Bureau of Economic Research.

Davis-Kean, P. (2005). The influence of parent education and family income on child achievement: The indirect role of parent expectations and the home environment. *Journal of Family Psychology, 19,* 294–304.

Dearing, E., McCartney, K., & Taylor, B. A. (2001). Change in family income matters more for children with less. *Child Development, 72,* 1779–1793.

Driscoll, A. K., Sugland, B. W., Manlove, J., & Papillo, A. R. (2005). Community opportunity, perceptions of opportunity and the odds of an adolescent birth. *Youth and Society, 37,* 33–61.

Dunn, L. M., & Markwardt, F. C., Jr. (1970). *Peabody Individual Achievement Test manual.* Circle Pines, MN: American Guidance System.

Eccles, J. (1992). School and family effects on the ontogeny of children's interests, self perceptions, and activity choices. In J. E. Jacobs (Ed.), *Developmental perspectives on motivation.* Lincoln, NE: University of Nebraska Press.

Elder, G., Jr. (1994). Time, human agency, and social change: Perspectives on the life course. *Social Psychology Quarterly, 57,* 4–15.

Entwisle, D. R., & Alexander, K. L. (1990). Beginning school math competence: Minority and majority comparisons. *Child Development, 61,* 454–471.

Entwisle, D., & Alexander, K. L. (1992). Summer setback: Race, poverty, school composition and mathematics achievement in the first two years of school. *American Sociological Review, 57,* 72–84.

Entwisle, D., & Alexander, K. L. (1993). Entry into school: The beginning school transition and educational stratification in the United States. *Annual Review of Sociology, 19,* 401–423.

Fan, X., & Chen, M. (2001). Parental involvement and students' academic achievement: A meta-analysis. *Educational Psychology Review, 13,* 1–22.

Felmlee, D. H. (1988). Returning to school and women's occupational attainment. *Sociology of Education, 61,* 29–41.

Finn, J. P., & Achillles, C. M. (1990). Tennessee's class size study: Findings, implications, and misconceptions. *Educational Evaluation and Policy Analysis, 21,* 97–110.

Furstenberg, F. F., Brooks-Gunn, J., & Morgan, S. P. (1987). *Adolescent mothers in later life.* New York: Cambridge University Press.

Ginsberg, H. P., & Russell, R. L. (1981). Social class and racial influences on early mathematical thinking. *Monographs of the Society for Research in Child Development, 46*(2, Serial No. 193).

Halle, T., Kurtz-Costes, B., & Mahoney, J. L. (1997). Family influences on school achievement in low-income African-American children. *Journal of Educational Psychology, 3,* 527–537.

Harris, Y., R., Terrel, D., & Allen, G. (1999). The influence of education context and beliefs on the teaching behavior of African American mothers. *Journal of Black Psychology, 25,* 490–503.

Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experiences of young American children.* Baltimore: Brookes.

Haveman, R., & Wolfe, B. (1995). The determinants of children's attainments: A review of methods and findings. *Journal of Economic Literature, 23,* 1829–1878.

Hill, N., Castellio, D., Lansford, J. E., Nowlin, P., Dodge, K. A., Bates, J. E., & Pettit, G. S. (2004). Parent-academic involvement as related school behavior, achievement, and aspirations: Demographic variations across adolescence. *Child Development, 75,* 1491–1509.

Hoff-Ginsberg, E., & Tardif, T. (1995). Socioeconomic status and parenting. In M. Bornstein (Ed.), *Handbook of parenting, Vol. 4.* (pp. 161–187). Mahwah, NJ: Lawrence Erlbaum.

Jaffee, S. (2002). Pathways to adversity in young adulthood among early childbearers. *Journal of Family Psychology, 16,* 38–49.

Jordan, N. C., Huttenlocher, J., & Levine, S. C. (1992). Differential calculation abilities in young children from middle and low-income families. *Developmental Psychology, 28,* 644–653.

Kaplan, D. S., Liu, R. X., & Kaplan, H. B. (2004). Explaining intergenerational parallelism in adverse school experiences: Mediating influence of young and middle adulthood experiences. *The Journal of Experimental Education, 72,* 117–159.

Kellaghan, T. (1997). Relationship between home environment and scholastic behavior in a disadvantaged population. *Journal of Educational Psychology, 33,* 107–119.

Kisker, E. E., Rangarajan, A., & Boller, K. (1998). *Moving into adulthood: Were the impacts of mandatory programs for welfare-dependent teenage parents sustained after the program ended?* Washington, DC: U.S. Department of Health and Human Services, Assistant Secretary for Planning and Evaluation.

Kohl, G. O., Lengua, L. J., & McMahon, R. J. (2000). Parent involvement in school conceptualizing multiple dimensions and their relations with family and demographic risk factors. *Journal of School Psychology, 38,* 501–523.

Kowaleski-Jones, L., & Duncan, G. (1999). The structure of achievement and behavior across middle childhood. *Child Development, 4,* 930–943.

Laosa, L. (1980). Maternal teaching strategies in Chicano and Anglo-American families: The influence of culture and education on maternal behavior. *Child Development, 51,* 759–765.

Leadbeater, B. J. (1996). School outcomes for minority-group adolescent mothers at 28 and 36 months post-partum: A longitudinal follow-up. *Journal of Research on Adolescence, 6,* 629–648.

Lee, V. E., & Burkam, D. (2002). *Inequality at the starting gate: Social background differences in achievement as children begin school.* Washington, DC: Economic Policy Institute.

Love, J. M., Kisker, E. E., Ross, C. M., Schochet, P. Z., Brooks-Gunn, J., Paulsell, D., et al. (2002). *Making a difference in the lives of infants and toddlers and their families: The impacts of Early Head Start. Volume 1: Final technical report.* Princeton, NJ: Mathematica Policy Research.

Luster, T., Bates, L., Fitzgerald, H., Vandenbelt, M., & Key, J. P. (2000). Factors related to successful outcomes among preschool children born to low-income adolescent mothers. *Journal of Marriage and the Family, 62,* 133–146.

Macmillan, R., McMorris, B. J., & Kruttschnitt, C. (2004). Linked lives: Stability and change in maternal circumstances and trajectories of antisocial behavior in children. *Child Development, 75,* 205–220.

Magnuson, K. (2003). *The effect of increases in welfare mothers' education on their young children's academic and behavioral outcomes* (Discussion Paper 1274–03). University of Wisconsin, Institute for Research on Poverty.

Magnuson, K., & Duncan, G. (2004). Parent- vs. child-based intervention strategies for promoting children's wellbeing. In A. Kalil & T. DeLeire (Eds.), *Family investments in children: Resources and behaviors that promote success* (pp. 209–236). Mahwah, NJ: Lawrence Erlbaum.

Manlove, J. S. (1998). The influence of high school dropout and school disengagement on the risk of school-age pregnancy. *Journal of Research on Adolescence, 8,* 187–220.

McGroder, S. M., Zaslow, M. J., Moore, K. A., & LeMenestrel, S. M. (2000). *National evaluation of Welfare-to-Work Strategies – Impacts on young children and their families two years after enrollment: Findings from the Child Outcomes Study.* Washington, DC: U. S. Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation, Administration for Children and Families.

Morris, P., Duncan, G., & Kaufman, E. (2005). Child well-being in an era of welfare reform: The sensitivity of transition in development to policy change. *Developmental Psychology, 41,* 919–932.

Mott, F. L. (2004). The utility of the HOME-SF scale for child development research in a large national longitudinal survey: The National Longitudinal Survey of Youth 1979 Cohort. *Parenting Science and Practice, 4,* 259–270.

National Center for Education Statistics (2005). *Adult participation in education 2004–2005*. Washington, DC: U.S. Department of Education, Institute for Education Sciences. Retrieved August 23, 2006 from http://nces.ed.gov/pubs2006/adulted/index.asp.

Oreopaulos, P., Page. M., & Stevens, A. (2006). The intergenerational effects of compulsory schooling. *Journal of Labor Economics, 24,* 726–760.

Pungello, E. P., Kupersmidt, J. B., Burchinal, M. R., & Patterson, C. (1996). Environmental risk factors and children's achievement from middle childhood to adolescence. *Developmental Psychology, 32,* 755–767.

Quint, J., Bos, J., & Polit, D. (1997). *New chance: Final report on a comprehensive program for young mothers in poverty and their children.* New York: MDRC.

Raudenbush, S. W. (2001). Comparing trajectories and drawing causal inference from longitudinal data. *Annual Review of Psychology, 52,* 501–525.

Rich, L. M., & Kim, S. (1999). Patterns of later life education among teenage mothers. *Gender and Society, 13,* 798–817.

Rutter, M. (2003). Psychosocial influences: Critiques, findings, and research needs. *Development and Psychopathology, 12,* 375–405.

Saxe, G. B., Guberman, S. R., & Gearhart, M. (1987). Social processes in early number development. *Monographs of the Society for Research in Child Development, 52*(2, Serial No. 216).

Shonkoff, J. P., & Phillips, D. A. (Eds.). (2000). *From neurons to neighborhoods: The science of early childhood development.* Washington, DC: National Academy Press.

Singer, J. D. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. *Journal of Educational and Behavioral Statistics, 24,* 323–355.

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75,* 417–453.

Sobel, M. E. (1998). Causal inference in statistical models of the process of socioeconomic achievement. *Sociological Methods and Research, 27,* 318–348.

Stevens, J. H. (1988). Social support, locus of control, and parenting in three low-income groups of mothers: Black teenagers, Black adults, and White adults. *Child Development, 59,* 635–642.

Stevenson, D. L., & Baker, D. P. (1987). The family-school relation and the child's school performance. *Child Development, 58,* 1348–1357.

Stipek, D. J., & Ryan, R. H. (1997). Economically disadvantaged preschoolers: Ready to learn but further to go. *Developmental Psychology, 33,* 711–723.

Taylor, L. C., Clayton, J. D., & Rowley, S. J. (2004). Academic socialization: Understanding parental influences on children's school-related development in the early years. *Review of General Psychology, 8,* 163–178.

Vadenbelt, M., Luster, T., & Bates, L. (2001). Caregiving practices of low-income adolescent mothers and the academic competence of their first grade children. *Parenting: Science and Practice, 1,* 185–215.

Votruba-Drzal, E. (2003). Income changes and cognitive stimulation in young children's home learning environments. *Journal of Marriage and Family, 65,* 341–355.

Way, N., & Leadbeater, B. J. (1999). Pathways toward educational achievement among African American and Puerto Rican adolescent mothers: Reexamining the role of social support from families. *Development and Psychopathology,* 349–364.

Zachry, E. M. (2005). Getting my education: Teen mothers' experiences in school before and after motherhood. *Teachers College Record, 207,* 2566–2598.

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