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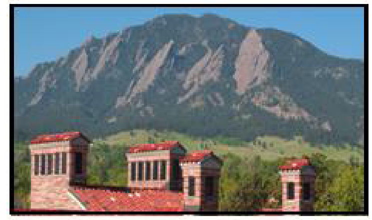

WORKING PAPER

When Do Socioeconomic Resources Matter Most in Early Childhood?

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April 2013

Population Program POP2013-01

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RUNNING HEAD: SES and Development in Early Childhood

* This research is based on work supported by a grant from the National Science Foundation (SES 1061058). Research funds were also provided by the NIH/NICHD funded CU Population Center (R24HD066613). The authors thank Richard Jessor, Joshua Goode, and Jeff Dennis for their contributions to this project. Direct correspondence to Stefanie Mollborn, Sociology and Institute of Behavioral Science, 483 UCB, Boulder, CO 80309-0483. E-mail: mollborn@colorado.edu.

Abstract

Research has established the importance of early socioeconomic advantage and disadvantage for understanding later life outcomes, but less is known about change in the relationship between socioeconomic status (SES) and child development within the period of early childhood. Competing hypotheses drawn from the literature posited: (1) a stable SES-development relationship, (2) a stronger relationship in infancy than at older ages, and (3) a stronger relationship at school entry than at younger ages. Using the nationally representative Early Childhood Longitudinal Study-Birth Cohort (2001–2007), we followed 8600 children from infancy through kindergarten entry to model change over time in the relationship between socioeconomic status and cognitive and behavioral development. The unexpected main finding was that the relationships between three socioeconomic measures (household income, assets, and maternal educational attainment) strengthened from infancy through age 4 or 4½, then weakened slightly until the start of kindergarten. Indirect evidence suggested that preschool education may be an explanation. We argue for researchers to expand the school transition to include the now nearly universal prekindergarten year, as well as for attention to psychological and physiological developmental factors that may shape the relationship between SES and cognitive and behavioral development throughout early childhood.

Keywords: socioeconomic status (SES), cumulative advantage and disadvantage, early childhood, growth curve analysis, ECLS-B

When Do Socioeconomic Resources Matter Most in Early Childhood?

Socioeconomic inequality is regarded as a fundamental cause of disparities in physical, socioemotional, and cognitive development across the life course (Link & Phelan, 1995). Seeking to understand how inequality contributes to variation in development, social scientists have drawn on the concepts of cumulative advantage and disadvantage, hypothesizing that an abundance or dearth of socioeconomic resources at one point in the life course establishes a path of enduring well-being or hardship even when material circumstances change (Case, Lubotsky, & Paxson, 2002; DiPrete & Eirich, 2006). Research investigating this path dependence has focused on early childhood as a period when environmental context is expected to enhance or constrain critical periods of development and growth. Because early childhood conditions have long-term consequences, every U.S. dollar invested in early childhood education is estimated to return $8-14 later on (Duncan, Ludwig, & Magnuson, 2007). Despite increasing acknowledgment of the critical importance of support during early childhood, young children are particularly socioeconomically marginalized: Poverty rates are at their highest in early childhood, with 25% of U.S. children ages 6 and under living below the poverty line in 2010 and 48% classified as low-income (Addy & Wight, 2012).

The developmental stage called early childhood masks a wealth of developmental changes within young children over time, as well as changes in their families and contexts. Much of the literature on policy measures in early childhood focuses on the preschool period, rather than on earlier ages (Duncan et al., 2007). In contrast, research on the effects of socioeconomic status has investigated all ages within early childhood. The interdisciplinary literature on cumulative advantage and disadvantage has identified periods as early as fetal development when exposure to compromised nutrition or a mother's physical response to stress curtails children's optimal long-run development (Barker, Eriksson, Forsen, & Osmond, 2002; Boardman, Powers, Padilla, & Hummer, 2002). A distinct body of work on the school transition points to kindergarten and first grade as an important point when socioeconomic status sorts students into unequal educational experiences and sets up their trajectories of future achievement (Alexander, Entwisle, & Dauber, 1993; Entwisle, Alexander, & Olson, 2004).

As provocative as these and other findings are, much extant research on early childhood and later outcomes relies on between-person variation observed in natural experiments or retrospective data to establish an association between exposure to hardship at one point in childhood and later outcomes. Other studies treat early childhood as a homogeneous age block from 0-5 years old (e.g., Duncan, Yeung, Brooks-Gunn, & Smith, 1998; Wagmiller, Lennon, Kuang, Alberti, & Aber, 2006). Collectively, these studies lack repeated observations on individuals over the course of early childhood. As a result, extant research cannot account for unobserved characteristics or intervening events that may explain observed associations; nor can it directly compare the influence of socioeconomic circumstances on development at various stages *within* the same individual. Longitudinal data can open the "black box" of the preschool years between birth and the transition to school to track the relationship between socioeconomic resources and outcomes within children over time. An analysis based on longitudinal nationally representative data can better pinpoint the period during which socioeconomic resources are most consequential for children and inform policy regarding the most effective time to intervene in the early lives of disadvantaged children with income supplements or educational programs designed to offset the effects of economic hardship. We employed this approach to determine at what point in early childhood socioeconomic status matters most for children's cognitive and behavioral school readiness at kindergarten entry. Using nationally representative longitudinal survey data that followed the same children from birth through the start of kindergarten, we conducted growth curve analyses to model change within children over time in the relationship between socioeconomic resources and cognitive and behavioral outcomes.

BACKGROUND

Socioeconomic status (SES) and child development in the early life course

Early childhood, often defined at birth through age 5, is increasingly recognized as fundamental for understanding socioeconomic and other social disparities throughout life. Some researchers have arrived at this insight by documenting "inequalities at the starting gate" of school entry (Lee & Burkam, 2002) and reasoning that they must have been established during early childhood. Burkam and colleagues (2004) found differences of more than a standard deviation between the kindergarten reading, mathematics, and general knowledge scores between children from the lowest SES quintile compared to the highest. Another line of research has noted the increasing importance of SES in middle childhood compared to adolescence. For example, Guo (1998) found that childhood (primarily measured at ages 5-8) is a more important period than adolescence for the development of cognitive ability. A third strand of research has directly compared early childhood to later life stages, treating ages 0-5 as a homogeneous block. Duncan and colleagues (1998) found that family poverty in early childhood was more important than later poverty for understanding cognitive achievement. Wagmiller and colleagues (2006, p. 850) summarized extant research: "Because early childhood is the period in which children acquire cognitive and social competencies that form the basis of future learning and academic success, persistent economic disadvantage during this period can have long-term effects on subsequent school performance and later status attainment." Reasoning similarly, Duncan and colleagues (2007) and Heckman (2008) concluded that policy investments in early childhood are the most efficient for maximizing returns throughout the life course.

Despite children's and parents' many developmental and circumstantial changes across early childhood, none of the work described above has actually measured the SES-development relationship across the range of ages 0-5. In doing so here, we articulated three competing hypotheses about change in the relationship between SES and cognitive and behavioral development across early childhood. Figure 1 summarizes and illustrates each. To adjudicate among the hypotheses, growth curve analyses estimated the concurrent relationship between SES and cognitive and behavioral development in the same children from infancy through kindergarten start. We included three of the four typically measured dimensions of socioeconomic status: education, wealth, and income (occupational status was excluded). Each of these domains has been found to be consequential for child development (Dearing, McCartney, & Taylor, 2001; Duncan & Magnuson, 2001; Hillemeier, Morgan, Farkas, & Maczuga, 2011; Mayer, 1997; Shanks, 2007). Analyses focused on cognitive and behavior scores because of their mutually reinforcing relationship in the early life course (Halonen, Aunola, Ahonen, & Nurmi, 2006) and their implications for later socioeconomic attainment (Alexander et al., 1993; Weller, Schnittjer, & Tuten, 1992).

FIGURE 1 HERE

Hypothesis 1: Constant SES-development relationship over time

Early childhood is used to describe a developmental stage ranging from birth to the beginning of school age. The relationship between socioeconomic status and child development has been documented at points throughout this age range. For example, previous research has identified socioeconomic disparities in birth outcomes (Blumenshine, Egerter, Barclay, Cubbin, & Braveman, 2010), as well as in cognitive outcomes during the transition to school (Burkam et al., 2004). Thus, it is possible that the relationship between SES and developmental outcomes remains constant throughout the ages between these time points. This logic motivates the first hypothesis.

The last two hypotheses assume that the SES-development relationship is more consequential in some parts of early childhood than others. Developmental researchers have identified "critical periods" in early life during which certain conditions must exist for children's development to progress optimally (Dietz, 1994). Because socioeconomic status shapes a child's developmental conditions (Guo & Harris, 2000), it may be more important during such critical periods. The last two hypotheses differ in the ages they identify as most critical.

Hypothesis 2: Decreasing SES-development relationship over time

Building on the "Barker hypothesis" about the fetal origins of physical health disparities in later life (Barker et al., 2002), researchers have found evidence linking birth weight with cognitive and motor development in childhood and adolescence (Boardman et al., 2002; Datar & Jacknowitz, 2009). This research suggests that prenatal conditions are a key driver of developmental disparities. Because SES has been linked to birth outcomes (Blumenshine et al., 2010), the relationship between SES and early childhood development may thus be stronger the earlier in the life course one looks. This logic underlies the idea of cumulative advantage and disadvantage across the life course, an essential theoretical idea in both the stratification and health disparities literatures (Case et al., 2002; DiPrete & Eirich, 2006). DiPrete and colleagues (2006) have articulated a path-dependent model of cumulative advantage, in which early SES shapes early development, which subsequently affects later development. In other words, a path of compromised development may be self-sustaining once begun, and the earlier the disadvantage, the more time it has to accumulate. The implication of this idea is that, though inequalities grow larger as time passes, SES has a stronger relationship with child outcomes at earlier time points, and then path-dependent developmental processes take over that are at least partially independent of later socioeconomic conditions. DiPrete and coauthors (2006) highlighted the work of developmental psychologists documenting path-dependent models of reading ability in which early development feeds into later development (Bast & Reitsma, 1998). Research on the relationship between SES and health throughout the life course has supported similar path-dependent cumulative advantage processes, in which earlier conditions are more influential than later conditions (Hayward & Gorman, 2004; Willson, Shuey, & Elder, 2007).

Hypothesis 3: Increasing SES-development relationship over time

Although many life course scholars might intuitively identify prenatal conditions or the beginning of life as the most important time in the relationship between SES and child development, some emerging research points to a different critical period in early childhood: the transition to school. Life course theory focuses on transitions as significant turning points in individuals' development (Laub & Sampson, 1993). The addition of the social institution of school to the other major social institution in most children's lives—the family—starts children on a new social and educational trajectory. At the same time, the educational system builds on inequalities that already exist at the family level. High-SES students not only start school with higher test scores than low-SES students (Entwisle, Alexander, & Olson, 1997), but they also typically attend neighborhood schools that are better equipped, spend more money per student, and give their students higher grades (Entwisle et al., 2004). For these and other reasons, family background affects children's academic outcomes more strongly during the transition to school than in later years. A path-dependent cumulative advantage process appears to be the explanation for this: The correlation of reading scores from the transition to school with tenth-grade reading and math scores has been estimated at 0.57 (Weller et al., 1992), and with sixth-grade scores in an Australian sample it was 0.66 (Butler, Marsh, Sheppard, & Sheppard, 1985). Children's academic trajectories are also surprisingly stable from the transition to school onwards with regards to ability group placement (Dauber, Alexander, & Entwisle, 1996) and grades (Alexander et al., 1993).

The relationship between SES and development across early childhood through the transition to school has not been assessed previously, but extant research supports the idea that this relationship may strengthen as early childhood progresses. Two previous studies have used our study's data (the ECLS-B) to estimate regression models analyzing the relationship between socioeconomic status and children's outcomes at specific time points in early childhood. Halle and colleagues (2009) found small but significant relationships between both maternal education and household income and children's cognitive and behavior scores at 9 months old, and these relationships were much stronger at 24 months. Hillemeier and colleagues (2011) found that the relationship between maternal education and children's cognitive delay increased from infancy through 48 months. Neither of these studies examined development at older ages or modeled the relationship between SES and outcomes within children across time.

Considerable research has documented growing socioeconomic disparities in educational outcomes across the early life course, even though exposure to classroom learning actually reduces socioeconomic gaps (Downey, Von Hippel, & Broh, 2004; Ready, 2010). Much of this work takes kindergarten or first grade as its starting point (Entwisle et al., 2004). However, preschool is an increasingly universal setting for building or reinforcing foundational cognitive skills like letter recognition, phonics, and basic numeracy, as well as social interaction skills. Like elementary schools, preschools vary in program quality and curricular content, although between-school variability tends to be smaller than variability between families in learning environments (Downey et al., 2004; Ready, 2010). Hence, preschool settings may become the educational training ground in which family-based SES differences are first manifested or mitigated by school influences.

METHOD

Data

The data is from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B). This dataset followed a nationally representative sample of about 10,600 children born in 2001 from infancy through the fall of their kindergarten year (U.S. Department of Education, 2007).[i] The ECLS-B is the only nationally representative U.S. study that has tracked children through the first years of life using both parent interviews and direct assessments. The sample was drawn using a clustered, list frame design drawn from all 2001 births registered in the National Center for Health Statistics vital statistics system. Children were included from 96 different counties or county groups across the U.S. The small number of children with mothers below age 15 at their birth were not eligible.

This study used multiple waves of data, including waves of information collected when the children were about 11, 24, and 52 months old (typically the fall before the start of kindergarten), and in the fall of their kindergarten year at an average of 66 months old (most children were interviewed at kindergarten entry in the fall of 2006, but some were re-interviewed to capture their kindergarten entry in the fall of 2007). The primary parent was interviewed face to face, and this was almost always the biological mother. Budgetary constraints dictated that the kindergarten wave use a random subsample of about 85% of the children who had completed the parent interview of the preschool wave. In order to preserve specific population numbers for minority groups, all American Indian/Alaska Native children who completed either the 2-year or the preschool wave were included (Snow et al., 2009). The weighted response rates for the parent interviews were as follows for each wave: 74, 93, 91, 92, and 93%. As missing data is allowable in a growth curve analysis, we were able to keep all children who had data for at least two waves (of waves 1, 2, 3, and kindergarten). In addition, some of the covariates we used applied to biological mothers only and so we further restricted our sample to children whose biological mothers completed the parent survey at all available waves. Based on these constrictions, our eligible sample of children (those who had at least two reading or math outcomes, had biological mothers complete the survey, and who had valid weights and clustering information) was approximately 8850 children. After listwise deletion of missing data, about 8500 children were analyzed for the reading and math outcomes, and about 8200 for the behavior outcome.[ii]

Measures

Outcomes. We used three different outcome variables to capture different aspects of a child's well-being including cognitive/reading, cognitive/math, and positive behavior outcomes.

Time-varying outcomes were measured at all waves (1, 2, 3, and kindergarten). The kindergarten wave was taken from either wave 4 or wave 5, depending on the wave at which the child first began kindergarten.

The cognitive outcomes came from one-on-one child assessments adapted from reliable assessment batteries previously developed for other studies or developed specifically for the ECLS-B. Children in the early waves were too young for measuring reading and math and so were given the Bayley Short Form – Research Edition (BSF-R) mental assessment at waves 1 and 2. This assessment measured early cognitive development including communication, expressive and receptive vocabulary, problem-solving, and comprehension.[iii] The BSF-R mental scale had an overall IRT reliability coefficient of r_{xx}=0.80 at wave 1 and r_{xx}=0.98 at wave 2. See Nord et al. (2006) and Snow et al. (2009) for additional information on these assessments. In later waves (3 and kindergarten), interviewers administered early reading and math assessments adapted from various reliable assessment batteries developed for other studies targeting similar ages, such as the Peabody Picture Vocabulary Test, the Preschool Comprehensive Test of Phonological and Print Processing, the PreLAS® 2000, the Test of Early Mathematics Ability-3, and sister study Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K).[iv] Early reading was assessed by test with 35 items covering areas appropriate to the preschool age of the children such as phonological awareness, letter recognition and sound knowledge, print conventions, and word recognition (ECLS-B-reported reliability=0.84). Early math was assessed in two stages, and children were routed after the first stage depending on their score. These assessments evaluated counting, number sense, operations, geometry, pattern understanding, and measurement (ECLS-B-reported reliability=0.89). We standardized each of the scale scores for the cognitive, reading and math evaluations within each wave, which then allowed us to compare a child's score relative to his or her peers across the cognitive evaluations in waves 1 and 2 and early reading and math in waves 3 and kindergarten.

Measurement of child behavior also varied by wave, with early waves using the average of a number of indicators observed by the interviewer (the Interviewer Observations of Child Behavior assessment at waves 1 and 2), and later waves using early child care and education providers (wave 3) and kindergarten teachers (kindergarten wave, drawn from the Preschool and Kindergarten Behavior Scales—Second Edition, the Social Skills Rating System, the Family and Child Experiences Study, and new questions developed for the ECLS-B at waves 3 and kindergarten). These later measures were also standardized within each wave to allow for cross-wave comparison.[v] Examples of indicators included were: the number of times the child displayed positive affect, frequency of social engagement, and how often the child showed cooperation. The number of behavior items varied by wave with 6, 10, 15, and 16 behavior items in waves 1, 2, 3, and kindergarten, respectively. Negative behaviors were reverse coded so that higher behavior scores always represented more positive behaviors while lower scores represented more negative behaviors. Our study used only nonparent reports as parent reports may have been more susceptible to social desirability bias. By wave, alpha reliability scores were 0.80, 0.94, 0.99, and 0.93 (waves 1, 2, 3, and kindergarten, respectively).

Independent variables. Constructed variables for child's age at assessment were taken at each wave and rounded to the nearest month, centering each with 1 year set to zero. We also calculated the square of the centered age term, which was centered to the sample mean. The independent variables were all time-invariant background factors with the exception of child age and socioeconomic resources (described below). Many of the time-invariant indicators were collected in more than one interview, allowing us to fill in gaps using reports from later waves when earlier waves were missing. Reports in the ECLS-B survey were prioritized over birth certificate reports. Additionally, all independent variables were centered to the sample mean except for age, age squared, and the interaction terms.

We included several demographic controls. Teen parent status indicated whether or not either the child's biological mother or father (or both) was under the age of 20 when the child was born. We used each parent's own report when available but filled in missing data from other sources where the parent's own report was missing. Child gender was a constructed measure in the ECLS-B. Child race was also constructed by the ECLS-B and coded as White, Black, Hispanic, and other race (including Asian/Pacific Islander, Native American/Alaska Native, and multiracial children). We used indicators of whether the household primary language was English and whether the mother was foreign born as proxies for immigration status. The mother's marital status at birth was included.

Control variables measuring prenatal conditions and birth outcomes were also analyzed. Birth weight was constructed by ECLS-B and coded as moderately low (<2500g and $\geq$1500g) or very low (<1500g), compared to normal ($\geq$2500g). Preterm birth was defined as birth before 37 weeks' gestation. Additional variables indicated whether the biological mother had smoked or drunk at least one alcoholic drink per week during the last trimester of pregnancy. Women not receiving prenatal care in the first trimester or not receiving care at all were coded as 1, with those receiving care in the first trimester coded as 0. Birth order was coded as 1 for the mother's first live birth, 2 for second-born, and so on.

Other variables were used to measure disadvantaged backgrounds. One indicator of disadvantage measured whether the biological mother's mother had been a teen mother, which included a category for missing information because those who did not live with their biological mother as a child or whose biological mother had died prior to the interview were not asked this question. Additional indicators measured whether the child's biological mother had repeated any grade in school, if the mother's family was ever on welfare when the mother was between the ages of 5 and 16, and whether or not the mother lived with both biological parents continuously until age

16. To control for endogeneity bias, we included cognitive scores from wave 1, health status as reported by the parent (very good/excellent versus good/fair/poor), if the child had ever been diagnosed as having asthma, and positive behavior as time-invariant background indicators. Each individual analysis omitted the measure that was equivalent to that specific outcome. For example, in models predicting cognitive/reading scores, wave 1 constants for health, asthma, and behavior were included, but wave one constants for cognitive scores were omitted. Finally, duration of child care by someone other than a parent was coded as 0, 1-29, or 30 or more hours per week.

Socioeconomic status. We measured three dimensions of socioeconomic status: income, education, and wealth. Information from kindergarten entry was used, but 2006 measures were used to fill in any missing information for 2007 kindergarten starters. We used an income-to-needs ratio, which coded (ECLS-B-constructed or ECLS-B-imputed, when necessary) household income as a percentage of each survey year's federal poverty threshold for the reported household size. The mother's educational attainment, also constructed by the ECLS-B, was continuous (recoded from a categorical measure) and reported the total years of education the mother had completed. A household assets scale took the average of the following dichotomous indicators: whether or not the household owned a car, had stocks or investments, had a checking or savings account, owned its residence, and received free or subsidized housing (Cronbach's alpha = 0.71).

To test for age-related change in the relationship between socioeconomic resources and child development, we created interactions between child age and each of the three socioeconomic measures, as well as interactions between these measures and child age squared. Additional analyses used a similar approach to assess interactions between child age/age squared and child care hours (none, part-time, and full-time).

Analyses

We first analyzed descriptive information to document change in socioeconomic resources over time. Multivariate analyses used growth curve models to predict trajectories by child outcome (reading, math, and behavior), analyzing time points (level 1) nested within individual children (level 2). Multilevel regression models were estimated for all models.

We interacted child age and its square term with each socioeconomic resource measure to estimate the relationship between socioeconomic resources and trajectories of child outcomes. The interaction term captured age-related change in the relationship between socioeconomic resources and child outcomes. Comparing linear and quadratic functions of child age (level 1), the quadratic models were the best fit (determined by comparing the Bayesian Information Criterion and significance of age squared terms), showing that socioeconomic disparities did not change uniformly with age. These models provide statistically efficient and unbiased estimates of trajectories in child outcomes under assumptions of multivariate normality (Raudenbush & Bryk, 2002). The methods used allowed for inclusion of all children who had at least two waves of data, which minimized the impact of survey attrition. The within-child focus of our models allowed for within-individual change, inherently controlling unmeasured stable differences across children. Additional models replaced the socioeconomic interactions with interactions between child age (and age squared) and hours of nonparental child care. Due to problems of multicollinearity, models interacting multiple resources with age and age squared in the same model did not produce reliable estimates. Interaction terms with child age/age squared for each socioeconomic measure and for child care hours and age and age squared were therefore included one at a time in separate models.

We used Stata to estimate the models using the "xtmixed" command. To make the findings representative for the 2001 U.S. birth cohort, we used probability weights and a sandwich estimator of standard errors that adjusted for clustering within the primary sampling units. In addition, we simplified the models by assigning one unique variance parameter per random effect and assumed covariance parameters to be zero. The form of the basic multilevel model for person *i* at time *t* is:

$$S_{ti} = \beta_{0i} + \beta_{1i}(A_{ti} - L) + \Sigma\, \beta_{ki}X_{kti} + r_{ti} \quad (1)$$

$$\beta_{0i} = \gamma_{00} + \Sigma\, \gamma_{0j}W_{ji} + u_{0i}, \quad (2a)$$

$$\beta_{1i} = \gamma_{10} + \Sigma\, \gamma_{1j}W_{ji} + u_{1i}, \quad (2b)$$

$$\beta_{ki} = \gamma_{k0}. \quad (2c)$$

The linear increase in the developmental trajectory for each child is reflected in the coefficient β_{1i}, and is allowed to vary randomly. The value L reflects the centering term of age 1 year. The β_{ki} coefficients for k level-1 time-varying variables were treated as fixed (i.e., $\beta_{ki} = \gamma_{k0}$). The γ coefficients for j time-invariant W variables indicate the effect of background characteristics on each outcome in 2a, and the trajectories over time of each outcome in 2b.

RESULTS

Descriptive analyses

Table 1 reports weighted means for all variables, at all waves for time-varying measures. Because the three outcomes were standardized to the full sample mean at each wave, change over time for reading, math, and positive behavior is not meaningful. But socioeconomic resources did change meaningfully throughout early childhood. Average household income increased from 290% of the federal poverty line (adjusted for household size) in infancy to 351% in the fall of kindergarten. This increase was concentrated in the prekindergarten year. Average household assets increased with age as well, but this change was small with about 3½ of the 5 assets possessed by the typical household throughout early childhood. Average maternal educational attainment also increased over time by more than one third of a year, with change more concentrated in the earlier years. Finally, the average number of hours per week spent in nonparental child care increased from about 16 in infancy and at age 2, to 23 at age 4½, to 34 (including kindergarten attendance) at kindergarten start. Note that our goal is to determine changes in the *effects* of resources over time, and that changes in levels of resources across the study period will not influence these effects.

INSERT TABLE 1 HERE

When does socioeconomic status matter most in early childhood?

Growth curve analyses capturing time points nested within individual children estimated the time-varying association between socioeconomic resources and children's cognitive and behavioral outcomes. As expected, we found that concurrent socioeconomic resources were positively related to child development. Supplemental models that included all controls and socioeconomic measures but did not interact socioeconomic measures with age found that all three measures significantly predicted cognitive/reading scores, household income and maternal education predicted cognitive/math scores, and household income and assets predicted behavior scores.

Table 2 reports models that included interactions between each socioeconomic resource and child age and age squared. Figure 2 interprets the interactions, graphing the relationship between each socioeconomic resource and each child outcome across the age range of the study. The shaded portion of the figure indicates ages above the average age when children left the study (i.e., results for children who started kindergarten at older ages). Figure 2 illustrates that the three socioeconomic resource types had similarly shaped relationships to each child outcome over time, with peak positive effects at around age 4 to 4½. The strength of these positive relationships increased sharply from zero or below in infancy to an inflection point at around the start of the prekindergarten year, followed by a much less marked decrease through the fall of kindergarten start. At the relationship's peak strength, the increase in cognitive/reading and math scores associated with an increase in household income equivalent to 200% of the federal poverty line was almost 0.2 standard deviations. The equivalent relationship with positive behavior scores was smaller, peaking at about 0.06 standard deviations. A change from possessing half of the household assets in the scale to all of them predicted an increase in cognitive/math and reading scores of more than one quarter of a standard deviation at the relationship's peak, and about one eight of a standard deviation for behavior. An increase in maternal education equivalent to the change from a high school degree to a college degree predicted an increase in cognitive/reading and math scores of 0.4 standard deviations at the peak of the relationship, with a weaker peak for behavior of about 0.08 standard deviations. In sum, although the strength of the relationship varied, the association between socioeconomic resources and early child development strengthened rapidly from infancy through the beginning of prekindergarten, then weakened slightly but remained strong through the start of kindergarten.

TABLE 2 AND FIGURE 2 HERE

Supplemental piecewise growth curve models estimated this U-shaped relationship another way to assess its robustness. We estimated a linear relationship between each socioeconomic resource and each outcome from wave 1 (infancy) to wave 3 (age 4½), then estimated a distinct linear relationship from wave 3 to wave K (kindergarten start). Quadratic terms could not be included in the piecewise models because of the limited number of waves of data. Confirming our main analyses, there was a significant positive change in the relationship between each socioeconomic resource and each outcome between waves 1 and 3. Confirmation of the downturn between prekindergarten and kindergarten was inconsistent. The piecewise models found a significant slight downturn in the relationship between each socioeconomic resource and cognitive/reading scores and between maternal education and cognitive/math scores. There were no significant changes from wave 3 to wave K in the relationships between maternal education and behavior scores, or between income or assets and cognitive/math scores. In contrast to our main models' findings, changes in the relationships between income and assets and behavior scores were significant and positive between waves 3 and K in the piecewise models. In sum, our supplemental piecewise models strongly supported the initial increase in the strength of the SES-development relationship but were equivocal about the subsequent decrease found between prekindergarten and kindergarten in the quadratic models.

Because they did not represent monotonic change from infancy through the start of the school transition, these findings did not neatly support any of the hypotheses listed in Figure 1. In exploring why we consistently found a peak in the relationship between socioeconomic resources and children's cognitive and behavioral development during prekindergarten, we were constrained by data limitations for the growth curve framework. We could not introduce additional interactions of other variables with child age to try to explain change over time in the SES-development relationship (represented by the interactions of each resource with child age and age squared). Including additional variables that were not interacted with child age or conducting cross-sectional analyses could not address our interest in change over time in the socioeconomic resource-child development relationship. For this reason, we can only provide suggestive evidence of the potential role of preschool education in understanding change over time in this relationship. Other potential alternative explanations are discussed in the next section.

One possible explanation for the curvilinear relationship between socioeconomic resources and child cognitive and behavior development is that family socioeconomic status is translated into preschool education, which subsequently becomes the prime shaper of child development during prekindergarten (see discussion below). Previous research supports the idea that parental socioeconomic status translates into more educationally beneficial preschool experiences (Augustine, Cavanagh, & Crosnoe, 2009). Evidence from our supplemental analyses (displayed in Figure 3) indirectly supported this idea for cognitive outcomes. Despite substantial average levels of nonparental care in the early years of life, relationships between exposure to care and children's developmental outcomes were near zero. Starting about at age 4 to 4½, the amount of time spent in nonparental child care (which includes preschool) became increasingly strongly related to cognitive/reading and math scores. This relationship strengthened substantially throughout the prekindergarten period into kindergarten. A similar pattern over time, but in the negative rather than positive direction, was evident for behavior scores. These findings, that exposure to nonparental care in the prekindergarten period was associated with an increase in cognitive scores and a decrease in behavior scores, echo previous literature (Crosnoe, 2007; Magnuson, Ruhm, & Waldfogel, 2007; NICHD Early Child Care Research Network, 2002).

INSERT FIGURE 3 HERE

DISCUSSION

Researchers and policymakers are increasingly emphasizing early childhood as an important time to bolster families' socioeconomic resources. Yet a dearth of longitudinal, nationally representative data has largely kept the relationship between socioeconomic resources and development in the first five years of life as a "black box." Here, we articulated competing hypotheses for change across early childhood in the SES-development relationship and tested them using ECLS-B data, which tracked a nationally representative sample of children from birth through the start of kindergarten. We unexpectedly found a curvilinear relationship between socioeconomic resources and children's cognitive and behavioral development during early childhood. In the domains of income, assets, and maternal education, this relationship increased sharply from near zero in infancy to a peak at age 4 to 4½, then decreased slightly but remained strong through kindergarten start.

Why does the relationship between family SES and behavioral and cognitive development peak in prekindergarten rather than progressing linearly throughout early childhood? As described above, limitations with the growth curve model prevented us from directly testing mediation of this change over time. To stimulate future research, we highlight three potential explanations that are supported in the literature, although we emphasize that they are not mutually exclusive and may interact. We first focus on the role of *preschool*, which has different implications for cognition versus behavior. Although many children receive nonparental care throughout early childhood, by the year prior to kindergarten, nonparental care is nearly universal and much more likely to be center-based. Fully 82% of our sample received nonparental care in the year before kindergarten, and 92% of those children were in center-based "preschools."

Besides being widespread and occurring in more formal settings, center-based care in the prekindergarten year (but not earlier in childhood) has been shown to temper the effects of family-related factors such as SES on children's cognitive development. Using ECLS-B twin data, Tucker-Drob (2012) found that family-level influences on kindergarten reading and math scores were much higher for children not enrolled in center-based preschool at age 4½ than for those enrolled, accounting for 72-73% of the variance in scores in the former group and 42-45% in the latter. Prekindergarten center-based care moderated the effect of family SES on kindergarten cognitive scores, with socioeconomic inequalities in child outcomes less pronounced among children who had been enrolled in preschool. In contrast, preschool enrollment at age 2 did not affect the importance of family environment. These findings echo previous research (Magnuson, Meyers, Ruhm, & Waldfogel, 2004) that also found center-based care in the year before kindergarten to be more beneficial for children from lower-SES backgrounds.

Providing that children are enrolled in preschool in the prekindergarten year, the implications of these findings are that the relationship between family SES and children's cognitive outcomes should be strong but begin to diminish with exposure to prekindergarten. Our findings were suggestive of this pattern. However, it is important to note that the few children not enrolled in preschool at this age tend to be from lower-SES families (Tucker-Drob, 2012) and higher SES tends to predict higher-quality preschool education (Augustine et al., 2009), both of which suggest a stronger SES-cognitive development during prekindergarten than would be expected if preschool enrollment were universal.

An explanation for the curvilinear relationship between family SES and children's behavior scores requires different reasoning because center-based care in the year before kindergarten predicts lower scores for behavior, in contrast to higher cognitive scores (Magnuson et al., 2007; NICHD Early Child Care Research Network, 2002). Here, the reduced probability of preschool enrollment among lower-SES children (Tucker-Drob, 2012) may be key. The worsening behavior scores of the generally higher-SES children enrolled in prekindergarten care may reduce the relationship between SES and behavior in the year prior to kindergarten.

Overall, the association between SES and behavior was weaker at each wave compared to the association between SES and cognitive outcomes. This is consistent with prior literature, which has shown that SES is only weakly associated with children's behavior in very early childhood (Earls, 1980) and becomes more pronounced by middle childhood, and that associations between SES and behavior by school entry are smaller in magnitude compared to those for cognitive development (Bradley & Corwyn, 2002; Duncan, Brooks-Gunn, & Klebanov, 1994; McLeod & Shanahan, 1996). Numerous studies have documented stronger associations between family structure and children's behavior problems net of household income during early childhood (Amato, 2010; Parcel, Campbell, & Zhong, 2012), suggesting that different but related domains of household context operate on distinctive components of children's development.

The second explanation we highlight for the peak in the SES-child development relationship during prekindergarten is the *developmental "growth spurt"* that begins around age 4 or 5 (Entwisle & Alexander, 1998). From then until about age 8, children experience intense cognitive and social development and learning at a rate that is estimated to be 10 times as high as that of a high school student (Jencks, 1985). Thus, the same child care setting may have stronger developmental implications at age 4 or 5 compared to earlier ages. Beyond preschool education, the family context may also have different developmental consequences at different ages because of this growth spurt.

For example, Guo and Harris (2000) found that parenting style and two aspects of the home setting (available cognitive stimulation and general physical environment) mediated much of the relationship between family poverty and cognitive development (mostly measured at age 5 and older). Their study argues for the importance of these family-related factors over nonparental care: Analyzing a subsample of children of working mothers, Guo and Harris found no relationship between poverty and child care quality or between child care quality and cognitive outcomes. Thus, the developmental growth spurt may interact with preschool as an explanation for the peak in the SES-development relationship by heightening the importance of prekindergarten education. Alternatively or additionally, it may change the implications of family-related factors related to the SES-development relationship.

Finally, there is a more interaction-related potential explanation for the peak in the SES-development relationship: *children's changing awareness and performance of social class*. Previous research has shown that preschoolers readily make social class distinctions and articulate differences between rich and poor (Ramsey, 1991). Four-year-olds also perform social class in preschool settings, primarily through distinct linguistic styles resulting in greater opportunities to develop language skills for higher-SES children (Streib, 2011). These findings have implications for both the cognitive and behavioral domains. For class awareness and performance to be so well established by age 4, a developmental process must have occurred earlier in life, which could contribute to the growing SES-development relationship peaking around that age.

Regardless of the actual explanation or combination of explanations for the curvilinear SES-development relationship in our study, *we argue that our findings support a modified version of Hypothesis 3*. This hypothesis expected the SES-development relationship to be strongest at the transition to school. We assert that our results speak for an expansion of the conceptualization of the transition to school to include the prekindergarten year. In past research, the transition to school has typically been defined as encompassing kindergarten—which is widespread in public schools but not mandatory for children—and first grade—the beginning of mandatory, formal academic education (Entwisle et al., 2004). The universality of prekindergarten education has changed over time, but findings from our sample reveal formally organized, near-universal center-based care at this age today. Even though most prekindergarten education takes place outside the public school system, it has many of the same empirical implications as the transition to school. For example, like elementary school (Downey et al., 2004; Ready, 2010), center-based prekindergarten care is a socioeconomic equalizer (Tucker-Drob, 2012) and has important consequences for future educational outcomes (Entwisle et al., 2004). There are also arguments based on factors that transcend formal schooling. Because of the developmental growth spurt that lasts from about ages 4 or 5 to 8 and because of preschoolers' established awareness and performance of social class, the developmental stage of prekindergarten is developmentally distinct from earlier childhood and has much in common with the transition to school. For all these reasons, we suggest that future research include the prekindergarten year when studying the transition to school. In this revised conceptualization, our findings suggest that the relationship between family SES and cognitive and behavioral development grows until the start of the school transition in prekindergarten, when it remains high and is subsequently translated into the socioeconomic disparities that other researchers have documented and tracked starting with the school transition (Burkam et al., 2004; Downey et al., 2004; Ready, 2010).

Research looking at socioeconomic inequality using ages 0-5 to represent the developmental stage of early childhood obscures the heterogeneity of this time period. Our results reinforce the idea that it is the interaction of social environments with individuals that produces disparities, and research examining the influence of SES should consider psychological and physiological changes in addition to the social transitions occurring in children's and parent's lives. As the mechanisms of

SES influence are multiple, complex, and variable over time (Link and Phelan, 1995), this study focuses on the timing of the cumulative effect of these mechanisms, rather than exploring individual processes. Theoretical development with an interdisciplinary approach that illustrates how different factors intertwine during specific developmental stages would allow researchers to more accurately describe and model the mechanisms through which SES influences children.

Human capital investments have the greatest returns for the young, because younger persons have more time to recover returns and because "learning begets learning" (Heckman, 2008). While this logic explains why a focus on early childhood is broadly important and argues for a reallocation of funds from programs targeting adults, our results, which clearly point to a peak in the importance of resources around age 4 or 4½, suggest that policymakers interested in reducing inequality should increase attention on the preschool years. Schools, and specifically preschools, serve as equalizers (Magnuson et al., 2004), yet our results suggest that more can be done to mitigate the effects of disadvantage on children's cognitive and behavioral development. While not abandoning the importance of preschool, new programs and research should also look beyond preschool for ways to reduce socioeconomic disparities.

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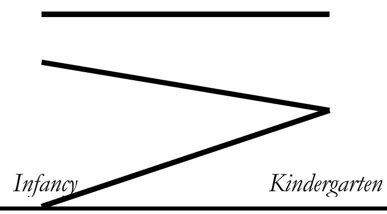
Figure 1. Hypothesized forms of the relationship between socioeconomic resources and child outcomes throughout early childhood

Hypothesis	*Relationship pattern*	*Expected growth curve of SES effect*
1. Constant relationship	Positive relationship between SES and child development remains constant with age	
2. Cumulative advantage/path dependence	Positive relationship between SES and child development decreases linearly with age	
3. Transition to school	Positive relationship between SES and child development peaks at the transition to school	



Note: All explanations use analyses predicting growth curves in cognitive and behavioral development from infancy through kindergarten start.

Figure 2a. Effect of Household Income/Poverty Line across Child Age

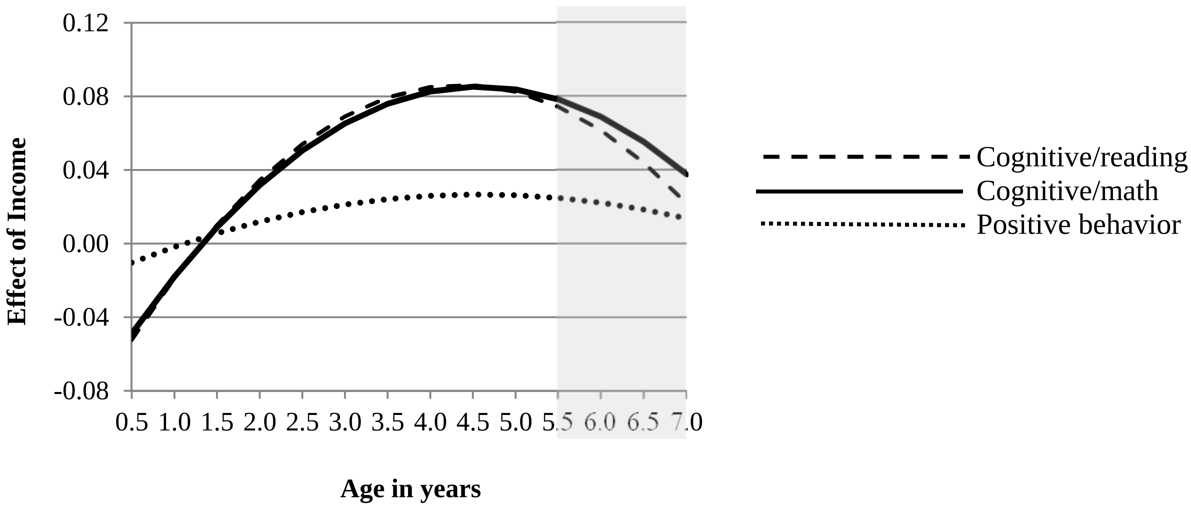


Figure 2b. Effect of Household Asset Scale across Child Age

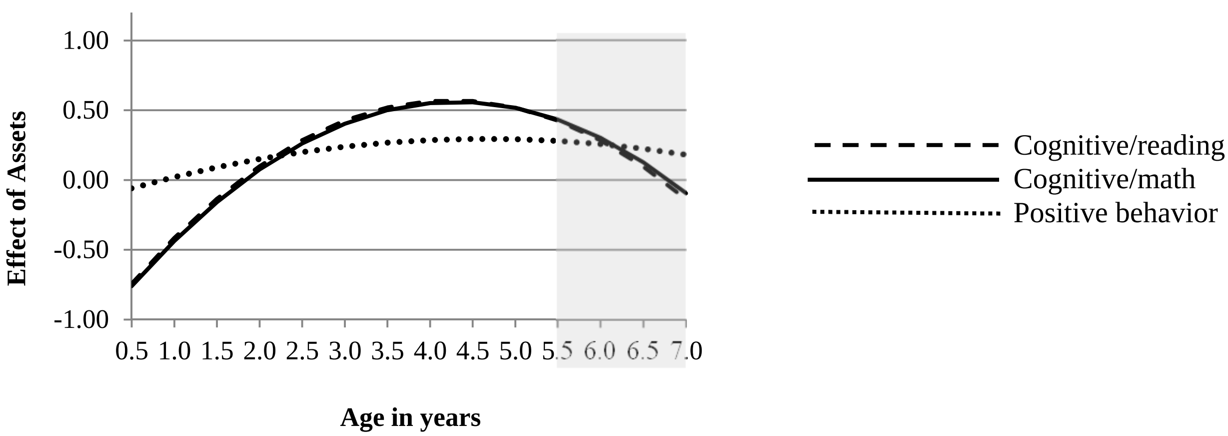
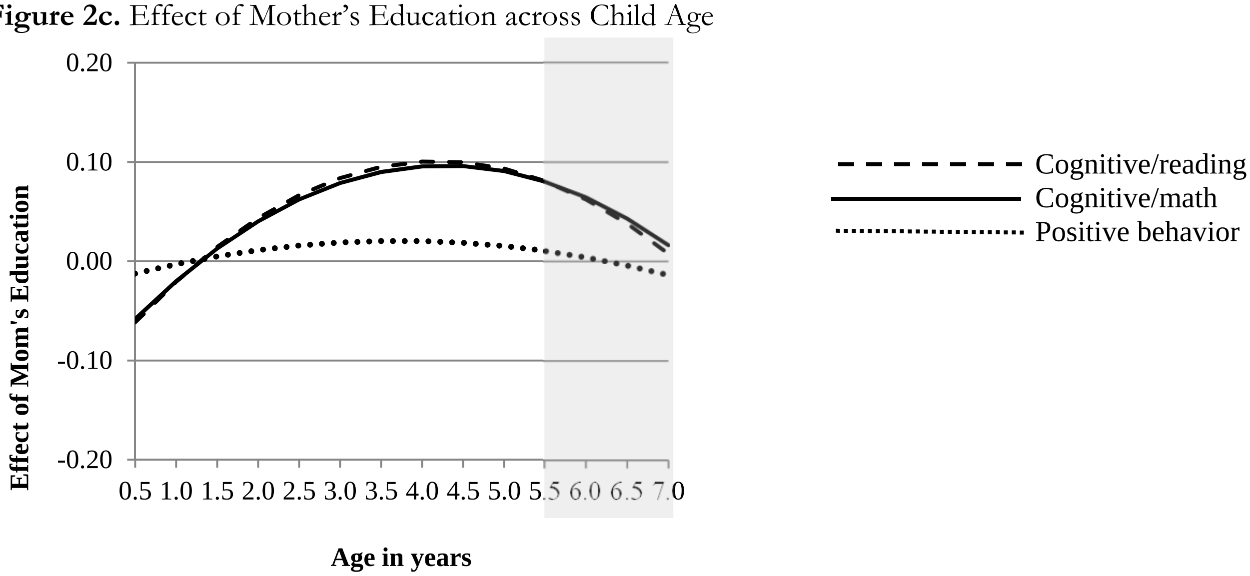
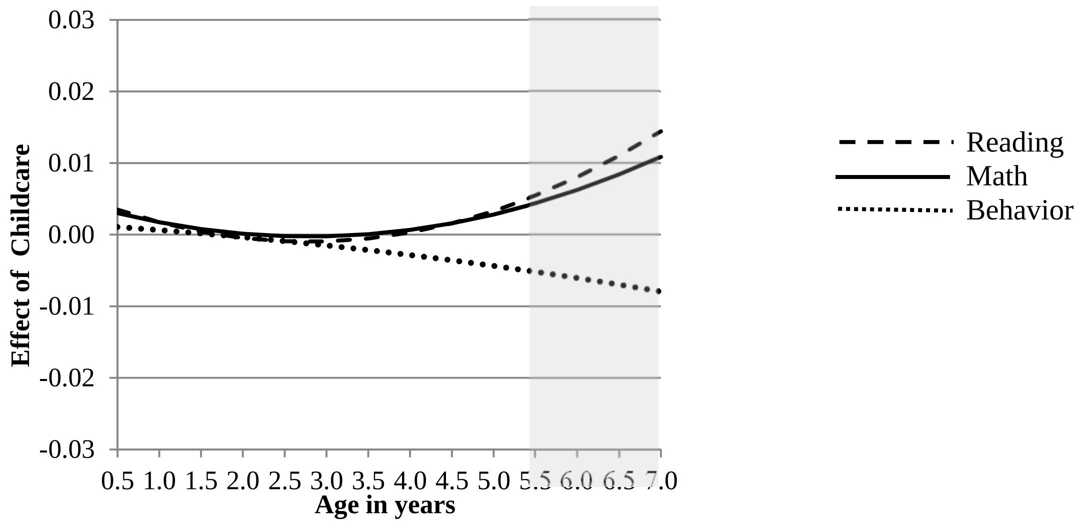


Figure 2c. Effect of Mother's Education across Child Age



Notes: Source: Early Childhood Longitudinal Study-Birth Cohort, 2001-2007. *N* people ≈ 8450 and *N* person-time ≈ 27450 for cognitive/math and cognitive/reading, 8350 and 25500 for behavior. Analyses account for probability weights and clustering. Effects are calculated from Table 2. Shaded areas indicate ages older than average age at exiting sample.

Figure 3. Effect of Hours in Nonparental Child Care by Child Age



Notes: Source: Early Childhood Longitudinal Study-Birth Cohort, 2001-2007. *N* people ≈ 8450 and *N* person-time ≈ 27450 for cognitive/math and cognitive/reading, 8350 and 25500 for behavior. Analyses account for probability weights and clustering. Effects are calculated from models including all control variables, hours in nonparental care, and the interaction of hours in nonparental care with child age and age squared. Shaded areas indicate ages older than average age at exiting sample.

Table 1. Weighted Means for Time-Invariant and Time-Varying Variables

Variable	Wave 1	Wave 2	Wave 3	Wave K
Child age (0.5 to 7.0 years)	0.88	2.04	4.37	5.51
Background controls (time-invariant)				
Born to teen mother and/or father°	0.12			
Male°	0.51			
Child race/ethnicity (White)	0.54			
Black	0.14			
Hispanic	0.25			
Other/multiracial	0.07			
English not household's primary language°	0.18			
Birth weight (normal)	0.93			
Moderately low	0.06			
Very low	0.01			
Preterm birth°	0.11			
Mother smoked during pregnancy°	0.11			
Mother drank during pregnancy°	0.01			
Late or no prenatal care°	0.08			
Birth order (1-12)	2.04			
Mother was married at birth°	0.68			
Mother was foreign born°	0.20			
Mother born to teen mother (no)	0.70			
Yes	0.11			
Missing information	0.18			
Mother repeated a grade in school°	0.15			
Mother's family received welfare in childhood°	0.11			
Mother lived with two parents in childhood°	0.59			
Very good/excellent health°	0.89			
Ever had asthma diagnosis°	0.05			
Socioeconomic resources (time-varying)				
Household income (proportion of poverty line; 0.06-20.97)	2.90	3.05	3.03	3.51
Household asset scale (0-1)	0.69	0.71	0.73	0.73
Mother's educational attainment (8-20 years)	13.25	13.40	13.67	13.62
Child care				
Hours/week in nonparental care/kindergarten (0-160)	15.55	15.97	23.07	33.76
Child outcomes (time-varying)				
Cognitive/early math (-4.25 - 5.59)	0.18	0.17	0.04	-0.09
Cognitive/early reading (-4.25 - 5.59)	0.18	0.17	0.02	-0.11
Positive behavior (-3.75 – 1.96)	0.11	0.11	0.07	0.03

Notes: Source: Early Childhood Longitudinal Study-Birth Cohort, 2001-2007. Analysis sample N≈8450 children; N varies for each wave. Analyses account for sample design effects. Range for age and continuous outcome variables are in parentheses. ° 1 = yes.

Table 2. Unstandardized Coefficients from Multilevel Linear Regression Models of Child Outcomes

	Cognitive/Reading						Cognitive/Math					
Variable	**1**		**2**		**3**		**1**		**2**		**3**	
Child age (months)	0.05	**	0.04	**	0.05	***	0.04	**	0.03	**	0.04	***
Child age squared	-0.03	***	-0.02	***	-0.03	***	-0.02	***	-0.02	***	-0.02	***
Born to a teen parent°	-0.04	***	-0.04	***	-0.05	***	-0.03	***	-0.03	***	-0.04	***
Male°	-0.16	***	-0.16	***	-0.17	***	-0.15	***	-0.15	***	-0.15	***
Child race/ethnicity (White)												
Black	-0.08	*	-0.08	*	-0.08	*	-0.12	**	-0.12	*	-0.12	**
Hispanic	-0.08	*	-0.08	**	-0.08	**	-0.10	***	-0.10	***	-0.10	***
Other/multiracial	0.00		0.00		0.01		-0.03	***	-0.03	***	-0.03	***
Household language not English°	-0.09	***	-0.09	***	-0.09	***	-0.07	***	-0.08	***	-0.07	***
Birth weight (normal)												
Moderately low	-0.22	***	-0.22	***	-0.22	***	-0.25	***	-0.24	***	-0.25	***
Very low	-0.32	***	-0.32	***	-0.32	***	-0.36	***	-0.36	***	-0.36	***
Preterm birth°	-0.13	***	-0.13	***	-0.13	***	-0.12	*	-0.12	*	-0.12	*
Smoked in pregnancy°	-0.07	*	-0.07	*	-0.07	*	-0.06	**	-0.06	**	-0.06	**
Drank in pregnancy°	0.09		0.10		0.10		0.12		0.12		0.12	
Late/no prenatal care°	-0.06	**	-0.06	*	-0.07	*	-0.07	***	-0.06	***	-0.07	***
Birth order	-0.05	***	-0.04	***	-0.04	***	-0.04	**	-0.03	**	-0.03	**
Mother married at birth°	0.03	***	0.03	***	0.03	***	0.02	***	0.02	***	0.02	***
Mother foreign born°	-0.04	**	-0.04	**	-0.04	*	-0.03	***	-0.03	***	-0.03	***
Mother had teen mother (no)												
Yes	0.00		0.00		0.00		0.00		0.00		0.00	
Missing information	0.00		0.00		0.00	**	-0.02	***	-0.02	**	-0.02	**
Mother repeated a grade°	-0.06		-0.06		-0.06		-0.08		-0.08		-0.08	
Mother on welfare as child°	0.00		0.00		0.00		-0.02	**	-0.02	**	-0.02	*
Mother lived with two parents°	0.02	***	0.02	**	0.02	***	0.03	***	0.02	***	0.03	***
Wave 1 constants												
Asthma diagnosis°	0.06		0.06		0.06		0.04		0.04		0.04	
Very good/excellent health°	0.11	***	0.11	***	0.11	***	0.11	***	0.11	***	0.11	***
Positive behavior	0.06		0.06		0.06		0.06		0.06		0.06	
Household income/poverty line	-0.02	***	0.03	***	0.03	***	-0.02	***	0.03	***	0.03	***
Household asset scale	0.03	**	-0.42	***	0.03	**	0.02		-0.44	***	0.01	
Mother's education (years)	0.03	***	0.03	***	-0.02	**	0.03	***	0.03	***	-0.02	***
Child age*income	0.06	***					0.06	***				
Child age2*income	-0.01	***					-0.01	***				
Child age*assets			0.61	***					0.60	***		
Child age2*assets			-0.09	***					-0.09	***		
Child age*mother's education					0.08	***					0.07	***
Child age2*mother's education					-0.01	***					-0.01	***
Constant	0.02		0.02		0.01		0.01		0.01		0.00	
Variance (age)	0.01		0.01		0.01		0.01		0.01		0.01	
Variance (age2)	0.00		0.00		0.00		0.00		0.00		0.00	
Variance (constant)	0.13		0.12		0.13		0.14		0.14		0.14	

Table 2, Continued. Unstandardized Coefficients from Multilevel Linear Regression Models of Child Outcomes

	Positive Behavior					
Variable	**1**		**2**		**3**	
Child age (months)	-0.01		-0.01		-0.01	
Child age squared	0.00		0.00		0.00	
Born to a teen parent°	-0.04		-0.04		-0.04	
Male°	-0.25	***	-0.25	***	-0.25	***
Child race/ethnicity (White)						
Black	-0.02		-0.02		-0.02	
Hispanic	-0.04		-0.04		-0.04	
Other/multiracial	-0.08		-0.09		-0.08	
Household language not English°	0.03		0.03		0.03	
Birth weight (normal)						
Moderately low	-0.06	***	-0.06	***	-0.06	***
Very low	-0.13	***	-0.13	***	-0.13	***
Preterm birth°	-0.03	*	-0.03	*	-0.03	*
Smoked in pregnancy°	-0.09	***	-0.09	***	-0.09	***
Drank in pregnancy°	-0.24	*	-0.24	*	-0.24	*
Late/no prenatal care°	-0.01	*	-0.01	*	-0.01	*
Birth order	-0.02	**	-0.02	**	-0.02	**
Mother married at birth°	0.02		0.02		0.02	
Mother foreign born°	-0.05		-0.05		-0.05	
Mother had teen mother (no)						
Yes	0.02		0.02		0.02	
Missing information	0.00		0.00		0.00	
Mother repeated a grade°	-0.09	***	-0.09	***	-0.09	***
Mother on welfare as child°	0.03		0.03		0.03	
Mother lived with two parents°	0.03	***	0.03	***	0.03	***
Wave 1 constants						
Cognitive score	0.14	***	0.14	***	0.14	***
Asthma diagnosis°	0.00		0.00		0.00	
Very good/excellent health°	0.10	***	0.10	**	0.10	***
Household income/poverty line	0.00		0.01	***	0.01	***
Household asset scale	0.14	**	0.02		0.14	**
Mother's education (years)	0.01		0.01		0.00	
Child age*income	0.02	***				
Child age2*income	0.00	***				
Child age*assets			0.15	***		
Child age2*assets			-0.02	***		
Child age*mother's education					0.02	***
Child age2*mother's education					0.00	***
Constant	0.03		0.03		0.03	
Variance (age)	0.01		0.01		0.01	
Variance (age2)	0.00		0.00		0.00	
Variance (constant)	0.12		0.12		0.12	

Notes: Source: Early Childhood Longitudinal Study-Birth Cohort, 2001-2007.
N people ≈ 8450 and *N* person-time ≈ 27450 for cognitive/math and cognitive/reading, 8350 and 25500 for behavior.
Analyses account for probability weights and clustering.
* p<.05 ** p<.01 *** p<.001; two-tailed tests.

ENDNOTES

[i] All *N*s are rounded to the nearest 50 due to ECLS-B confidentiality requirements.

[ii] Due to use of the growth curve approach, the person-year was the unit of analysis rather than the individual, so the analysis sample was 27,900 for reading, 27,850 for math, and 23,500 children for behavior. The average number of waves per child was 3.3 for reading and math and 2.9 for behavior, with each child in the sample providing 2-4 waves of information.

[iii] The Bayley Scales of Infant Development, Second Edition (BSID-II) was used by ECLS-B to develop the BSF-R.

[iv] Because the items (often copyrighted) from assessments were not available to end users of the data, we relied on scores constructed by ECLS-B staff using item response theory (IRT) modeling.

[v] When available, we used the wave 3 reports from the early care and education providers (ECEP). Many children who had a wave 5 kindergarten entry were in preschool at wave 4, but not at wave 3. For these children, no information from an ECEP provider was available in wave 3. To fill in the gaps this created, we filled in data with the ECEP provider information from wave 4. For children with neither wave 3 or 4 ECEP survey data available, we used an age-adjusted average of their reports from waves 2 and K to fill in the wave 3 behavior outcome.