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Life-course changes in the mediation of cognitive and non-cognitive skills for parental effects on children's academic achievement

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ABSTRACT

We assess life-course changes in how cognitive and noncognitive skills mediate the effect of parental SES on children's academic achievement using data from the Early Childhood Longitudinal Study-Kindergarten Cohort. Our results show: (1) the direct effect of parental SES declines while the mediating effect of skills increases over time; (2) cognitive and non-cognitive skills differ in their temporal sensitivities to parental origin; and (3) in contrast to the effect of cognitive skills, the mediating effect of non-cognitive skills increases over time because non-cognitive skills are more sensitive to changes in parental SES. Our results offer insights into the dynamic role skill formation play in status attainment.

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1. Introduction

It is well understood that family background exerts strong influences on children's educational outcomes, with children from higher-SES families academically outperforming those from lower-SES families (Becker, 1993; Blau and Duncan, 1967; Bourdieu, 1977; Duncan and Brooks-Gunn, 1997; Hauser et al., 1983; McLanahan and Sandefur, 1994; Sewell et al., 1969). However, the question of *how* family SES actually affects children's educational outcomes is still subject to debate. Broadly speaking, three categories of causal mechanisms have been considered: direct effects of material resources, indirect effects through cognitive skills or "hard" skills measured by test scores, and indirect effects through a broad range of socio-behavioral skills or "soft" skills, such as motivation, self-control, social skills and work habits.[1]

The first two causal mechanisms—the direct effect of family resources on achievement (Becker, 1993; Mincer, 1974; Kaushal et al., 2011) and the indirect effect via cognitive skills (Griliches and Mason 1972; Jencks et al., 1979; Hauser et al. 1983; Sewell et al. 1969)—are well established. The role of socio-behavioral skills in status attainment also has a long tradition in stratification research dating back to the Wisconsin socio-psychological model of status attainment (Hauser et al., 1983; Sewell et al., 1969). In recent years, however, their role has gained renewed interest. A growing body of research

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[1] Following DiPrete and Jennings (2012), we refer to this broad class of "soft skills" as socio-behavioral skills while recognizing that they are multidimensional in nature and that to date, there is still no commonly agreed upon nomenclature for these sets of skills and behaviors among the multidisciplinary collection of scholars in psychology, economics and sociology who study them.

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suggests that these class of skills may be as important as cognitive skills in predicting a variety of outcomes, ranging from educational attainment (DiPrete and Jennings, 2012; Duncan and Magnuson, 2011; Lleras, 2008; Rosenbaum, 2001) to income and labor market performance (Cunha and Heckman, 2009; Hall and Farkas, 2011; Jackson, 2006) to incarceration and teenage childbearing (Heckman et al., 2006). Moreover, sociological theories have long speculated that the family is instrumental in shaping critical socio-behavioral skills that are important for future success, such as motivation, aspirations and self-control (Boudon, 1974; Bourdieu, 1977; Goyette and Xie, 1999; Heckman, 2006, 2011; Lareau, 2011; Kao and Tienda, 1995; Kim, 2011).

Yet to date, important questions remain about the role of socio-behavioral skills in status attainment. While it is commonly accepted that socio-behavioral skills, like cognitive skills, mediate the intergenerational transmission of family advantages or disadvantages, it is far from clear, *a priori*, that they mediate the effects of family SES in the same manner as cognitive skills. Our current understanding is limited in at least two important ways. First, we do not know the relative importance of cognitive versus socio-behavioral skills as mediators of family origin. For skills to mediate the effects of family SES on achievement outcomes, two conditions must hold: (1) they must affect achievement outcomes, and (2) family SES must affect them. While the former relationship has been widely examined, the later relationship is far less well understood. Second, most prior studies have taken a static conceptualization of skill formation by using single-point-in-time measures of skills (Duncan et al., 2007; Lleras, 2008; Hauser et al., 1983; Jencks et al., 1979; Mood et al., 2012; Sewell et al., 1969). Growing evidence, however, suggests that the developmental trajectories of cognitive skills differ from those of socio-behavioral skills. We do not know how these potential differences in the evolution of cognitive versus socio-behavioral skills over the life-course might shape the ways in which they mediate family SES effects in different ways.

To address these gaps in our understanding, we employ a two-step strategy. First, we decompose the impact of family background on children's academic achievement into: (1) direct effects of family background and (2) indirect effects via cognitive and socio-behavioral skills. We estimate these models alternatively using skills measured at kindergarten to 5th grade. This approach allows us to evaluate the relative importance of cognitive versus socio-behavioral skills as mediators of family SES effects and to determine whether the mediating roles of these two types of skills change over time. Second, we employ growth curve models to explicitly evaluate the dynamic effects of family SES on trajectories of cognitive as well as socio-behavioral skills. Doing so allows us to examine the reasons why the mediating roles of cognitive and socio-behavioral skills might change over time.

Overall, we find that cognitive skills are stronger mediators of family SES than socio-behavioral skills. This is both because socio-behavioral skills are less predictive of later achievement and because they are less affected by family SES. The later findings are particularly relevant because they suggest that the effect of family SES in shaping socio-behavioral skills is weaker than previously theorized. When we take a developmental perspective and examine these relationships as they change over a child's life course, we find that the mediating role of socio-behavioral skills increases over time, although they remain weaker mediators than cognitive skills. Moreover, the increase in the role that socio-behavioral skills play over time can be attributed mainly to the increasing influence of mother's education on socio-behavioral skills.

1.1. Theoretical and methodological issues

In Fig. 1, we present a stylized conceptual model of status attainment. We revive the classical Wisconsin socio-psychological model as a starting point for understanding the causal pathways through which family SES influences children's achievement outcomes (Hauser et al., 1983; Sewell et al., 1969). In its original formulation, the Wisconsin model conjectures that the influence of family background on children's status attainment is entirely mediated through children's social-psychological traits defined as educational and occupational aspirations. We deviate from this position to include both a direct effect of family SES on children's achievement outcomes and an indirect effect via children's cognitive skills. In the following sections, we briefly review the literature pertaining to each of the three causal mechanisms linking family SES and children's achievement (i.e., direct effects, indirect effect via cognitive skills and indirect effects via socio-behavioral skills) and highlight the gaps in our knowledge.

1.2. Direct effects of family SES

Family SES may exert direct effects on children's educational outcomes because a higher family SES means more potential resources that could be expended to promote children's education. The resource explanation has been popular in economics. According to this explanation, parents have an intrinsic “altruistic interest” in their children's socioeconomic wellbeing and purposely invest in their children (Becker, 1993; Mincer, 1974). Parental investment in children may take a variety of forms, such as purchased goods and services (e.g., quality child care, school supplies and books, recreation and entertainment activities, and private lessons) and time spent on children (e.g., help with homework and attendance at school events) (Kaushal et al., 2011). Note that these examples of parental investment are all about resources, in the sense that they are subject to firm budget constraints, and parents could divert their uses towards other uses (including other children) if withholding them from a particular child.

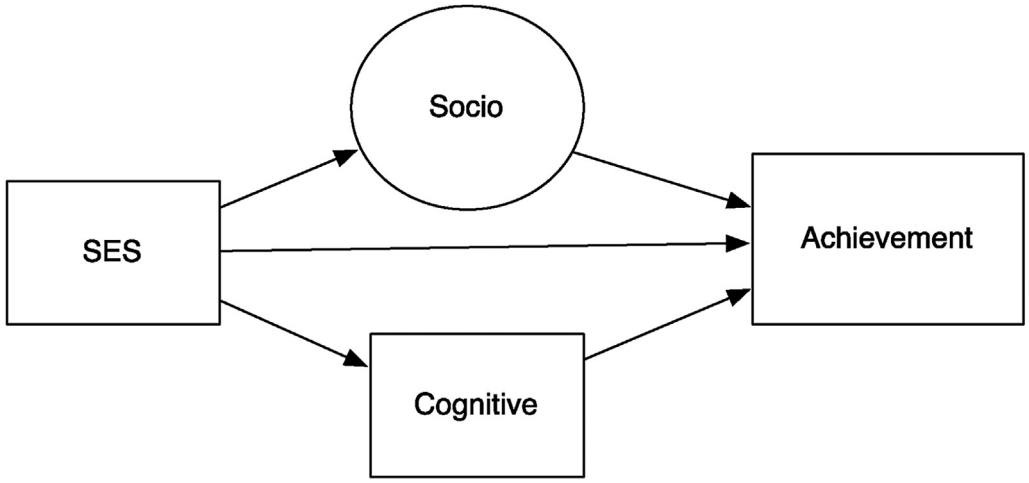


Fig. 1. Stylized model of status attainment.

1.3. Indirect effects through cognitive skills

Another main causal pathway through which family SES affects children's educational outcomes is via cognitive abilities, also called "hard skills." We do not yet know the true extent to which cognitive abilities are determined by nature (i.e. genetics) versus nurture (i.e. environment), but it is safe to say that the two forces interact in certain ways that shape one's cognitive abilities (e.g., Nisbett, 2009; Plomin et al., 1977). Studies show that the most important period for cognitive skill development is early to middle childhood (Cunha and Heckman, 2009; Guo and Harris, 2000; Keane and Wolpin, 1997). During this period, high-SES families enhance children's math and verbal development by offering greater material resources (Klebanov et al., 1998; Korenman et al., 1995) and more stimulating home environments (Bronte-Tinkew et al., 2008; Parcel and Dufur, 2001) than low-SES families. These "hard" skills, in turn, go on to positively influence a variety of achievement outcomes, including children's educational attainment (Farkas and Vicknair, 1996; Griliches and Mason, 1972; Warren et al., 2002).

1.4. Indirect effects through socio-behavioral skills

Socio-behavioral skills have recently resurfaced as another important causal mechanism through which family SES background affects children's academic achievement. These skills are multidimensional in nature and encompass a broad class of individual attitudes, behaviors and habits that are correlated with but distinct from cognitive traits (for a detailed review see Borghans et al., 2008). By socio-behavioral skills, researchers have meant a variety of characteristics distinct from purely cognitive abilities, ranging from leadership and perseverance (Jencks et al., 1979) to self-esteem and locus of control (Heckman et al., 2006), aspirations and expectations (Sewell et al., 1969), and school-related attitudes and behaviors (Clasessens et al., 2009; Duncan and Magnuson, 2011; Lleras, 2008; Rosenbaum, 2001).[2]

For socio-behavioral skills to mediate family SES effects on children's achievement, they must (1) influence academic achievement and (2) be influenced by family SES. There is ample evidence that skills such as motivation, perseverance and work habit positively influence students' academic performance. Studies consistently show that such traits have significant effects on academic performance, net of students' cognitive skills, in kindergarten (DiPrete and Jennings, 2012; Jennings and DiPrete, 2010), middle school (DiPrete and Jennings, 2012; Farkas et al., 1990) and in high school (Bowles and Gintis, 1976). It is not difficult to understand why teachers might value such skills in the classroom and how such skills might have direct effects on classroom performance. Students who pay more attention and who have consistent work habits learn more because there are more engaged with classroom instruction. In contrast, those who are less motivated, who lack sufficient control over emotions and behaviors and who have poor work habits may be more easily distracted and are unable to fully take advantage of important classroom learning opportunities.

[2] In referring to such a variety of personality and psychological traits, socio-behavioral skills in the social science literature do not conform to the conventional notion of "skills," a term that normally applies only to abilities or facilities acquired through learning or training.

While consensus exists that socio-behavioral skills, such as self-control, social skills, and attention-related capacities, positively predict children's academic outcomes, there is disagreement among policy-makers and academics as to their importance relative to cognitive abilities. The "Neurons to Neighborhoods" report of the National Research Council and Institute on Medicine argues that early intervention programs should devote equal attention to enhancing children's socio-emotional development and their cognitive development (Shonkoff and Phillips, 2000). On the other hand, reports from the National Research Council's Committee on the Prevention of Reading Difficulties in Young Children (Snow et al., 1998) and the National Association for the Education of Young Children (NAEYC) argue for the primacy of "hard" skills such as literacy and math competence for success in schools.[3]

The academic literature is also mixed. Some studies demonstrate that traits such as self-control explain much more of the variation in children's academic performance than cognitive abilities (Duckworth and Seligman, 2005; Wolfe and Johnson, 1995). Still others argue that socio-behavioral skills have far more persistent effects on children's later academic achievement than cognitive skills (Chetty et al., 2010; Heckman et al., 2007). In contrast, other studies show that "hard" skills trump "soft" skills as determinants of academic success. Based on analyses of data from six longitudinal studies, Duncan et al. (2007) find that early math and reading skills are stronger predictors of later achievement than socio-behavioral traits, such as attention-related capacities, social strengths and behavioral deficits. Lleras (2008) reports similar results from a study analyzing data from the National Educational Longitudinal Study, as do Claessens et al. (2009) based on data from the Early Childhood Longitudinal Study.

The second condition that must be fulfilled for socio-behavioral skills to mediate family SES effects is that family SES must influence them. Longstanding sociological theories postulate that families play an instrumental role in shaping children's socio-behavioral skills. Sociologists have long argued that attainment of higher education is a cultural expectation specifically valued by the middle class but not shared by the lower class (Boudon, 1974; Bourdieu, 1977; Brand and Xie, 2010; Jencks et al., 1972; Goyette and Xie, 1999; Smith and Powell, 1990). For example, in a study of middle and working class families, Lareau (2011) documents disparities in the types of skills that are promoted, consciously or unconsciously, by parents. In contrast to poor and working class parents, middle-class parents are more likely to "cultivate" children's cognitive and socio-behavioral traits along specific dimensions that foster academic achievement.

However, the relationship between family SES and socio-behavioral factors may be weaker than what some scholars would expect. For example, comparison of monozygotic and dizygotic twins typically shows that only 25% of total variation in socio-behavioral traits is due to shared family traits (i.e. both genetic and environmental) (Floderus-Myrhed et al., 1980; Rowe and Plomin, 1981). In contrast, approximately 40% of total variation in adult IQ, a cognitive trait, is due to shared family traits. Using the National Longitudinal Study of Youth (NLSY), Duncan et al. (2005) find that family SES is a surprisingly weak predictor of social-psychological indicators such as shyness, self-esteem and depression.

A recent study by Mood et al. (2012) attempts to directly address the question of how family SES effects on children's educational outcomes are mediated by cognitive versus socio-behavioral skills, using Swedish registry data on approximately 180,000 fathers and sons. Their measures of cognitive and socio-behavioral skills (i.e. social maturity, emotional capacity and leadership skills) are assessed when sons are age 18. The study finds that the intergenerational correlation of educational attainment is mainly mediated by children's cognitive skills and only weakly mediated by socio-behavioral traits. Unfortunately, the study does not inform us why the mediating effects for socio-behavioral skills are weak. Is it because socio-behavioral skills are poor predictors of later educational outcomes, or is it because father's education is a poor predictor of socio-behavioral skills?

Another factor to consider is the potentially evolving role of cognitive and socio-behavioral skills over one's life course. This point is critical because mounting evidence demonstrates that there are important differences between the developmental trajectories of cognitive and those of socio-behavioral skills (see Borghans et al., 2008 for a detailed review). Specifically, cognitive skills undergo the greatest amount of change in early childhood and stabilize by adolescence. Socio-behavioral skills, on the other hand, continue to undergo changes throughout childhood and into young adulthood. We call this conjecture the "sensitive period hypothesis," or the proposition that there are sensitive periods in the life course when skills are more or less malleable to environmental influences (Borghans et al., 2008; Cunha and Heckman, 2009; Guo and Harris, 2000). Emerging evidence supports this hypothesis. For example, Cunha and Heckman (2009) find that parental investments, such as the number of books at home and frequency of trips to museums, have strong effects on cognitive skills at earlier ages and have strong effects on socio-behavioral skill formation at later ages.

Static conceptualizations of skills cannot capture important dynamics in skill formation, nor can they capture the changing roles of cognitive and socio-behavioral skills as mediators of family SES over the life course. For example, if the effects of family SES on socio-behavioral skills grow with time, then a static measure of socio-behavioral skills would lead to an underestimation or overestimation of the mediating role of socio-behavioral skills, depending on the time at which socio-behavioral skills are measured. Therefore, a developmental perspective that explicitly considers changes in skill formation over time allows us to identify potential sensitive periods in the relationship between family origin and skill development and to address questions regarding whether the mediating role of cognitive and socio-behavioral skills changes over the life course.

[3] http://www.naeyc.org/about/positions/pdf/psmath.pdf.

2. Material and measures

We use panel data from the Early Childhood Longitudinal Study, Kindergarten Class (ECLS-K). The ECLS-K is a national cohort-study of kindergarteners followed from kindergarten entry to 8th grade between 1998 and 1999 (Tourangeau et al., 2006). We chose the ECLS-K for several reasons. First, it offers repeated measures of children's cognitive skills and socio-behavioral skills, which allows us to observe how both these traits evolve over an important period in childhood. Second, the data offer multiple indicators of children's socio-behavioral skills so as to allow us to reduce measurement error through factor analysis. Third, the data cover a critical period during which skills were not only acquired and shaped but also affect subsequent academic performance.

Baseline interviews were conducted during the fall of kindergarten entry for over 20,000 children. Follow-up interviews were conducted in the spring of kindergarten, fall and spring of 1st grade, spring of 3rd grade, spring of 5th grade and spring of 8th grade. We omit interviews conducted during the fall of 1st grade because only a subsample of children (approximately 30%) were interviewed. Our sample is restricted to children who complete the student questionnaire in 8th grade and have non-missing values for 8th grade academic achievement. The only other exclusion restrictions placed in selecting the final analytical sample are that children have non-missing values for sampling weights (67 cases dropped). This leaves us with a final analytical sample of 9646 students. Missing data on any other variables does not result in a student being excluded from the analysis.[4] Instead, we use Full Information Maximum Likelihood (FIML) imputation to account for missing data, allowing us to include all available data in our analysis. FIML has been shown to outperform listwise deletion under the assumption that data are missing at random given observed covariates (Little and Rubin, 1987). To account for the hierarchical nature of the data and the fact that multiple children were sampled within schools and classrooms, we adjust standard errors in model estimation by clustering the data by teacher. To account for attrition across waves and to make our estimates more nationally representative, all analyses are conducted with sampling weights.

2.1. Measures

2.1.1. Academic achievement

The Academic Ratings Scale (ARS) captures teacher ratings of student performance in four areas of academic performance—oral expression, writing skills, math skills, and science skills. Teachers rated children's skills, knowledge and behaviors on a 5-point scale from “Not Yet” to “Proficient.” These measures are derived from teachers' daily observations of student performance regarding competency in these four areas. Whereas teachers were asked to evaluate all students on their oral expression and writing skills, only half of the students were evaluated for their math skills and the other half were evaluated for their science skills. Therefore, our composite includes ARS math skills when available, and when not, ARS science skills are included. We construct a composite measure of academic achievement using these four ARS measures by first standardizing each ARS measures to have a mean of zero and a standard deviation of one and then taking their unweighted average.

2.1.2. Cognitive and socio-behavioral skills

Item Response Theory (IRT) scores in math and reading are used to capture cognitive skills. IRT uses patterns of response to estimate the probability of correct answers if children were given all assessment questions at each wave of the survey. IRT measures were collected in both the fall and spring of kindergarten, spring of 1st grade, 3rd grade and 5th grade. We average the fall and spring kindergarten scores to obtain an average score for kindergarten. At each wave of the survey, we standardized the IRT scores to facilitate interpretation.[5]

Children's socio-behavioral skills are based on the Social Ratings Scale (SRS), the frequency with which students are reported to exhibit certain skills and behaviors (i.e. 4-point scale ranging from “Never” to “Very often”). The SRS asked teachers to rate students along the following dimensions: approaches to learning, self-control, interpersonal skills, externalizing problem behaviors, and internalizing problem behavior. The first three indicators capture positive aspects of socio-behavioral traits whereas the last two represent problem behaviors. SRS measures were collected in both the fall and spring of kindergarten, spring of 1st grade, 3rd grade and 5th grade. We average the fall and spring kindergarten ratings to obtain SRS measures for students in kindergarten.

Approaches to Learning measures children's attentiveness, task persistence, eagerness to learn, learning independence, and organization. *Self-Control* measures child's ability to control behavior by respecting the property of others, controlling temper, accepting peer ideas, and responding appropriately to peer pressure. *Interpersonal Skills* captures ability to form and maintain friendships, getting along with others, comforting and helping other children, expressing feelings in positive ways, and showing sensitivity to others' feelings. *Externalizing Problem Behaviors* measures the frequency with which the child argues, fights, gets angry, acts impulsively, and disturbs ongoing activities. Finally, *Internalizing Problem Behavior* measures the presence of anxiety, loneliness, low self-esteem, and sadness.

[4] All models were also estimated using listwise deletion (i.e. dropping observations with at least one missing variable on all variables in the analysis). The results using listwise deletion do not differ substantively from results using FIML. Listwise deletions reduce the sample to 6640 observations. The majority of missing data are due to missing cognitive test scores and teacher reports of children's socio-behavioral traits.

[5] We test the robustness of our results to results derived from using unstandardized IRT math and reading test scores and obtained similar results.

We conducted factor analysis to estimate a single latent factor underlying these five indicators of socio-behavioral skills. We found that internalizing problem behavior had the least inter-temporal correlation suggesting that it is the least empirically stable measure and may be more sensitive to developmental changes and random shocks over the life-course. Additionally, while four measures—approach to learning, self-control, interpersonal skills and externalizing behavior—correlated strongly to a single latent factor, internalizing behavior did not. Therefore, we focus our analysis on the four SRS measures that best map together onto a single latent factor—approach to learning, self-control, interpersonal skills and externalizing behavior. Each measure was standardized with respect to the distribution at each survey year and included into our measurement model.[6]

2.1.3. Family socioeconomic status (SES)

We use permanent household income and maternal education to measure family socioeconomic status. Permanent income is measured as the log average household income between kindergarten and 5th grade. We use permanent income rather than single-year measures of income because multiyear measures better capture family income variability and are more reliable measures of socioeconomic status (Solon, 1999). Exact income was not collected. Instead, total household income was placed into one of 13 income categories. We use the midpoint of each income range to calculate the permanent (average) income level from kindergarten to 8th grade. Maternal education is measured in levels ranging from 1 to 9 (i.e. 1 = 8th grade or below and 9 = doctorate).[7]

2.1.4. Other controls

We also control for various individual and family characteristics that might influence academic performance in 8th grade. The variables include gender, race, student's age at kindergarten entry, a dummy variable indicating if the student is disabled, number of books in the household, family structure, mother's age at first birth.

2.2. Statistical strategy

We adopt a two-step analytical approach. In the first step, we use structural equation modeling to decompose the total effects of family SES on children's academic performance into a direct component and two indirect components via cognitive versus socio-behavioral skills and compare the relative importance of the three pathways. We estimate these models alternatively using skills measured in kindergarten, 1st, 3rd, and 5th grade to explore how the relationships change over time.[8] The baseline model with skills measured in kindergarten ascertains the influence of family origin on children's academic performance through affecting their skills early in life. Alternatively estimating models with later measures of skills allows us to assess the potential variation of family's influence on the development of cognitive and socio-behavioral skills over the life course and how potential differences in these developmental trajectories affect how skills mediate the total effects of family origin on academic achievement over time.

In the second step, we leave behind the decomposition framework in order to focus on the changing relationship between family origin and skill formation. To do this, we employ growth curve models. The main advantage of growth curve models (GCM) is that this method allows researchers to obtain estimates of both within- and between-person differences in growth trajectories (Muthén, 1997). For example, it allows us to determine how family background might explain differences in growth trajectories between individual children as well as how family origin might explain differences in the way skills evolve over time within a child's life-course.[9] In the following sections, we describe each of these statistical approaches in detail.

2.3. Decomposing family SES effects

We use structural equation modeling (SEM) to decompose the total effects of family SES on children's later academic achievement into the following components: (1) the direct effect, (2) the indirect effect through cognitive abilities, and (3) the indirect effect through socio-behavioral skills. Fig. 1 presents our conceptual framework. We measure family SES by permanent family income and mothers' education. Note that we treat income, education, cognitive skills, and academic

[6] The factor loading for were 0.802 for approach to learning 0.881 for self-control, 0.917 for interpersonal skills, and −0.687 for externalizing skills in kindergarten; 0.764 for approach to learning 0.867 for self-control, 0.992 for interpersonal skills, and −0.704 for externalizing skills in 1st grade; 0.811 for approach to learning 0.879 for self-control, 0.911 for interpersonal skills, and −0.734 for externalizing skills in 3rd grade; 0.818 for approach to learning 0.877 for self-control, 0.915 for interpersonal skills, and −0.742 for externalizing skills in 5th grade. In supplemental analysis, models were estimated where all five SRS scales were included in the measurement model. We also estimated SEM and GCM models where each SRS scale was introduced separately. Overall, the results from supplemental analyses do not differ substantively from the results that are presented. These results are available upon request.

[7] We use mothers' education and not fathers' education because we wanted to minimize missing values due to lack of information on fathers. In robustness checks, we use average of fathers' and/or mothers' education and all results were consistent with the results presented in the paper.

[8] Kindergarten measures of cognitive and socio-behavioral skills are averaged from assessments collected from the fall and spring of kindergarten.

[9] The main limitation of this method, however, is that it cannot address potential bias due to unobserved heterogeneity. As a robustness check, we estimate individual fixed effect models to account for this potential source of bias and to estimate how changes in family SES relate to changes in skill formations over time. The drawback to this latter approach, however, is that we lose the ability to learn how variation in key variables of interest, such as mothers' education, that might cause variation in skill formation across children.

achievement as observed variables. We treat students' socio-behavioral skills as a latent variable measured by our four SRS indicators.

We also include a common set of family background characteristics that have been shown to influence children's skill formation and academic performance. We allow these covariates to have direct effects on achievement outcomes and indirect effects via pathways through cognitive and socio-behavioral skills. All covariates are allowed to freely correlate with both family income and education. We allow all background variables, these covariates, and family income and mother's education, to correlate freely among themselves.

Following notations in the structural equations tradition (Bollen, 1989), we can express the structural model depicted in Fig. 2 mathematically as

$$\eta = B\eta + \Gamma\chi + \zeta, \tag{1}$$

where η stands for our three endogenous variables: academic achievement, cognitive skills, and socio-behavioral skills, with the last assumed to be a latent variable composed from multiple indicators. χ represents exogenous variables: family income, mothers' education, and all other covariates. B and Γ are their respective parameter vectors, often referred to as "structural parameters." ζ is a vector of error terms. We estimate a standard recursive model that assumes that the $E(\zeta)$ is zero and ζ is uncorrelated with χ.

In the case when η represents our latent variable, socio-behavioral skills, we specify a measurement model describing the relationship between the latent variable and its four observed indicators, approach to learning, self-control, interpersonal skills and externalizing behavior. Let Y be a vector of our four observed measures and η represent our latent variable representing socio-behavioral skills. We have:

$$Y = \Lambda_y\eta + \varepsilon \tag{2}$$

where Λ_y is a matrix of parameters, commonly referred to as "measurement parameters." Again, we assume independence of errors so that $\mathrm{cov}(\varepsilon, \eta) = \mathrm{cov}(\varepsilon, \zeta) = 0$. Under these assumptions, we simultaneously estimate the structural and measurement parameters in our model.[10] We rely on three standard indicators of model fit that are commonly used with large samples (N > 200): the root mean square error of approximation (RMSEA), the Tucker Lewis Index (TLI), and the Comparative Fit Index (CFI). The convention recommends that RMSEA be below 0.05 and TLI and CFI close to 1.0 (Bollen and Curran, 2006).

2.4. Family origin effects on skill formation over time

In the second part of our empirical work, we turn to estimating growth curve models in order to identify trajectories in skill formation over the life course and to determine whether these trajectories differ for cognitive and socio-behavioral skills. We first estimate random coefficient models or growth curve models (GCM). GCM are hierarchical models with the first level modeling individuals' developmental trajectories and the second level modeling between-person variations in these trajectories (Bollen and Brand, 2010). We model cognitive and socio-behavioral skill formation as parallel processes. Doing so allows us to compare directly how the same set of predictors may affect the growths of two sets of skills differently.

Fig. 3 conceptually illustrates the growth curve model that we estimate. Both types of skills are assessed at four different points in time between kindergarten entry and 5th grade. The figure shows that the growth trajectories of cognitive and socio-behavioral skills are attributed to two types of growth factors: (1) initial differences in skill levels, referred to as random intercepts, and (2) individual differences in growth rates, referred to as random slopes. Our model allows the intercept and slope of cognitive skills to freely correlate with each other at the individual level; similarly, the intercept and slope of socio-behavioral skills are also allowed to correlate. Moreover, both the intercept and slope of cognitive skills are allowed to correlate with the intercept and slope of socio-behavioral skills. For simplicity, growth in cognitive and socio-behavioral skills is modeled as linear functions over time.[11]

Our model of parallel processes can be formally described below. The level-1 equation describes within-individual (i) change over time (t) in skill formation:

$$Cog_{it} = \alpha_i + \beta_i t + \varepsilon_{it} \tag{3}$$

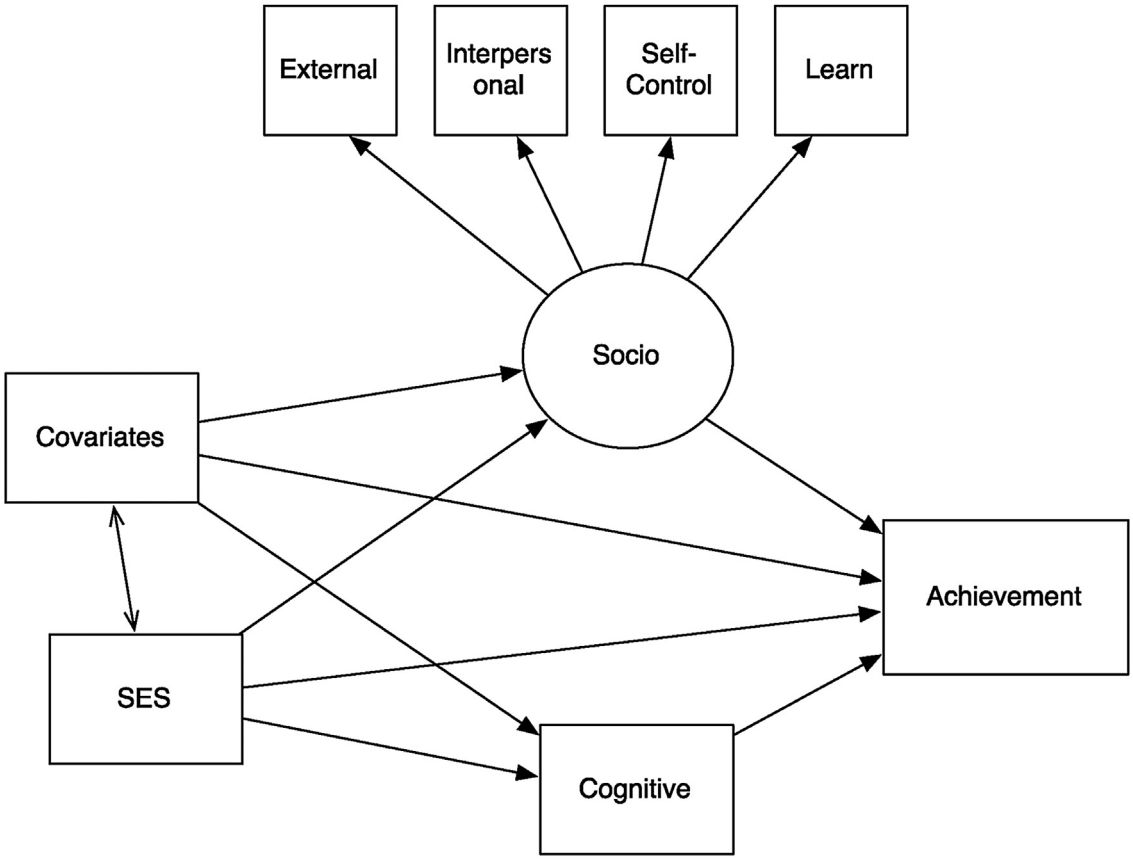
$$Soc_{it} = \gamma_i + \eta_i t + u_{it} \tag{4}$$

Both cognitive (Cog_{it}) and socio-behavioral (Soc_{it}) skill trajectories are characterized by an intercept, α_i or γ_i, and a slope, β_i or η_i, respectively.

The following set of equations describes level-2 relationships or variation in trajectories for cognitive and socio-behavioral skills that can be attributed to differences across individuals:

[10] We use Mplus, Version 6 (Muthen and Muthen, 2010).

[11] In analysis not shown here, we estimated growth models with alternative growth specifications. We found that linear growth best fit the data and therefore proceeded to model parallel processes with linear growth.



Note. Socio = Socio-behavioral skills, SES = Mother's education and permanent family income. Covariates include log number of books, child's race, child's sex, marital status, and mother's age at first birth.

Fig. 2. Structural model with covariates.

$$\alpha_i = \alpha_0 + \alpha_1 x_{i1} + \ldots + \alpha_k x_{ik} + \upsilon_i \quad (5)$$

$$\beta_i = \beta_0 + \beta_1 x_{i1} + \ldots + \beta_k x_{ik} + \sigma_i \quad (6)$$

$$\gamma_i = \gamma_0 + \gamma_1 x_{i1} + \ldots + \gamma_k x_{ik} + \omega_i \quad (7)$$

$$\eta_i = \eta_0 + \eta_1 x_{i1} + \ldots + \eta_k x_{ik} + \delta_i \quad (8)$$

These equations state that the intercepts and slopes associated with cognitive and socio-behavioral skills trajectories are a function of person-level independent variables (x_k) that do not vary across time. In our study, the variables include child and family characteristics. The model basically states that the intercepts and slopes for cognitive and socio-behavioral skills, respectively, depend on a set of child and family characteristics. As mentioned above, we model growth in cognitive and socio-behavioral skills as parallel processes which allow the intercept, α_i, and slope, β_i, of cognitive skills and the intercept,γ_i, and slope, η_i, of socio-behavioral skills to freely correlate.[12, 13]

[12] We estimate these models in Mplus.

[13] We complement GCM with individual fixed effect (FE) analyses to address bias due to unobserved heterogeneity. The limitation of FE analyses is that time-invariant factors that affect skill formation, such as mothers' education and permanent income, cannot be estimated. In estimating FE models, we switch from using permanent family income to log family income at each wave to estimate family income effects. Fixed effect results using log family income do not substantively differ from GCM results for permanent income in that they show that family income has larger effects on changes in socio-behavioral skills than cognitive skills. These results are available upon request.

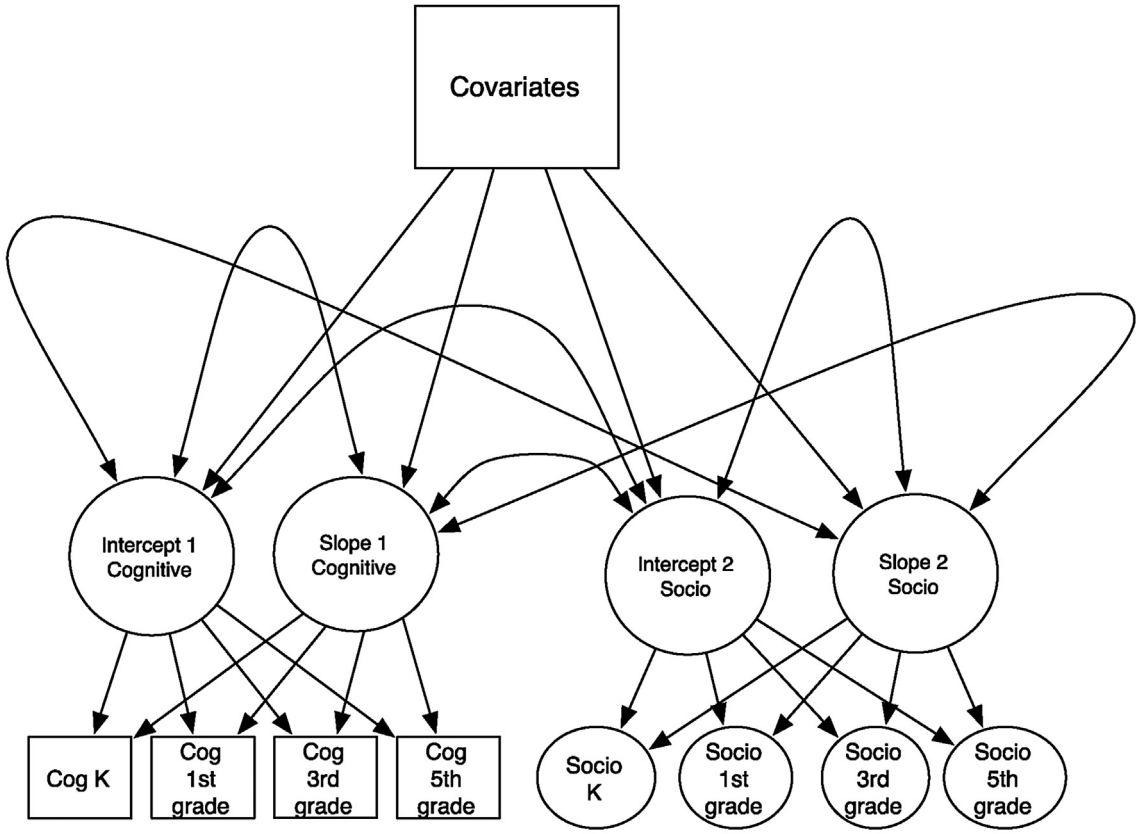


Fig. 3. Growth curve analysis of cognitive and socio-behavioral skills.

3. Discussion

3.1. Descriptive statistics

Table A1 in the Appendix presents the weighted descriptive statistics for the sample. Table A2 in the Appendix shows the correlation matrix of the study variables. Not surprisingly, Table A2 shows that both family income and mothers' education are positively correlated with children's cognitive skills, measured from kindergarten to 5th grade. Interestingly, the table also shows that while the correlations between family SES and children's socio-behavioral skills are positive, they are smaller in magnitude than the correlations between family SES and cognitive skills at each point in time. Both cognitive and socio-behavioral skills are positively correlated with children's later achievement. Once again, however, we see that the correlations with cognitive skills are larger in magnitude than those with socio-behavioral skills. Taken together, the statistics suggest that the mediating effect of socio-behavioral skills may be weaker than the mediating effect of cognitive skills.

3.2. Decomposition of family SES effects

Our first statistical approach is to use structural equation modeling to decompose the effects of family SES on children's academic achievement into three components: (1) direct effects, (2) indirect effects via cognitive skills, and (3) indirect effects via socio-behavioral skills. In order to understand the variation in the mediating role of children's skills over the life course, we estimate the relationships illustrated in Fig. 2 five times, alternatively using skills measured at (1) kindergarten, (2) 1st grade, (3) 3rd grade, and (4) 5th grade. The results from these decomposition models are presented in Table A3 and A4 in the Appendix. We report standardized coefficients. In Table A3, we present the estimated effects of our covariates on 8th grade academic achievement across these five models. For example, column 1 shows the effects of child and family characteristics, including children's cognitive and socio-behavioral skills, on 8th grade achievement, using measures of children's skills assessed at kindergarten. Column 4 shows the estimated effects with skills measured at 5th grade. In Table A4, we present the estimated effects of child and family characteristics on children's cognitive and socio-behavioral skills from models where skills are alternatively measured from kindergarten to 5th grade.

The results in Table A3 show that family SES (i.e. permanent income and mothers' education), children's skills, and our control variables all predict 8th grade academic achievement in the expected directions. The results show that cognitive and socio-behavioral skills measured as early as kindergarten affect later achievement. We also see that the effect of cognitive skills is larger than the effect of socio-behavioral skills, nearly three times as large at each point in time. These findings are consistent with studies of Lleras (2008) and Claessens et al., (2009), who also find that "hard" skills are more predictive of later achievement than "soft" skills.

Turning to the predictors of cognitive skills from our five models that alternatively use skills measured at different points in time in Table A4, we see that (1) mothers' education and permanent income have sizable effects on cognitive skills measured at all four time-points and (2) these effects remain relatively constant across time. The results for socio-behavioral skills differ from cognitive skills in several ways. First, mothers' education and permanent income are weaker predictors of early measures of children's socio-behavioral skills. Mothers' education is not significantly correlated with socio-behavioral skills at kindergarten. By first grade, it become statistically significant but its effect remain weaker relative to its effect on cognitive skills. Similarly, permanent income has a relatively weaker effect on socio-behavioral skills than on cognitive skills. For example, in kindergarten, a standard deviation increase in permanent income is associated with a 0.071 standard deviation increase in socio-behavioral skills but a 0.187 standard deviation increase in cognitive skills. Second, whereas the effects of family SES on cognitive skills remain relatively stable across time, the effects of family SES on socio-behavioral skills grows more substantially. For example, the effect of mothers' education on socio-behavioral skills grows from 0.039 in kindergarten to 0.110 in 5th grade. In contrast, the effects of mothers' education on cognitive skills grow from 0.153 to 0.186 over the same period. Third, despite the growing effects of family SES on socio-behavioral skills, they remain smaller than those on cognitive skills. For example, the effects of mothers' education and income on 5th grade measures of socio-behavioral skills are 0.110 and 0.120, smaller than comparable effects on cognitive skills, respectively at 0.186 and 0.225.

Table 1 summarizes the results from Tables A3 and A4 by presenting the total, direct and indirect effects of family SES on achievement across time. This table highlights two key points. First, it shows that while the direct effects of mothers' education and permanent income on children's 8th grade academic achievement decline over time, the indirect effects via cognitive and socio-behavioral skills increase with time for both income and mother's education. For example, the direct effect of income is 0.065 standard deviations in kindergarten but reduces to 0.000 when skills are measured at 5th grade. On the other hand, the indirect effect via cognitive skills on 8th grade achievement increases from 0.07 to 0.124 standard deviations. Likewise, the indirect effect via socio-behavioral skills also increases from 0.010 to 0.023 when we move from baseline measures of socio-behavioral skills to 5th grade measures.

The second key point is that, relative to cognitive skills, socio-behavioral skills mediate an increasingly greater proportion of the indirect effects of family SES over time. For example, at baseline, only 9% of the indirect effect of mothers' education that is mediated by skills could be attributed to socio-behavioral skills. By 5th grade, that percentage increased to 17%. Conversely, the relative importance of cognitive skills as a mediating factor declines over this same period.

3.3. *Effects of family background on skill trajectories*

In the second part of our analysis, we use growth curve models to better understand the changing relationship between family environment and skill formation. In particular, we are interested in detecting whether there are sensitive periods when skills are more or less malleable to family environment and whether this period occurs later for socio-behavioral skills than for cognitive skills. The sensitive period hypothesis predicts that cognitive skills are mainly determined in early childhood while socio-behavioral skills are mainly determined in later childhood (Borghans et al., 2008; Cunha and Heckman, 2009; Guo and Harris, 2000). Based on this prediction, one would expect to see family SES strongly affecting the initial conditions or the intercept of cognitive skills but having little effect on the initial conditions or intercept of socio-behavioral skills. At the same time, family SES would have a strong effect on the growth trajectory or slope of socio-behavioral skills but have little effect on the growth trajectories or slope of cognitive skills, which are posited to be mainly determined in early childhood. Of course, the actual trajectories of cognitive and socio-behavioral skills can be more complicated than this stylized hypothesis. For example, cognitive skills may be primarily determined early in life but continue to be affected by family SES even in later childhood. Nevertheless, we use this stylized hypothesis as a useful background for interpreting the results in Table 2.

Table 2 presents the results from our growth curve analysis. For each covariate, we obtain estimates of its effect on initial inter-personal differences in skills (intercepts) and on growth rates of skills over time (slopes). We present standardized coefficients. The results show that both mother's education and permanent income are strongly predictive predictors of initial differences in cognitive skills, with intercept coefficients estimated at 0.176 and 0.202, respectively. In terms of their effect on the slope, we see that permanent income significantly predicts growth in cognitive skills but mothers' education does not. These results offer mixed support for the sensitive period hypothesis. They show that family SES has a stronger effect on initial differences in cognitive skills than on growth in cognitive skills but also that permanent income does have an enduring effect on the development of cognitive skills over time. Turning to socio-behavioral skills, we see that permanent income has a significant effect on initial differences but no significant effect on the slope. Mother's education, on the other hand, has no significant effect on initial differences in socio-behavioral skills but a significant and lasting effect on growth of socio-behavioral skills over time. The results for socio-behavioral skills also offer mixed support for the sensitive period hypothesis. As the stylized sensitive period hypothesis suggest, we find evidence that mother's education has a stronger effect on socio-behavioral skills in later childhood than in early childhood. However, in contrast to what a stylized sensitive period

Table 1
Total, Direct and Indirect Effects of Income and Education on Children's 8th grade Academic Achievement from Models using Skills Alternatively Measured at Kindergarten, 1st Grade, 3rd Grade and 5th Grade.

	K	1st grade	3rd grade	5th grade
Mother's education				
Total effect	0.191	0.192	0.191	0.201
Direct effect	0.129	0.111	0.085	0.078
Indirect effect via cognitive skills	0.056	0.069	0.091	0.102
Indirect effect via socio-behavioral skills	0.006	0.012	0.015	0.021
% of indirect effects mediated by				
Cognitive skills	91%	85%	86%	83%
Socio-behavioral skills	9%	15%	14%	17%
Permanent income				
Total effect	0.145	0.143	0.147	0.147
Direct effect	0.065	0.053	0.016	0.000
Indirect effect via cognitive skills	0.070	0.077	0.111	0.124
Indirect effect via socio-behavioral skills	0.010	0.014	0.020	0.023
% of indirect effects mediated by				
Cognitive skills	87%	85%	85%	84%
Socio-behavioral skills	13%	15%	15%	16%

Notes: The total, direct and indirect effects presented in this table were calculated from structural equation modeling estimates presented in Appendix Tables A3 and A4.

hypothesis would predict, the results also show that permanent income has a significant effect on initial differences but not on the slope.

4. Conclusions

In this paper, we evaluated the relative roles of cognitive versus socio-behavioral skills in mediating the effects of family socioeconomic status (SES) on children's academic achievement. Moreover, in contrast to prior studies that have examined these relationships at a single point in time, we explicitly considered the differences between cognitive and socio-behavioral skills in developmental trajectories. We explored the implications of these differences for their respective roles in mediating the relationship between family SES background and children's academic achievement.

Overall, we find that socio-behavioral skills are weaker mediators of family SES effects than cognitive traits for two reasons: (1) socio-behavioral skills are less predictive of achievement outcomes than cognitive skills and (2) socio-behavioral skills are also less affected by family SES than are cognitive skills. While both types of skills positively affect later achievement, the effects of socio-behavioral skills are about one third the size of the effects of cognitive skills on later achievement. Socio-behavioral skills are also weaker mediators than cognitive skills because they are less influenced by family SES.

Our research also highlights the importance of taking a dynamic view of skill formation. Static approaches fail to capture differences in the developmental trajectories of cognitive and socio-behavioral skills that are crucial to our understanding of how skills mediate family SES effects over time. Specifically, our findings offer evidence in support of the sensitive period hypothesis of skill acquisition, which argues that there are periods during which skills are more or less malleable to social environment, and that the sensitive period for socio-behavioral skills occurs later in childhood than the sensitive period for cognitive skills. Our results reveal that family SES is (1) more likely to affect initial differences in cognitive skills than socio-behavioral skills but (2) more likely to affect changes in socio-behavioral skills over time. For example, the findings show that both income and mother' education correlate with initial differences in cognitive skills but only income correlates with initial differences in socio-behavioral skills. In contrast, mother's education is not significantly correlated with changes in cognitive skills but is strongly correlated with changes in socio-behavioral skills. Overall, these findings are consistent with the claim that cognitive skills develop earlier in the life-course and are less vulnerable to changes in family SES in later childhood. In contrast, socio-behavioral skills develop later in life because they are more sensitive to mother's education throughout the life-course. As a result, while the mediating effects of socio-behavioral skills start off weak, it is important to note that their role as a mediator, particularly as mediators of mother's education, increase over the life-course.

This study is not without its caveats. Measurement error in our indicators of socio-behavioral skills poses a potential problem. Cognitive skills are likely to be more precisely measured than socio-behavioral skills, both because the method of assessing the latter is cruder and because socio-behavioral skills are more multi-dimensional in nature. One may argue that the weak correlation between family SES and socio-behavioral skills is due to measurement error associated with measuring socio-behavioral skills and therefore, we underestimate the true influence of family SES. For two reasons, however, it seems unlikely that all our findings are attributable to measurement error. First, to some degree, we address these concerns through factor analysis in capturing the latent structure that underlies our five indicators of socio-behavioral skills. This method allows us to reduce measurement error and increase the reliability of our measures. Second, while measurement error may, in part, account for why we find weak estimated effects of family SES on early measures of socio-behavioral skills, it cannot explain why the pattern of the observed effects increases with time. If measurement error is present in early measures, it should also be present in later measures, and yet family SES becomes more predictive of later measures.

Table 2
Linear growth models of cognitive and socio-behavioral skills trajectories.

	Cognitive Skills				Socio-behavioral Skills			
	Intercept		Slope		Intercept		Slope	
	β	β/SE	β	β/SE	β	β/SE	β	β/SE
Mother's education	0.176***	7.206	0.043	1.560	0.054	1.560	0.103*	2.023
Permanent income	0.202***	8.372	0.067*	2.188	0.10*	2.379	0.094	1.823
Log number books	0.137***	5.742	−0.031	−1.019	0.094**	2.770	−0.215***	−3.886
Black	−0.064*	−2.426	−0.113***	−3.550	−0.119**	−3.411	0.019	0.308
Asian	0.021	1.172	0.038	1.564	0.041**	2.675	0.066*	2.441
Hispanic	−0.052*	−2.580	0.065**	2.814	0.071**	2.871	0.036	0.891
Male	−0.063**	−3.427	0.107***	4.899	−0.311***	−13.957	−0.104**	−2.733
Single parent	−0.031	−1.375	−0.003	−0.104	−0.059	−1.807	−0.037	−0.781
Mom's age at first birth	0.090***	4.078	0.056*	2.108	0.039	1.470	0.050	1.061
Intercept	−1.913***	−6.443	−1.276***	−3.501	−1.721***	−3.417	−0.789	−0.997
Residual variance	0.748		0.952		0.812		0.94	
Model fit	RMSEA		CFI		TLI			
	0.032		0.912		0.882			

Note: Sample size is 9646. All other covariates are measured at baseline. Both cognitive and socio-behavioral skills are measured at percentile scores, normed with respect to the sample at each wave. All models account for stratification by schools by clustering by school id. Correlation between the slope of cognitive skills and the slope of socio-behavioral skills is at each wave is between 0.25 and 0.28.
***p < 0.001, **p < 0.01, *p < 0.05 (two-tailed test).

Our study faces the same problems of unobserved heterogeneity as all studies analyzing observational data. In this particular case, our main concern is that we cannot observe parents' own skills, neither their cognitive nor their socio-behavioral skills. We attempted to address this problem with robustness checks using fixed-effects analysis although using this method does not allow us to estimate time-invariant measures such as mothers' education. Our supplementary results using fixed effect analysis and log family income to measures family SES largely confirmed our findings from our decomposition models and growth curve analysis.

Ideally, we would like to observe children as they transition into young adulthood, a period where socio-behavioral skills are presumed to undergo further changes. Unfortunately, we are constrained by the data and do not observe the children in study beyond 8th grade. In future analysis, we will replicate our analysis using other data on adolescents and young adults in order to determine if our results hold when we focus on educational achievement outcomes measure later in the life-course. Future work will also examine the relative roles of cognitive and socio-behavioral skills in mediating the effect of family SES on attainment outcomes such as labor market performance.

In recent years, there has been renewed interest in the role that socio-behavioral skills play in the intergenerational transmission of advantage and disadvantage. To date, we know much more about how socio-behavioral skills affect attainment outcomes than we do about their social origins. Taken as a whole, the results of this research have important implications for research on intergeneration social mobility. Our results show that while socio-behavioral traits are predictive of academic success, they are only weakly correlated, especially at young ages, with commonly understood dimensions of vertical social hierarchy. This finding presents a puzzle because it sits in contrast with much of what we believe to be true regarding the role of the family in skill formation. In this sense, the paper raises some important and largely unanswered questions. For example, is it possible that socio-behavioral skills, in contrast to cognitive skills, do not conform to common notions of a scale – i.e., the more the better – but are situational and individual-specific? How might other aspects of the family, such as cultural norms, shape children's socio-behavioral development? Because socio-behavioral skills develop later in life, might factors such as peer groups, neighborhoods and schools play a greater role in shaping children's socio-behavioral skills than the family? While we are unable to directly answer these questions, we have produced empirical findings that raise critical questions and offer new avenues for future research.

Appendix

Table A1
Weighted Means and Standard Deviations.

Variable	Mean	SD	Min	Max
Unstandardized 8th grade achievement	3.07	0.87	1.04	4.96
Unstandardized IRT Test Scores				
Kindergarten	35.97	10.39	11.59	109.01
1st grade	70.02	19.28	13.70	148.52
3rd grade	113.96	24.92	41.87	179.51
5th grade	137.25	24.32	50.92	185.26

(*continued on next page*)

Table A1 (*continued*)

Variable	Mean	SD	Min	Max
Socio-behavioral Skills				
Kindergarten	−0.091	1.042	−3.730	1.707
1st grade	−0.059	1.038	−3.718	1.432
3rd grade	−0.070	1.038	−3.835	1.460
5th grade	−0.064	1.050	−3.701	1.457
Family SES				
(Log) Permanent Income	10.74	0.82	7.60	12.97
Mothers' Education (Range: 1–9)	4.35	1.79	1.00	9.00
Controls				
Log number of books	3.92	1.02	0.00	5.30
Single parent	0.22	–	0.00	1.00
Male	0.52	–	0.00	1.00
Black	0.17	–	0.00	1.00
Asian	0.03	–	0.00	1.00
Hispanic	0.18	–	0.00	1.00
Mom's age at first birth	24.21	5.32	12.00	45.00

Notes: Children's academic achievement is based on a composite measure of subjective teacher assessments of children's proficiency in verbal and math/science proficiency. Cognitive skills are IRT reading and math scores. Children's socio-behavioral scores are based on teachers' subjective assessments. Academic achievement, cognitive skills and socio-behavioral scores have been transformed into percentile scores and normed with respect to the sample at each point in time. In all cases, sample weights provided by the ECLS-K are used to calculate descriptive statistics.

Table A2
Zero Order Correlations of Main Study Variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00																	
2	0.51	1.00																
3	0.56	0.82	1.00															
4	0.63	0.72	0.82	1.00														
5	0.64	0.68	0.77	0.90	1.00													
6	0.35	0.31	0.33	0.34	0.33	1.00												
7	0.35	0.27	0.31	0.32	0.32	0.56	1.00											
8	0.39	0.26	0.30	0.34	0.34	0.51	0.55	1.00										
9	0.39	0.22	0.25	0.29	0.31	0.46	0.50	0.56	1.00									
10	0.37	0.43	0.43	0.49	0.49	0.13	0.20	0.24	0.25	1.00								
11	0.34	0.40	0.38	0.43	0.43	0.10	0.14	0.16	0.18	0.59	1.00							
12	0.26	0.37	0.34	0.40	0.40	0.15	0.14	0.14	0.12	0.50	0.45	1.00						
13	−0.20	−0.18	−0.20	−0.23	−0.23	−0.16	−0.15	−0.17	−0.16	−0.42	−0.17	−0.19	1.00					
14	−0.15	−0.03	−0.03	0.00	0.02	−0.23	−0.22	−0.23	−0.27	0.01	0.00	−0.04	−0.03	1.00				
15	−0.16	−0.13	−0.17	−0.23	−0.25	−0.14	−0.13	−0.16	−0.15	−0.29	−0.11	−0.24	0.34	0.00	1.00			
16	0.09	0.10	0.06	0.03	0.04	0.04	0.06	0.09	0.11	0.01	0.02	−0.12	−0.06	−0.02	−0.08	1.00		
17	−0.12	−0.26	−0.19	−0.20	−0.18	−0.04	−0.02	−0.02	−0.02	−0.23	−0.28	−0.34	0.02	0.00	−0.16	−0.11	1.00	
18	0.26	0.30	0.28	0.31	0.33	0.11	0.12	0.15	0.14	0.42	0.45	0.31	−0.19	−0.01	−0.17	0.06	−0.16	1.00

Note: 1 = Achievement, 2 = Cog. Skill (K), 3 = Cog. skill (1st grade), 4 = Cog. skill (3rd grade), 5 = Cog. skill (5th grade), 6 = Socio. skill (K), 7 = Socio. skill (1st grade), 8 = Socio. skill (3rd grade), 9 = Socio. skill (5th grade), 10 = Permanent income, 11 = Mother's education, 12 = Log books, 13 = Single-parent, 14 = Male, 15 = Black, 16 = Asian, 17 = Hispanic, 18 = Mother's age at first birth.

Table A3
Direct Effect of Family SES, Skills and Covariates on Children's Academic Achievement with Skills Alternatively Measured at Kindergarten, 1st Grade, 3rd Grade, and 5th Grade (N = 9239).

	(1)		(2)		(3)		(4)	
	K		1st grade		3rd grade		5th grade	
	β	β/SE	β	β/SE	β	β/SE	β	β/SE
Mother's education	0.129***	6.286	0.111***	5.410	0.085***	4.367	0.078***	4.300
Permanent income	0.065**	2.948	0.053*	2.370	0.016	0.739	0.000	−0.006
Cognitive skills	0.37***	4.942	0.411***	4.881	0.506***	5.814	0.548***	5.677
Socio-behavioral skills	0.145***	8.050	0.149***	7.655	0.154***	3.946	0.19***	10.958
Log number books	0.004	0.159	0.020	0.892	0.012	0.600	0.013	0.641
Black	−0.054*	−2.328	−0.056*	−2.399	−0.019	−0.864	0.008	0.399
Asian	0.039**	2.557	0.035	1.958	0.035*	2.459	0.019	1.479
Hispanic	0.029	1.551	0.014	0.765	0.015	0.893	0.010	0.571

Table A3 (*continued*)

	(1)		(2)		(3)		(4)	
	K		1st grade		3rd grade		5th grade	
	β	β/SE	β	β/SE	β	β/SE	β	β/SE
Male	−0.119***	−7.549	−0.117***	−7.369	−0.126***	−8.450	−0.124***	−8.661
Single parent	−0.056**	−3.127	−0.05**	−2.778	−0.055**	−3.287	−0.042*	−2.635
Mother's age at first birth	0.025	1.382	0.024	1.370	0.001	0.069	−0.010	−0.662
Residual Variance	0.624		0.593		0.533		0.500	

Note: Sample size is 9646. Standardized estimates are presented. The dependent variable in columns 1 to 4 is 8th grade academic achievement for all models. Cognitive and socio-behavioral skills are measured alternatively from baseline to 5th grade. All other covariates are measured at baseline. All models account for stratification by schools by clustering according to school id.

[a] RMSEA = 0.030; CFI = 0.930, TFI = 0.886.

[b] RMSEA = 0.038; CFI = 0.934, TFI = 0.892.

[c] RMSEA = 0.036; CFI = 0.943, TFI = 0.906.

[d] RMSEA = 0.031; CFI = 0.961, TFI = 0.961.

***p < 0.001, **p < 0.01, *p < 0.05 (two-tailed test).

Table A4

Determinants of Cognitive and Socio-behavioral Skills with Skills Alternatively Measured at Fall Kindergarten, Spring Kindergarten, 1st, 3rd and 5th Grade (N = 9239).

	(1)		(2)		(3)		(4)	
	K		1st grade		3rd grade		5th grade	
	β	β/SE	β	β/SE	β	β/SE	β	β/SE
Cognitive Skills								
Mother's education	0.153***	6.834	0.169***	7.344	0.180***	8.711	0.186***	8.820
Permanent income	0.187***	7.774	0.187***	7.993	0.219***	9.198	0.225***	9.592
Log number books	0.134***	5.846	0.097***	4.463	0.115***	5.206	0.097***	4.472
Black	−0.058*	−2.224	−0.065**	−2.831	−0.107***	−4.695	−0.134***	−5.716
Asian	0.022	1.368	0.026	1.722	0.018	1.297	0.037**	3.224
Hispanic	−0.061***	−3.173	−0.029	−1.582	−0.024	−1.303	−0.019	−1.073
Male	−0.058***	−3.424	−0.055**	−3.219	−0.005	−0.322	0.009	0.584
Single parent	−0.024	−1.113	−0.040	−1.877	−0.024	−1.165	−0.028	−1.472
Mom's age at 1st birth	0.086***	4.121	0.081***	4.021	0.104***	5.429	0.114***	6.039
Residual Variance	0.753		0.769		0.697		0.674	
Socio-behavioral Skills								
Mother's education	0.039	1.507	0.080**	3.084	0.098***	3.627	0.110**	3.409
Permanent income	0.071*	2.129	0.093**	2.694	0.136***	3.946	0.120***	4.165
Log number books	0.095**	3.291	0.042	1.440	−0.022	−0.723	−0.019	−0.687
Black	−0.083**	−2.758	−0.069*	−2.408	−0.080**	−2.398	−0.07*	−2.221
Asian	0.025	1.792	0.031	1.799	0.041**	3.094	0.069***	5.101
Hispanic	0.042	1.950	0.067**	3.077	0.055*	2.499	0.075**	3.349
Male	−0.233***	−11.521	−0.244***	−12.073	−0.253***	−12.023	−0.303***	−16.950
Single parent	−0.061*	−2.251	−0.034	−1.206	−0.026	−0.976	−0.087***	−3.560
Mom's age at 1st birth	0.027	1.209	0.022	0.945	0.039	1.530	0.063**	2.780
Residual Variance	0.879		0.882		0.862		0.814	

Note: Sample size is 9646. Standardized estimates are presented. Cognitive and socio-behavioral skills are alternatively measured from baseline to 5th grade. All other variables are measured at baseline. All models account for stratification by schools by clustering according to school id. ***p < 0.001, **p < 0.01, *p < 0.05 (two-tailed test).

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