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# Children's Early Approaches to Learning and Academic Trajectories Through Fifth Grade

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Children's early approaches to learning (ATL) enhance their adaptation to the demands they experience with the start of formal schooling. The current study uses individual growth modeling to investigate whether children's early ATL, which includes persistence, emotion regulation, and attentiveness, explain individual differences in their academic trajectories during elementary school. Using data from the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K), the present investigation examined the association between ATL at kindergarten entry and trajectories of reading and math achievement across 6 waves of data from kindergarten, 1st, 3rd, and 5th grade ($n$ = 10,666). The current study found a positive link between early ATL and individual trajectories of reading and math performance. Overall, children's early ATL was equally beneficial for children regardless of their race/ethnicity and dimensions of their socioeconomic background. However, links between early ATL and academic trajectories differed by their gender and initial levels of math and reading achievement.

*Keywords:* academic achievement, approaches to learning, school readiness



When children enter kindergarten, they encounter many first-time expectations: to complete independent work, to adhere to strict time schedules, and to acquire basic literacy and math skills. Successfully meeting these demands depends on school readiness, which includes the skills and knowledge that children bring to school (Pianta, Cox, & Snow, 2007). One key set of school readiness indicators is *approaches to learning* (ATL), which are defined as the individual characteristics and observable behaviors that children show while taking part in learning activities (McWayne, Fantuzzo, & McDermott, 2004). Children's ATL includes persistence, emotion regulation, attentiveness, flexibility, and organization (Fantuzzo, et al., 2007; McWayne et al., 2004).

Meeting the demands of early schooling may foreshadow children's later achievement. According to life course theorists, *cumulative advantage* may be at work (Dannefer, 2003; DiPrete & Eirich, 2006), whereby the ways in which children first approach learning activities in school confer advantages that accumulate over time. Early ATL may lay a foundation of basic academic skills that facilitates later acquisition of more advanced academic skills (Cunha, Heckman, Lochner, & Masterov, 2006; Cunningham & Stanovich, 1997). As such, achievement gaps between kindergarteners who possess more versus less adaptive ATL may widen across elementary school. Mapping children's individual academic trajectories from kindergarten to fifth grade, the current study draws data from a nationally representative sample to examine whether early ATL yields longer term payoffs to children's academic growth.

## Approaches to Learning

With components such as persistence, emotion regulation, and attentiveness, children's ATL largely reflects self-regulation: the ability to manage one's behavior, emotions, and attention in voluntary and adaptive ways (Calkins & Fox, 2002; Eisenberg & Spinrad, 2004; Raver et al., in press). While engaged in learning activities, children draw on self-regulatory skills to remain at their desks doing seatwork, cooperate with classmates despite feeling angry or frustrated, and focus on lessons despite hearing chatter in the background (Blair, 2002; Raver, 2002). Underlying self-regulation are individual differences in temperament and executive

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functioning, which involve higher order cognitive processes such as attentional flexibility, planning, and inhibitory control (Carlson, 2005; Diamond, Barnett, Thomas, & Munro, 2007; Rothbart, Sheese, & Posner, 2007).

## ATL and Academic Achievement

A large number of studies reveal that children with better reading and math skills tend to approach learning in more adaptive ways. Children's academic competence, for example, has been positively associated with emotion regulation (Graziano, Reavis, Keane, & Calkins, 2007; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003; Raver, Garner, & Smith-Donald, 2007), attentiveness, and impulse control (Howse et al., 2003; NICHD Early Child Care Research Network [NICHD], 2003; Smith-Donald, Raver, Hayes, & Richardson, 2007). Also, higher scores on reading and math assessments have been related to better ratings on measures that simultaneously tap behavior and attention regulation, such as persistence (Fantuzzo, Sekino, & Cohen, 2004; Newman, Noel, Chen, & Matsopoulos, 1998), delay of gratification (Li-Grining, Votruba-Drzal, Bachman, & Chase-Lansdale, 2006; Mischel, Shoda, & Rodriguez, 1989), and effortful control (Blair & Razza, 2007). Similarly, greater math skills have been linked to direct assessments of executive functioning (e.g., peg-tapping measure of inhibitory control; Blair & Razza, 2007; McClelland et al., 2007). Also, better vocabulary and literacy skills have been associated with higher executive functioning (Blair & Razza, 2007; McClelland et al., 2007).

In addition to investigations that have examined the roles of specific dimensions of children's ATL, a second literature has considered the role of these skills as a whole. Global measures of ATL have been associated with better vocabulary, literacy, and math skills (Fantuzzo et al., 2007; McWayne et al., 2004). McClelland and colleagues (McClelland, Acock, & Morrison, 2006; McClelland, Morrison, & Holmes, 2000) have studied a similar set of behaviors referred to as learning-related skills, which includes self-control, persistence, organization, the ability to work independently, and the ability to work in groups. They have found that higher levels of learning-related skills are linked to better reading and math scores. In sum, we have learned from both areas of research (on broader measures of ATL and on measures of specific components of ATL) that children who approach learning in more adaptive ways are more likely to attain higher reading and math achievement.

## The Early Childhood Longitudinal Study's Kindergarten Cohort (ECLS-K)

In a third body of research, scholars have used the ECLS-K, a large-scale, nationally representative sample with strong academic achievement data, to address concerns of limited generalizability in prior studies. A positive link, for instance, has been found between latent constructs of children's cognitive skills and social–emotional competence, which was measured in part by teacher and parent reports of Approaches to Learning and Self-Control scales during kindergarten (Gershoff, Aber, Raver, & Lennon, 2007). Another study detected positive associations between academic skills in first grade and profiles of children's school readiness, which included Approaches to Learning and Self-Control scales reported by teachers and parents at kindergarten entry (Hair, Halle, Terry-Humen, Lavelle, & Calkins, 2006). Also, higher scores on the teacher-rated Approaches to Learning scale have been linked to increases in math scores from kindergarten to third grade (Bodovski & Farkas, 2007).

## Autoregressive Models

Many of the investigations reviewed above have conducted rigorous analyses that include both autoregressive techniques and individual growth modeling. In traditional autoregressive models, researchers analyze change over time by predicting later outcomes net of earlier outcomes (Kessler & Greenberg, 1981). In doing so, autoregressive models identify development with two data points (i.e., a starting point and an end point). Indeed, this is a rigorous test: Some studies have found that children's early ATL was predictive of elevated levels of later academic achievement but not when early achievement was taken into account (McClelland et al., 2007; NICHD, 2003). Still other studies detected positive associations between children's early ATL and later academic achievement, net of earlier achievement (Li-Grining et al., 2006; McClelland et al., 2000).

Studies using the ECLS-K have also employed autoregressive techniques. Scholars have found relations between teacher reports of the Approaches to Learning and Self-Control scales and children's reading achievement at the end of the kindergarten year, controlling for reading achievement in the fall (Ready, LoGerfo, Burkam, & Lee, 2005). A study by Duncan et al. (2007), which was published in this journal, included a substudy that found that the teacher-reported Approaches to Learning scale in the fall of kindergarten was related to academic achievement in third grade, controlling for achievement in the fall of kindergarten. More recent work shows that these findings hold through fifth grade (Claessens, Duncan, & Engel, 2009).

## Modeling Children's Individual Growth Trajectories

Guided by a more nuanced view of children's growth, we seek to advance the literature on children's ATL by modeling its influence on academic achievement using individual growth trajectories (Collins, 2006; Singer & Willett, 2003; Willett, 1989). These techniques allow for more precise characterization of patterns of individual development that unfold continuously over time. Growth models use at least three data points to reveal more precise and detailed trajectories of development that occur between a beginning point and end point, which may be important for understanding how children develop. With at least four data points, we are able to test more flexible models that can capture nonlinear growth, where models include polynomial terms that allow growth rates to change over time (Shonkoff & Phillips, 2000). Ceiling effects may occur, where children's growth patterns are characterized by flattening slopes over time. Alternatively, Matthew effects may transpire, where children's growth rates are demarcated by rising slopes across time (Stanovich, 1986). In contrast, autoregressive models, which rely solely on a starting point and end point to model growth, cannot capture such developmental patterns.

Another advantage of individual growth trajectory approaches is that they capture variation in development over time (Collins, 2006; Singer & Willett, 2003; Willett, 1989). Children, for example, may experience different rates of learning over time, with some children learning at a faster (or slower) rate during certain developmental stages compared with others. In other words, there may be interindividual differences in children's intraindividual growth.

Only three past studies have examined relations between children's early ATL and their individual academic trajectories. In a small local study ($n = 64$), parent ratings of kindergarteners' persistence were positively related to trajectories of reading achievement from kindergarten to third grade; however, no covariates were included (Newman et al., 1998). Another study estimated two sets of growth curves for a local sample of 260 children, controlling for child IQ, age, ethnicity, and maternal education (McClelland et al., 2006, p. 478). Higher teacher ratings of children's learning-related skills were linked to faster growth rates on the Peabody Individual Achievement Tests–Revised (PIAT-R) from kindergarten to second grade, and to higher growth rates on the North Carolina End-of-Grade Tests from third to sixth grade.

Lastly, using data from the ECLS-K, DiPerna, Lei, and Reid (2007) found that teacher reports of ATL were related to math achievement from kindergarten to third grade, net of children's age, general knowledge, interpersonal skills, and externalizing and internalizing behavior problems. Key limitations of that study, however, are that it omitted a comprehensive set of measured variables, including school, family, and other child characteristics. Moreover, DiPerna et al. did not investigate whether the link between ATL and math trajectories varied across different groups of children.

## Methodological Approach of the Current Study

We seek to build on past studies by estimating two sets of growth curve models that predict children's academic trajectories from their early ATL. In our first set of models, we control for a comprehensive set of background factors. This approach is important because it allows us to rule out third variables that may confound our estimation of this association. The omission of such third variables will lead to bias in this estimation, which economists refer to as *omitted variable bias* (Duncan, Magnuson, & Ludwig, 2004; McCartney, Bub, & Burchinal, 2006). Most of the studies reviewed previously, including the three prior studies on children's early ATL and academic trajectories, do not include extensive measurement of background characteristics. To reduce the threat of omitted variable bias in the present investigation, our first set of models predicts children's academic trajectories from their early ATL, net of a comprehensive set of child, family, and school factors.

In our second set of models, we combine autoregressive and individual growth trajectory techniques (Bollen & Curran, 2004; Cain, 1975; Cronbach & Furby, 1970). To minimize omitted variable bias, economists have used autoregressive models, where controlling for baseline outcomes allows us to take into account unmeasured heterogeneity in children that remains constant over time (Cain, 1975; Chase-Lansdale et al., 2003). Following this approach, our second set of growth curve models are hybrid models that predict children's academic trajectories from their early ATL, net of earlier academic achievement, as well as a comprehensive set of child, family, and school factors. By doing so, the current study is one of the first to examine the longer term academic benefits of children's early ATL by integrating this econometric technique with the developmental approach of modeling individual growth trajectories. To be sure, existing studies examining linkages between children's early ATL and academic trajectories have modeled initial status at Wave 1 as intercepts in growth models, where growth is modeled from, for example, Waves 1 to 4. However, no existing study on early ATL to our knowledge has explicitly taken into account the contribution of earlier achievement to later growth trajectories, where earlier achievement at Wave 1 is a predictor of later growth from, for example, Waves 2 to 4. Importantly, this provides an even stricter test of the linkage between children's early ATL and academic trajectories, as it combines the strengths of autoregressive and individual growth techniques (Bollen & Curran, 2004; Cain, 1975; Cronbach & Furby, 1970).

## Children's Early ATL as a Protective Factor

In the broader developmental literature, scholars have long studied risk and resilience, asking whether protective factors help children thrive in the context of adversity (Luthar, Cicchetti, & Becker, 2000). In the current study, early ATL may serve as a source of resilience for children who face risk factors, where children experiencing risk may reap even greater benefits from more adaptive ATL than children not facing risk (Luthar et al., 2000). Guided by this framework, we hypothesize that the difference between children with more versus less adaptive ATL will be larger among children facing risk than among those children not facing risk. In other words, among children possessing more adaptive ATL, achievement gaps between children who do and do not face adversity will be narrower. Here, we define risk in terms of demographic characteristics and early academic achievement.

**Demographic characteristics.** Achievement gaps related to children's race/ethnicity are a perennial concern among parents, educators, and policymakers. Past studies have consistently noted that African American children tend to score lower on achievement tests than European American children (Hedges & Nowell, 1995; Jencks & Phillips, 1998). Studies using the ECLS-K have recently found that the gap between African American and European American kindergarteners becomes nonsignificant with control variables; however, the gap widens over time (Fryer & Levitt, 2006; Reardon, 2008). Thus, it is important to investigate factors that may be related to smaller race/ethnicity gaps in academic achievement. The self-regulatory aspects of better ATL may help ethnic minority children cope with stereotype threat and test anxiety, which undermine achievement performance (McKown & Weinstein, 2002; Schutz & Davis, 2000). As such, we may see more modest achievement gaps between ethnic minority and European American students among children with better ATL. Moreover, given increasing diversity among children in the United States, it is important to test whether ATL functions similarly or differently across children of different racial/ethnic backgrounds (García Coll, Szalacha, & Palacios, 2005).

Interestingly, gender differences in achievement have been detected consistently in the ECLS-K, with girls trailing boys in math and boys lagging behind girls in reading (Chatterji, 2005, 2006; McCoach, O'Connell, Reis, & Levitt, 2006; Penner & Paret, 2008; Rathbun, West, & Germino-Hausken, 2004; Ready et al., 2005). Similarly, meta-analyses have found modest gender differences in cognitive abilities (Hyde, 2005). Yet, a recent meta-analysis of children in Grades 2–11 found that the standardized test scores of female and male students do not differ in math (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). These findings warrant further testing of the robustness of gender differences in academic achievement during middle childhood. Such differences may be related to children's socialization experiences (Caplan & Caplan, 2005), where parents tend to provide boys with more math-related materials (Simpkins, Davis-Kean, & Eccles, 2005). Better ATL may give girls an advantage when learning math, despite receiving relatively less support from parents in this domain. Gender differences might also be driven by individual characteristics. Compared to boys, girls tend to spend more time reading (Newman et al., 2007) and to be more interested in language and literacy (Meece, Glienke, & Burg, 2006). Boys with relatively better ATL may be more willing to spend time engaged in activities that they tend to find less interesting, such as reading. Thus, the gender gap in reading may be smaller for boys who possess more positive ATL, and the gender gap in math may be narrower for girls with more adaptive ATL.

We also examine three aspects of family socioeconomic status (SES): family income, parental education, and occupational prestige. Living below the poverty line (Duncan, Yeung, Brooks-Gunn, & Smith, 1998; Votruba-Drzal, 2006), low parental education (Davis-Kean, 2005; Sirin, 2005), and to a lesser extent less occupational prestige (Parcel & Menaghan, 1994) have been consistently linked with lower academic achievement during the elementary school years (Votruba-Drzal, Bachman, Davis, & Maldonado-Carreño, 2009). Lower SES parents have fewer economic resources to invest in their children and tend to have higher levels of stress, both of which jeopardize the quality of cognitive stimulation parents are able to provide in socioeconomically disadvantaged households (Becker, 1991; Elder, 1974; Votruba-Drzal, 2003; Votruba-Drzal et al., 2009). The self-regulatory components of ATL may help children cope with SES-related stressors, where at-risk children with better ATL display more resilience (Buckner, Mezzacappa, & Beardslee, 2003; Lengua, 2002). Children with more adaptive ATL may better capitalize on what learning opportunities are available to them at home and school (Raver, Garner, & Smith-Donald, 2007) and may elicit better parenting practices within the context of SES disadvantage (Votruba-Drzal et al., 2009). As such, economic disparities in achievement may be more modest for lower SES children with more adaptive ATL.

**Children's early academic achievement.** Finally, children's low levels of early academic achievement may place them at risk, where the transition to school may be more difficult for children who enter kindergarten with lower math and reading skills. In ECLS-K studies, lower academic skills at kindergarten entry have compromised academic achievement in third (Duncan et al., 2007) and fifth grade (Claessens et al., 2009). Yet, children with lower levels of early academic skills may compensate for this risk with more positive ATL, where better ATL helps such children acquire and build on basic academic skills. In contrast, children with higher levels of early academic skills are likely to succeed academically whether they possess more or less adaptive ATL (Newman et al., 1998). Thus, gaps between children with lower and higher early achievement may be narrower for children who approach learning in more positive ways.

Prior studies have formally tested whether one or two of the factors above moderate the link between children's ATL and academic achievement. These moderators have included race/ethnicity (Claessens et al., 2009; Raver, Gershoff, & Aber, 2007), gender (Duncan et al., 2007; Newman et al., 1998; Ready et al., 2005), global SES (Claessens et al., 2009; Duncan et al., 2007), and early math skills (Bodovski & Farkas, 2007). Findings regarding race/ethnicity and gender have been mixed, whereas results regarding global SES have been nonsignificant. Thus, further investigation into moderation by race/ethnicity, gender, and specific aspects of SES deserve attention. The moderating role of early reading skills has not been tested, and the moderating role of early math skills has only been investigated in the context of predicting gain scores, not individual growth trajectories.

Notably, none of the three studies that have examined the link between children's early ATL and academic trajectories have tested whether this association depends on other factors. Moreover, no study in the broader literature on children's ATL and academic achievement has examined a comprehensive set of moderators that includes demographic characteristics (e.g., child race/ethnicity and gender, families' poverty status, parents' education and occupational prestige) and children's early academic skills.

## Research Questions

Building on existing studies, we sought to answer two main research questions using the ECLS-K. First, we asked whether children with better ATL at kindergarten entry experienced steeper academic trajectories in math and reading achievement from kindergarten through fifth grade, compared with their peers with less adaptive ATL. Second, we investigated whether children's early ATL was especially protective for the academic trajectories of children at risk, defining risk in terms of demographic characteristics and children's early academic skills. To answer our research questions, we estimated two types of growth models (see below for details).

# Method

The present investigation capitalizes on the Early Childhood Longitudinal Study–Kindergarten Cohort (ECLS-K), an unprecedented longitudinal study of a nationally representative sample of over 20,000 kindergarteners. Beginning in the fall of 1998, the ECLS-K has conducted direct assessments with children and interviews with parents and teachers who have provided information on basic demographic information about children, families, and teachers. Data in the current study are drawn from six waves: the fall of kindergarten (Wave 1), the spring of kindergarten (Wave 2), the fall of first grade (Wave 3), the spring of first grade (Wave 4), the spring of third grade (Wave 5), and the spring of fifth grade (Wave 6).

To obtain a nationally representative sample, a multistage probability sample design was used. Altogether, 21,260 children participated in the base year of the study (U.S. Department of Education, 2001). Thereafter, decisions on how many cases to field at each subsequent wave were based on previous patterns of participation (for details, see Tourangeau, Nord, Lê, Pollack, & Atkins-Burnett, 2006). Response rates were at least 80% for child assessments, 78% for parent interviews, and 62% for teacher interviews at each of the six waves.

## Participants

The children included in this study are a subsample of the total ECLS-K sample. First, our analytic samples include children for whom the ECLS-K released longitudinal item response theory (IRT) scores that track their achievement progress from Waves 1 to 6. Second, to make sure that trajectories in our first set of analyses are not influenced by attrition from the ECLS-K sample, we limit our analyses to children who were members of the ECLS-K sample at Waves 1, 2, 4, 5, and 6. Most children in this sample were not present in the ECLS-K sample at Wave 3, but 30% of them were present at Wave 3 to facilitate the study of the summer set-back in learning. We use the ECLS-K longitudinal sampling weight C1_6FC0, which is a child-specific weight designed for analyses using the sample of students present at Waves 1, 2, 4, 5, and 6 (which we analyze here; Reardon & Gallindo, 2009; Tourangeau et al., 2006), to produce unbiased estimates for the population of U.S. kindergarten students in the fall of 1998. It is important to note that weights are designed to adjust not only for nonresponse bias but also for the oversampling of certain subpopulations. A total of 9,790 children were eligible for our first analytic sample on the basis of these criteria. Of these children, roughly 65% had valid data on all covariates. In comparison to children with valid data on all covariates, children who had missing data were more disadvantaged (i.e., more likely to belong to an ethnic minority group, to be born at low birth weight, to live in poverty, and to have parents who were less educated and unmarried).

The same approaches were used for our second analytic sample, where we predicted trajectories from Waves 2 to 6, and Wave 1 achievement was used as a covariate rather than an outcome. We limit our analyses to children who were present at Waves 2, 4, 5, and 6. We use the ECLS-K longitudinal sampling weight C2_6FC0, which is a child-specific weight designed for analyses using the sample of students present at Waves 2, 4, 5, and 6. On the basis of these criteria, a total of 10,666 children were eligible for our second analyses. This analytic sample is bigger than the first because the second one consisted of subsets of children that included children who had assessment data from Waves 2 to 6 only, as well as children who had assessment data from Waves 1 to 6.

Missing data on the covariates were imputed for the current study using the multiple imputation by chained equations technique in Stata (Royston, 2004), as traditional approaches to handling missing data, such as listwise deletion, can bias parameter estimates, inflate statistical power, and lead to invalid conclusions (Acock, 2005). Following imputation, five data sets with complete data on all covariates were produced. Analyses were conducted on five imputed datasets using HLM 6.04 (Raudenbush, Bryk, Cheong, & Congdon, 2004). The five imputed datasets were imported into the HLM program, which then conducted analyses on each imputed dataset and produced output displaying results based on an average of findings across the five separate analyses. After imputation, our second sample had complete data on all covariates, including Wave 1 achievement. In addition, sampling weights were used to account for missing data due to differential attrition. Table 1 lists descriptive statistics on early ATL, child race/ethnicity, child gender, SES, and academic achievement for both analytic samples. Descriptive statistics on other covariates and a correlation matrix for all variables are available from Christine P. Li-Grining upon request.

## Measures

**Academic achievement.** Children completed individualized direct cognitive assessments in reading and math that were developed for the ECLS-K (U.S. Department of Education, 2001, 2002). Items on the assessments combined questions from well-validated and reliable tests (e.g., the PIAT-R and the Peabody Picture Vocabulary Test–Revised) and others that were newly developed for the study. The reading assessment tests a broad range of children's language and literacy skills, including receptive vocabulary and reading comprehension. The math assessment includes items on general mathematical skills, such as understanding identifying numbers and recognizing geometric shapes.

To facilitate longitudinal comparisons of children's achievement scores, the ECLS-K calculated IRT scores, which estimate children's performance as if they had been administered the whole set of assessment questions. The first set of IRT scores was created for children participating in the kindergarten and first grade rounds of data collection. As children aged and the assessments were expanded in third and fifth grade, the ECLS-K recalibrated the IRT scores from all prior waves of data to make longitudinal comparisons possible (U.S. Department of Education, 2005). Growth modeling necessitates an outcome variable measured on a consistent metric over time (Singer & Willett, 2003). Thus, we used the recalibrated fifth grade IRT scores, which is in keeping with prior studies of academic growth using the ECLS-K (e.g., McCoach et al., 2006; Ready et al., 2005). Average reliabilities of the IRT scores from kindergarten through fifth grade were .93 for reading and .92 for math.

**Early ATL.** We captured children's early ATL by combining two sets of scales from the ECLS-K's Social Rating System (SRS; U.S. Department of Education, 2002), which is based on the Social Skills Rating System (SSRS; Gresham & Elliot, 1990). The first set includes the teacher and parent report versions of the ECLS-K's Approaches To Learning scale. The teacher version includes six items on attentiveness, persistence, learning independence, flexibility, organization, and eagerness to learn; the parent version includes six items on concentration, persistence, responsibility, creativity, eagerness to learn, and interest in a variety of things.

Because children's ATL largely reflects self-regulation (Fantuzzo et al., 2007; McWayne et al., 2004), we also used the teacher and parent report versions of the ECLS-K Self-Control scale. The teacher version included four items on children's ability to control their temper, to accept peer ideas for group activities, to respect the property rights of others, and to respond appropriately to pressure from peers. The parent version included five items on children's ability to control their actions and feelings (e.g., frequency with which a child fights, argues, throws tantrums, or gets angry; reverse coded). With a focus on school readiness, we used scales from the fall of kindergarten, where the split-half reliability statistics were .89, .68, .79, and .74 for the teacher- and parent-reported Approaches to Learning scales and teacher- and parent-reported Self-Control scales, respectively. All four scales used a metric in which 1 = *never*, 2 = *sometimes*, 3 = *often*, and 4 = *very often*; items were averaged to create each scale.

Table 1
*Descriptive Statistics*

| | Waves 1–6 sample ($n$ = 9,790) | | | | Waves 2–6 sample ($n$ = 10,666) | | | |
|---|---|---|---|---|---|---|---|---|
| Main variable of interest | *M* | *SD* | Min | Max | *M* | *SD* | Min | Max |
| Early approaches to learning | 3.03 | 0.39 | 1.25 | 4.00 | 3.03 | 0.39 | 1.25 | 4.00 |
| Demographic characteristics | | | | | | | | |
| Child race/ethnicity | | | | | | | | |
| White/non-Hispanic | 0.58 | 0.49 | 0.00 | 1.00 | 0.58 | 0.49 | 0.00 | 1.00 |
| Black/non-Hispanic | 0.11 | 0.31 | 0.00 | 1.00 | 0.11 | 0.31 | 0.00 | 1.00 |
| Hispanic | 0.18 | 0.39 | 0.00 | 1.00 | 0.18 | 0.38 | 0.00 | 1.00 |
| Asian | 0.07 | 0.25 | 0.00 | 1.00 | 0.07 | 0.25 | 0.00 | 1.00 |
| Other | 0.06 | 0.23 | 0.00 | 1.00 | 0.05 | 0.23 | 0.00 | 1.00 |
| Child gender | 0.50 | 0.50 | 0.00 | 1.00 | 0.50 | 0.50 | 0.00 | 1.00 |
| Socioeconomic status | | | | | | | | |
| Poverty | 0.18 | 0.39 | 0.00 | 1.00 | 0.18 | 0.39 | 0.00 | 1.00 |
| Parent education risk | 0.09 | 0.29 | 0.00 | 1.00 | 0.09 | 0.29 | 0.00 | 1.00 |
| Parent occupational risk | 0.61 | 0.49 | 0.00 | 1.00 | 0.61 | 0.49 | 0.00 | 1.00 |
| Child outcomes | | | | | | | | |
| Reading | | | | | | | | |
| Wave 1 | 30.04 | 10.04 | 14.90 | 124.28 | 30.04 | 10.04 | 14.90 | 124.28 |
| Wave 2 | 41.63 | 13.58 | 16.60 | 138.49 | 41.59 | 13.61 | 16.60 | 138.49 |
| Wave 3 | 48.63 | 17.43 | 17.07 | 146.06 | 48.55 | 17.40 | 17.07 | 146.06 |
| Wave 4 | 72.80 | 21.98 | 19.26 | 163.12 | 72.77 | 22.01 | 19.26 | 163.12 |
| Wave 5 | 119.24 | 24.73 | 45.51 | 178.92 | 119.24 | 24.77 | 45.51 | 178.92 |
| Wave 6 | 139.98 | 22.96 | 59.12 | 181.22 | 139.94 | 23.00 | 59.12 | 181.22 |
| Math | | | | | | | | |
| Wave 1 | 23.54 | 9.02 | 7.49 | 86.54 | 23.54 | 9.02 | 7.49 | 86.54 |
| Wave 2 | 34.05 | 11.63 | 8.73 | 104.18 | 34.00 | 11.58 | 8.73 | 104.18 |
| Wave 3 | 41.03 | 13.75 | 10.13 | 104.40 | 40.87 | 13.79 | 10.10 | 104.40 |
| Wave 4 | 58.53 | 16.77 | 13.08 | 120.50 | 58.52 | 16.73 | 13.08 | 120.50 |
| Wave 5 | 93.06 | 21.33 | 33.19 | 146.59 | 93.01 | 21.31 | 33.19 | 146.59 |
| Wave 6 | 114.47 | 21.15 | 46.97 | 150.94 | 114.37 | 21.15 | 46.97 | 150.94 |

*Note.* Descriptive statistics are unweighted. Waves 1, 2, 3, 4, 5, and 6 refer to the fall of kindergarten, spring of kindergarten, fall of first grade, spring of first grade, spring of third grade, and spring of fifth grade, respectively.

Guided by conceptual and statistical reasoning, we created an overall composite of early ATL based on the four scales. The individual items that make up each scale are not publicly available. Thus, we averaged the four scales to create our composite. Without the item-level data, it was impossible for us to generate the exact internal consistency of our early ATL measure. Thus we generated an estimate of the alpha. We used the split-half reliability statistics and correlations among the subscales as proxies for the nonrepeating, off-diagonal correlations among the items. We then calculated the mean interitem correlation and used a standard alpha equation (Nunnally & Bernstein, 1994) to estimate the reliability for early ATL ($\alpha$ = .92).

**Child characteristics.** Parental reports of other child characteristics were included as control variables, because they may be related to children's early ATL and academic trajectories (e.g., Li-Grining, 2007; McCoach et al., 2006). Age at kindergarten entry was measured in months, and gender was represented by a dummy variable indicating whether the child was male. There were five categories of race/ethnicity: White/non-Hispanic (reference group), Black/non-Hispanic, Hispanic, Asian, and a category including other racial/ethnic backgrounds. Additionally, low birth weight status, defined by whether children weighed 5.5 lbs (2.5 kg) or less at birth, was included as a health indicator.

**Family characteristics.** Parent reports of family and household characteristics during kindergarten were used as controls, because they may be related to children's early ATL and academic trajectories (e.g., Duncan et al., 1998; Li-Grining, 2007). Parents were coded as working or not employed, marital status reflected whether they were married, and mothers' age at first birth was measured in years. Other covariates included whether a language other than English was spoken at home, whether the family received welfare, and the number of individuals in the household.

Three indicators of socioeconomic disadvantage were created: (a) an indicator of poverty status during kindergarten, based on the federal poverty line; (b) a variable indicating whether the highest level of parental education in the household was less than high school; and (c) a dummy that differentiated whether parents held higher versus lower prestige jobs. Jobs that involved more expertise (e.g., physicians, engineers) were considered as having higher prestige versus jobs that involved less expertise (e.g., cleaners, laborers). The occupational prestige indicator was based on parents' reports of their occupation, which the ECLS-K recoded to reflect the average 1989 General Social Survey Occupational Prestige score (U.S. Department of Education, 2001).

**School characteristics.** We also controlled for aspects of children's experiences in kindergarten, including attributes of teachers and schools that have been linked to academic achievement (Greenwald, Hedges, & Laine, 1996; Nye, Konstantopoulos, & Hedges, 2004; Votruba-Drzal, Li-Grining, & Maldonado-Carreño, 2008), ATL (Finn & Pannozzo, 2004), and teacher expectations of children's social and academic behavior (Lin, Lawrence, & Gorrell, 2003). A dichotomous indicator of teacher education reflected whether or not teachers held graduate degrees (Greenwald et al., 1996), and a dummy variable for teacher experience captured whether teachers taught kindergarten for 3 years or less versus more than 3 years (Nye et al., 2004). Basic school demographic characteristics were included as controls, such as school type (private vs. public). Schools' geographic region was modeled by indicating whether the school was located in the Northeast (reference group), Midwest, South, or West (Lin et al., 2003). Finally, schools' urbanicity was represented by indicating whether schools were located in suburbs and large towns (reference group), central cities, or small towns and rural areas (Finn & Pannozzo, 2004).

## Analytical Strategy

**Main effects models.** To answer our first research question, we estimated two types of individual growth models. In our first set of growth models, we examined associations between early ATL and achievement trajectories from Wave 1 at the fall of kindergarten through Wave 6 at the spring of fifth grade (Singer & Willett, 2003). Individual growth models were estimated in HLM 6.04 using full information maximum likelihood (Raudenbush et al., 2004). We first specified an individual growth model and tested whether there was significant variability in initial levels of achievement and in achievement trajectories, using the equation:

$$Y_{tij} = \pi_{0ij} + \pi_{1ij}Time_{tij} + \pi_{2ij}Time^2_{tij} + \varepsilon_{tij}. \tag{1}$$

Repeated assessments of academic achievement across Waves 1 to 6 were modeled as a function of time. The variable $\text{Time}_{tij}$ captures the number of months that passed since September 1, 1998, because the exact start of the school year was not available in the public release data. For each child, the time variable was centered at the time of their kindergarten fall assessment. Thus, the intercept $\pi_{0ij}$ captures the achievement score of child *i* in school *j* at the fall of kindergarten. Notably, plots of children's individual trajectories suggested that they experienced nonlinear growth in academic achievement. Thus, two slope parameters ($\pi_{1ij}$ and $\pi_{2ij}$) were included in the Level 1 model. The first, $\pi_{1ij}$, represents the linear rate of change of child *i* in school *j*'s outcomes at the fall of kindergarten, and $\pi_{2ij}$ (i.e., the coefficient on the quadratic slope term) reflects the acceleration of the growth trajectory. A time-specific random effect $\varepsilon_{tij}$ was included as well.

In these unconditional models, the intercept and linear slope terms were estimated as random at Level 2. At Level 3 the intercept and linear slope terms of the Level 2 equations predicting the Level 1 intercept and linear slope terms were also estimated as random effects. The magnitude of variability on the quadratic slope term was exceptionally small and not substantively meaningful, so the quadratic slope term was fixed at Levels 2 and 3.

After confirming that there was significant variability in children's academic trajectories from Waves 1 to 6, we estimated a conditional growth model that addressed our first research question, using the equations below.

$$\pi_{0ij} = \beta_{00j} + \beta_{01j}ATL_{ij} + \beta_{02j}KT_{ij} + \beta_{03j}C_{ij} + \beta_{04j}F_{ij} + \beta_{05j}T_{ij} + r_{0ij}. \tag{2}$$

$$\pi_{1ij} = \beta_{10j} + \beta_{11j}ATL_{ij} + \beta_{12j}KT_{ij} + \beta_{13j}C_{ij} + \beta_{14j}F_{ij} + \beta_{15j}T_{ij} + r_{1ij}. \tag{3}$$

$$\pi_{2ij} = \beta_{20j} + \beta_{21j}ATL_{ij} + \beta_{22j}KT_{ij} + \beta_{23j}C_{ij} + \beta_{24j}F_{ij} + \beta_{25j}T_{ij}. \tag{4}$$

Here, at Level 2, the intercept and slope coefficients from the Level 1 equation were modeled as a function of ATL measured in the fall of kindergarten, the number of months between September 1, 1998, and the time of the assessment in the fall of kindergarten (*KT*), and a series of child (*C*; i.e., age, gender, race/ethnicity, and low birth weight status), family (*F*; i.e., poverty status, parental education, parents' occupational risk, parental employment, welfare receipt, marital status, maternal age at first birth, home language, and household size), and teacher (*T*; i.e., teacher education and experience) characteristics. The models also controlled for whether children changed teachers and whether they changed schools over the kindergarten year. All independent variables were centered around the grand mean for the sample, so the intercepts at Level 2 represent values for the average study participant.

At Level 3, we used the equations below to predict the Level 2 intercepts to take into account the nesting of data within schools:

$$\beta_{00j} = \gamma_{000} + \gamma_{001}\mathrm{ST}_j + \gamma_{002}\mathrm{R}_j + \gamma_{003}U_j + u_{00j}. \tag{5}$$

$$\beta_{10j} = \gamma_{100} + \gamma_{101}\mathrm{ST}_j + \gamma_{102}\mathrm{R}_j + \gamma_{103}U_j + \mathrm{u}_{10j}. \tag{6}$$

$$\beta_{20j} = \gamma_{200} + \gamma_{201}\mathrm{ST}_j + \gamma_{202}\mathrm{R}_j + \gamma_{203}U_j. \tag{7}$$

The intercepts of the Level 2 equations were modeled as a function of school type (*ST*), geographic region (*R*), and urbanicity (*U*). The equations predicting the Level 2 slope coefficients were fixed at Level 3 because we had no a priori hypothesis about how school characteristics would moderate the influence of the Level 2 independent variables.

The second type of growth model that we estimated analyzed relations between early ATL and achievement trajectories from Waves 2 to 6. These analyses controlled for early academic skills (i.e., initial level of academic skills at Wave 1), as well as child, family, and school characteristics. This second set of models used the same equations described above, except that the intercepts and slope coefficients in the Level 1 equation were also predicted by academic achievement at Wave 1. It is likely that the coefficients on ATL in this second set of models are downwardly biased, because initial levels of achievement may be one of the pathways through which early ATL enhances subsequent achievement trajectories. Thus, we refer to the estimates from this second set of models as lower bound estimates, whereas the estimates from our first set of models are considered upper bound estimates.

**Interaction effects models.** To address our second research question, we also conducted a set of interaction analyses. In both types of growth models, we added a series of interaction terms to the main effects models outlined above, where interaction terms were included as predictors of the linear rate of change in Equation 1.3. In the first set of growth models, we included race/ethnicity, gender, and SES interactions. Because Wave 1 achievement was used as a covariate in the second type of growth model predicting trajectories from Waves 2 to 6, we were able to add an interaction term between Wave 1 math scores and early ATL as a predictor of math trajectories. Similarly, we were able to add an interaction term between Wave 1 reading achievement and early ATL as a predictor of reading trajectories.

## Results

Before addressing our research questions, we estimated unconditional growth models of children's math and reading achievement. Results from these models, as well as findings in the remainder of the article, are weighted. Chi-square tests revealed that children varied significantly in their trajectories and initial levels of math and reading achievement. The math and reading scores for the average child in the sample were 21.11 and 25.31, respectively, at the fall of kindergarten. Furthermore, there were positive and significant coefficients on the linear slope terms, and negative and significant coefficients on the quadratic time terms, suggesting that children's achievement trajectories increased more slowly over time.

### Are Children's Early ATL and Achievement Trajectories Positively Linked?

Our first goal was to examine whether children's ATL at kindergarten entry was positively linked to their academic trajectories by estimating two types of main effects models. Table 2 presents findings from our main effects models, where the first and second columns show results from analyses predicting academic trajectories from Waves 1 to 6 and the third and fourth columns display findings from our analyses predicting achievement trajectories from Waves 2 to 6. In both analyses, academic trajectories are predicted from ATL at the fall of kindergarten. In the second row of Table 2, we see that the academic trajectories of children with better ATL grew at a faster rate than did those of children with less adaptive ATL.

As shown in the second row of the first and second columns of Table 2, our first set of growth models suggest that starting in the fall of kindergarten, each unit increase in early ATL was linked to 0.38 and 0.56 of an additional point in math and reading growth per month, respectively. Figure 1 illustrates our findings, showing math trajectories for children with less adaptive ATL (i.e., one standard deviation below the mean), average ATL, and better ATL (i.e., one standard deviation above the mean). The plot for reading trajectories looks nearly identical. What do these monthly growth rates mean for differences in children's level of academic achievement? To help interpret Figure 1 and the coefficients above, we also calculated effect sizes in terms of standard deviations. By the end of fifth grade, children with better ATL scored .56 and .52 of a standard deviation higher in math and reading, respectively, than children with less adaptive ATL.

Our second and more conservative set of growth models, which control for children's academic skills at the fall of kindergarten and model trajectories from Waves 2 to 6, provides lower bound estimates for associations between early ATL and children's academic trajectories. As seen in the second row of the third and fourth columns of Table 2, the magnitude of the association between early ATL and achievement trajectories was substantially reduced from the prior upper bound models, such that a unit increase in children's ATL was linked to 0.16 and 0.43 of an additional point in math and reading growth per month, respectively. These represent 58% and 23% reductions in the magnitude of associations for math and reading, respectively. On the basis of these more conservative

Table 2
*Main Effects of Children's Early Approaches to Learning on Their Academic Trajectories*

| | Trajectories across Waves 1–6 | | | | Trajectories across Waves 2–6 | | | |
|---|---|---|---|---|---|---|---|---|
| | Math | | Reading | | Math | | Reading | |
| Predictor of linear time term | Coefficient | *SE* | Coefficient | *SE* | Coefficient | *SE* | Coefficient | *SE* |
| Intercept | 2.16*** | 0.01 | 2.87*** | 0.02 | 2.13*** | 0.01 | 2.96*** | 0.02 |
| Early approaches to learning | 0.38*** | 0.03 | 0.56*** | 0.04 | 0.16*** | 0.03 | 0.43*** | 0.04 |
| Demographic characteristics | | | | | | | | |
| Child race/ethnicity | | | | | | | | |
| Black/non-Hispanic | −0.26*** | 0.04 | −0.18** | 0.05 | −0.22*** | 0.04 | −0.23*** | 0.05 |
| Hispanic | −0.11** | 0.04 | −0.08ᵗ | 0.05 | −0.04 | 0.04 | −0.15** | 0.04 |
| Asian | −0.08 | 0.07 | 0.03 | 0.08 | −0.11ᵗ | 0.06 | −0.14ᵗ | 0.08 |
| Other | −0.11* | 0.05 | −0.16* | 0.07 | −0.10* | 0.04 | −0.23** | 0.08 |
| Child gender | 0.19*** | 0.02 | −0.06* | 0.03 | 0.16*** | 0.02 | −0.05ᵗ | 0.03 |
| Socioeconomic status | | | | | | | | |
| Poverty | −0.09* | 0.04 | −0.15** | 0.06 | −0.10** | 0.03 | −0.14** | 0.05 |
| Parent education risk | −0.16*** | 0.04 | −0.22*** | 0.05 | −0.12** | 0.04 | −0.22*** | 0.05 |
| Parent occupational risk | −0.10*** | 0.02 | −0.15*** | 0.04 | −0.08*** | 0.02 | −0.12** | 0.03 |
| Early academic skills | | | | | | | | |
| Wave 1 math score | | | | | 0.02*** | 0.00 | | |
| Wave 1 reading score | | | | | | | 0.01* | 0.00 |

*Note.* Results presented above are excerpts from estimation of Equations 1 to 7. Full tables of results are not presented here for parsimony, but are available from Christine P. Li-Grining upon request. Waves 1, 2, 3, 4, 5, and 6 refer to fall of kindergarten, spring of kindergarten, fall of first grade, spring of first grade, spring of third grade, and spring of fifth grade, respectively.
* $p < .05$. ** $p < .01$. *** $p < .001$. ᵗ $t < .10$.

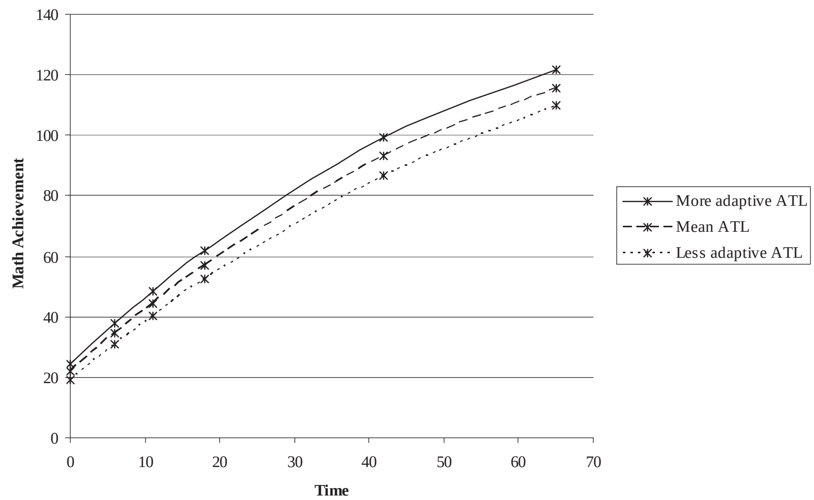


*Figure 1.* Children's early approaches to learning (ATL) predicting trajectories of math achievement. Time is measured in months, starting at the fall of kindergarten. The six plotted data points represent achievement at the fall of kindergarten, spring of kindergarten, fall of first grade, spring of first grade, spring of third grade, and spring of fifth grade.

models, by the end of fifth grade, the effect sizes for children with more versus less adaptive ATL were .26 and .35 of a standard deviation for math and reading, respectively.

## Does Early ATL Serve as a Protective Factor for Children at Risk?

Our second goal was to explore whether early ATL functioned as a protective factor for children at risk by estimating interaction models. In Table 3, the first two columns show findings from our less conservative growth models that included interactions for race/ethnicity, gender, and SES. The last two columns display results from our more conservative growth models that tested for race/ethnicity, gender, SES, and early achievement interactions.

**Race/ethnicity interactions.** Coefficients on our race/ethnicity interactions can be seen in rows 1–4 of columns 1 and 2 in Table 3. As shown there, we did not find systematic, consistent differences across children's racial/ethnic groups.

**Gender interactions.** However, we detected significant gender interactions, as shown in row 5. Our results suggest that these

Table 3
*Interaction Effects Between Children's Early Approaches to Learning and Their Demographic Characteristics and Early Academic Skills*

| | Trajectories across Waves 1–6 | | | | Trajectories across Waves 2–6 | | | |
|---|---|---|---|---|---|---|---|---|
| | Math | | Reading | | Math | | Reading | |
| Predictor of linear time term | Coefficient | *SE* | Coefficient | *SE* | Coefficient | *SE* | Coefficient | *SE* |
| Demographic characteristics | | | | | | | | |
| Race/ethnicity | | | | | | | | |
| Black/non-Hispanic × ATL | 0.01 | 0.03 | 0.02 | 0.04 | −0.01 | 0.03 | 0.02 | 0.04 |
| Hispanic × ATL | 0.01 | 0.03 | −0.04 | 0.04 | −0.01 | 0.03 | −0.07* | 0.03 |
| Asian × ATL | −0.01 | 0.04 | −0.08t | 0.05 | 0.03 | 0.04 | −0.03 | 0.04 |
| Other × ATL | 0.10* | 0.04 | 0.07 | 0.06 | 0.06 | 0.04 | 0.01 | 0.06 |
| Child Gender × ATL | −0.06** | 0.02 | 0.05* | 0.02 | −0.06** | 0.02 | 0.05* | 0.02 |
| Socioeconomic status | | | | | | | | |
| Poverty × ATL | 0.05t | 0.03 | 0.04 | 0.04 | 0.05 | 0.03 | 0.00 | 0.03 |
| Educational Risk × ATL | −0.01 | 0.03 | 0.00 | 0.04 | −0.04 | 0.03 | −0.02 | 0.04 |
| Occupational Risk × ATL | 0.03 | 0.02 | 0.05 | 0.03 | −0.03 | 0.02 | 0.03 | 0.03 |
| Early academic skills | | | | | | | | |
| Wave 1 Math Score × ATL | | | | | −0.01*** | 0.00 | | |
| Wave 1 Reading Score × ATL | | | | | | | −0.01*** | 0.00 |

*Note.* Results presented above are excerpts from estimation of Equations 1 to 7, plus interaction terms. Full tables of results are not presented here for parsimony, but are available from Christine P. Li-Grining upon request. Waves 1, 2, 3, 4, 5, and 6 refer to fall of kindergarten, spring of kindergarten, fall of first grade, spring of first grade, spring of third grade, and spring of fifth grade, respectively. ATL = approaches to learning.
* $p < .05$. ** $p < .01$. *** $p < .001$. t $t < .10$.

gender findings are robust and that the interactions were not due to differences in race/ethnicity and SES. Row 5 of columns 1 and 2 in Table 3 shows that in our final interaction models, the coefficients on the gender interactions were –.06 and .05 for math and reading, respectively. This indicates that early ATL was more protective for girls' math growth and boys' reading growth.

To get a sense of what these monthly gains mean for children's academic achievement over time, we again calculated effect sizes by the end of fifth grade. By that time, girls with better ATL outperformed girls with less adaptive ATL in math by .64 of a standard deviation. Yet, the math trajectories for boys with more versus less adaptive ATL were characterized by more similar slopes over time, where boys with more versus less adaptive ATL differed by only .49 of a standard deviation by the spring of fifth grade. Expressed differently, girls experienced a math benefit that was .15 of a standard deviation larger than that of boys. Figure 2 illustrates this finding across Waves 1 to 6.

We detected similar findings for children's reading trajectories from Waves 1 to 6. By the spring of fifth grade, the growth of reading skills of boys with better ATL was .56 of a standard deviation steeper than that of boys with less adaptive ATL. Yet, the reading trajectories for girls with more versus less adaptive ATL differed by only .45 of a standard deviation by the end of fifth grade. In other words, boys experienced a reading advantage that was .11 of a standard deviation larger than that of girls.

The last two columns of Table 3 present results from our more conservative growth models that included interactions for race/ethnicity, gender, SES, and early achievement predicting achievement trajectories from Waves 2 to 6. As displayed in row 5 of the last two columns of Table 3, the results of the more conservative model specification were identical to the findings from the less conservative models. Even after controlling for interactions between children's early ATL and initial level of academic achievement, ATL at kindergarten entry was more protective for girls' math growth and boys' reading growth across elementary school.

**SES interactions.** Additionally, we explored whether better ATL was particularly beneficial to children facing different forms of socioeconomic risk. Rows 6–8 of Table 3 show results for interactions between ATL and poverty status, educational risk, and occupational risk. Children's ATL was similarly protective across each of these socioeconomic groups, as seen in our less conservative growth models in columns 1 and 2 and in our more conservative growth models in columns 3 and 4.

**Early achievement interactions.** Lastly, we hypothesized that better ATL would be especially protective for academic trajectories among children with lower math and reading skills at kindergarten entry. Given the design of our growth models, we were only able to test this hypothesis in the second model, where academic skills at the fall of kindergarten were modeled as a covariate rather than as part of the growth trajectory. Results from these analyses are shown in the last two rows of columns 3 and 4 in Table 3. When we estimated trajectories from Waves 2 to 6, the coefficients on the interaction between initial academic skills and early ATL were −.01 for both reading and math. Though these coefficients are modest, it should be kept in mind that our coefficients are based on rates of change, not levels of achievement.

Overall, these results suggest that early ATL was particularly protective for children with lower levels of initial academic achievement. Again, to gauge what these monthly gains meant for children's academic achievement, we calculated effect sizes at the end of fifth grade. By that time, children with low initial levels of achievement but better ATL outscored children with low initial levels of achievement and less adaptive ATL by .39 and .47 of a standard deviation in math and reading, respectively. In contrast, children who scored higher in terms of both academic skills and ATL outperformed children with high initial levels of achievement

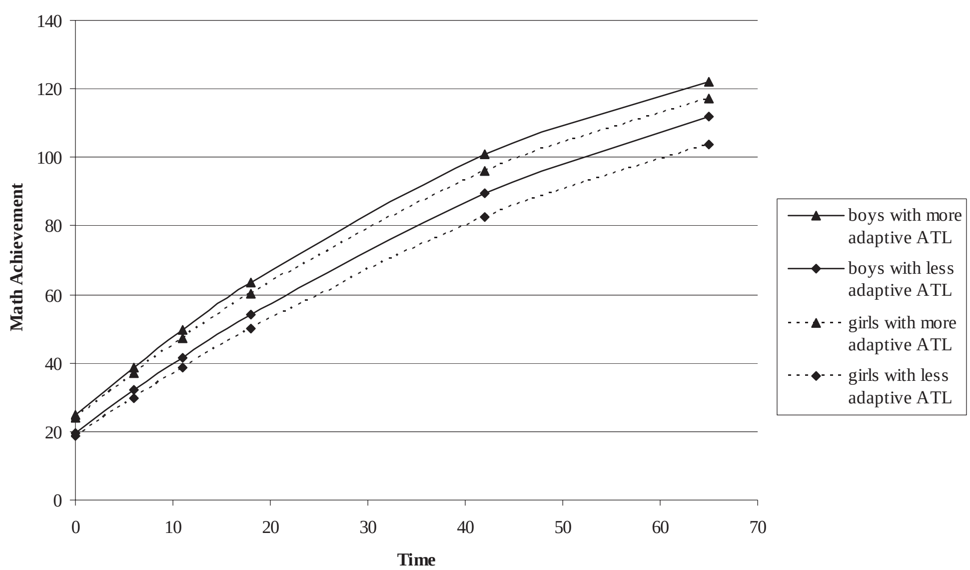


*Figure 2.* Children's early Approaches to Learning (ATL) × Gender interaction predicting trajectories of math achievement. Time is measured in months, starting at the fall of kindergarten. The six plotted data points represent achievement at the fall of kindergarten, spring of kindergarten, fall of first grade, spring of first grade, spring of third grade, and spring of fifth grade.

and less adaptive ATL by only .04 and .15 of a standard deviation in math and reading, respectively. Importantly, these interaction findings were significant net of interactions between early ATL and race/ethnicity, gender, and socioeconomic risk. Simply put, children who began kindergarten with lower academic skills experienced an ATL advantage that was .35 and .32 of a standard deviation greater than that of children who started kindergarten with higher academic competence in math and reading, respectively. Figure 3 illustrates this interaction for math, where it can be seen that the growth trajectories of children with lower initial math scores but better ATL were steeper than those of children with lower math scores and less adaptive ATL. The plot for reading skills looks very similar.

## Discussion

Across disciplines, scholars in the fields of developmental psychology (e.g., Blair, 2002; Raver, 2002), economics (Heckman, 2006), sociology (Farkas & Hibel, 2007), and education (Lee & Burkham, 2002) have underscored the role children's school readiness plays in shaping their long-term outcomes. In particular, sociologists highlight that inequalities between children at the start of school contribute to inequalities witnessed in adulthood (Farkas & Hibel, 2007).

### The Benefits of Early ATL to Academic Trajectories Through Fifth Grade

Given the importance of children's preparedness for school (Pianta et al., 2007), we sought to extend the existing literature on children's early ATL, which represents an important dimension of school readiness. Bringing together methods from developmental psychology and economics, we used the ECLS-K, whose strengths include strong measurement of academic achievement and a large-scale, nationally representative sampling design. On the basis of six waves of math and reading data from kindergarten and first, third, and fifth grade, the current study detected links between steeper academic trajectories and early ATL. Using individual growth curve modeling, we found that children who began kindergarten with varying levels of ATL followed different academic trajectories. Children with better ATL tended to experience greater rates of growth than those children with less adaptive ATL, with the differences between them increasing across elementary school. Moreover, these findings held when predicting trajectories across five waves of data from kindergarten and first, third and fifth grade, net of early academic skills.

These results, based on a global ATL measure that largely reflected children's persistence, emotion regulation, and attentiveness, are consistent with findings from past research based on more detailed ATL measures employed in relatively smaller, locally focused studies. Past research has noted that children's academic achievement is positively linked to more in-depth global ATL measures (McClelland et al., 2000) and to detailed assessments of specific ATL dimensions such as behavior, emotion, and attention regulation (e.g., Miech, Essex, & Goldsmith, 2001; Mischel et al., 1989; NICHD, 2003).

The contributions of the current study to the existing literature include the following. Most extant studies have examined linkages between children's ATL and academic achievement by testing autoregressive models (e.g., Claessens et al., 2009; Duncan et al., 2007), although three past studies have tested associations between children's ATL and individual academic trajectories (DiPerna et al., 2007; McClelland et al., 2006; Newman et al., 1998). To our knowledge, ours is one of the first studies to test links between ATL and academic achievement by integrating autoregressive techniques with individual growth modeling, where earlier academic achievement was explicitly modeled as a predictor of later

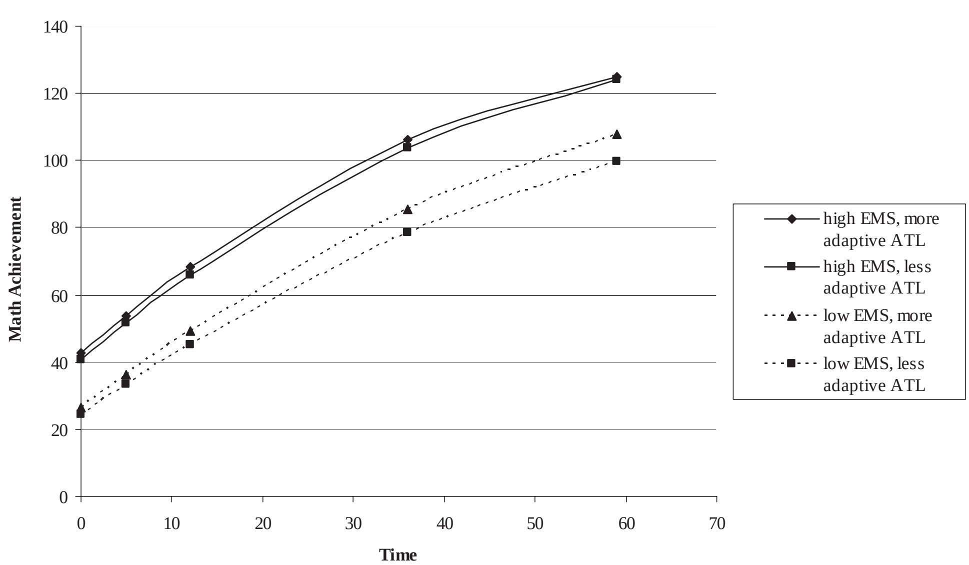


*Figure 3.* Children's early Approaches to Learning (ATL) × Early Math Skills (EMS) predicting trajectories of math achievement. Time is measured in months, starting at the spring of kindergarten. The five plotted data points represent achievement at the spring of kindergarten, fall of first grade, spring of first grade, spring of third grade, and spring of fifth grade.

academic trajectories. In doing so, the associations between early ATL and academic trajectories cleared a high statistical bar, where these relations were detected when employing robust techniques that controlled for constant, unmeasured individual differences in children. Furthermore, the current investigation extends prior individual growth trajectory studies by reducing the threat of omitted variable bias with a comprehensive host of covariates that include child, family, and school characteristics.

We also expand the extant literature by providing a range of effect sizes for gaps between children with more versus less adaptive ATL. Our upper bound estimates suggest that, by the end of fifth grade, children's early ATL was moderately to largely associated with academic achievement, but our lower bound estimates suggest that these links were modest to moderate in size. This range is important to note given that our autoregressive models might be over controlling (Newcombe, 2003). In other words, if higher levels of early ATL lead to higher levels of initial levels of achievement at the fall of kindergarten, then the inclusion of initial levels of achievement in our autoregressive growth curve models may downwardly bias our estimate of the associations between early ATL and achievement trajectories. Why did children who approached learning in more adaptive ways at kindergarten entry have the tendency to experience steeper academic trajectories? Strengths at the start of kindergarten may help set children on pathways of cumulative advantage, where children acquire better academic skills over time (Cunningham & Stanovich, 1997; DiPrete & Eirich, 2006). For example, better self-regulatory skills may facilitate children's focus on learning, helping them to stay in their seats during educational activities, to dampen distracting emotions, and to filter out information that is unrelated to learning (Blair & Razza, 2007; McClelland et al., 2007).

Children who can more easily manage their behavior, emotions, and attention may also develop better relationships with teachers and peers, who may in turn provide more instructional and emotional support to those children (Ladd, Birch, & Buhs, 1999; Raver, 2002). Furthermore, it is likely easier to teach children who tend to stay on task and who are flexible, organized, and motivated to learn. Future research on comprehensive mediating models of children's academic achievement should examine the specific pathways through which particular dimensions of ATL are linked to academic trajectories via multiple potential mediating mechanisms, such as instructional and emotional support provided by teachers and peers.



## The Protective Nature of Early ATL for Children at Risk

Unlike prior research on links between children's early ATL and individual academic trajectories, we tested for moderation. The examination of moderators deserves attention, given the importance of noting that developmental processes may operate differently across various groups of children, and particularly across diverse sociocultural contexts (García Coll et al., 2005). An advantage of our study is that the ECLS-K includes percentages of ethnic minority children that are sizable enough to test for racial/ethnic differences in the link between children's early ATL and academic trajectories. Our results suggest that these associations function similarly across racial/ethnic groups. These findings contribute to mixed results from existing ECLS-K studies, where some studies have not detected racial/ethnic differences (Claessens et al., 2009; Duncan et al., 2007), but others have (Raver, Gershoff, & Aber, 2007). It is promising that ATL operated similarly regardless of race/ethnicity, but replication is needed.

Similarly, we did not find that the association between children's early ATL and academic trajectories varied across groups based on poverty status, parents' education, or occupational prestige. These results build on other ECLS-K studies that have detected null findings with global measures of SES (Claessens et al., 2009; Duncan et al., 2007). What may explain these null findings regarding race/ethnicity and SES? It may be that specific dimensions of ATL, such as emotion regulation, and not ATL as a whole, provide children with the appropriate set of tools to deal with the multiple stressors associated with discrimination, poverty, and its correlates (Lengua, 2002).

However, links between children's early ATL and academic trajectories did vary across two moderators we examined. First, findings from our interaction models suggest that the relation between children's early ATL and academic trajectories varied as a function of gender. By the end of fifth grade, girls with better ATL demonstrated modestly greater benefits than boys in math, and boys with better ATL yielded modestly more benefits than girls in reading. These findings are consistent with those from a small, local study that identified more prosocial behavior and fewer observed behavior problems as protective factors for boys' literacy skills (Doctoroff, Greer, & Arnold, 2006). Our large survey-based study expands those results to a global measure of ATL, boys' reading trajectories, and girls' math trajectories.

Why would early ATL be more protective for girls' math trajectories and for boys' reading trajectories? Our findings suggest that these gender differences are not attributable to the modest gender differences we detected in early math and reading skills, as the gender interactions were detected net of interactions between children's early ATL and their early academic skills. Various explanations for gender differences have been proposed, including biological factors, psychological phenomena, and socialization processes (Huguet & Regner, 2007; Matthews, Ponitz, & Morrison, 2009). However, scholars have found more support for explanations related to socialization (Caplan & Caplan, 2005). Parents and teachers may spend less time nurturing boys' reading skills and more time fostering boys' math skills (Huguet & Regner, 2007). Parents, for example, have been found to be more encouraging of boys' participation in math activities and to provide boys with more math-related games and toys (Simpkins et al., 2005). Furthermore, possessing more positive ATL may help girls focus on math, which they tend to find relatively less interesting, compared with boys (Meece et al., 2006). Similarly, though boys tend to be less interested in language and literacy than girls (Meece et al., 2006), having more adaptive ATL may help boys remain engaged in reading activities. Additionally, the self-regulatory aspects of ATL may help girls cope with anxiety related to stereotype threat and math achievement and may help boys cope with anxiety related to stereotype threat and reading achievement (Muzzatti & Agnoli, 2007; Schutz & Davis, 2000).

Second, by the end of fifth grade, children's early ATL was moderately more beneficial when children entered kindergarten with lower academic skills. Among children who started kindergarten with lower academic achievement, there were moderate differences in their math and reading trajectories when comparing children with more versus less adaptive ATL. However, children who began kindergarten with higher academic competence had a very small gap in math and a modest gap in reading when compared with children with more versus less adaptive ATL at the end of fifth grade.

These findings are consistent with past studies on children's cognitive ability and skills showing that persistence is more strongly linked to reading scores among children with lower intelligence scores (Newman et al., 1998) and that the ECLS-K's teacher-rated Approaches to Learning scale is more strongly associated with changes in math scores from kindergarten to third grade for children with lower early math skills (Bodovski & Farkas, 2007). We build on past research by examining early skills in reading and math as moderators, and by estimating individual growth trajectories that more carefully model child development. Moreover, our results build on those of Duncan et al. (2007) and Claessens et al. (2009), who found that later academic achievement was predicted by early academic skills and the ECLS-K's teacher-rated Approaches to Learning scale. Importantly, our findings show how academic and nonacademic dimensions of children's school readiness work in concert to shape their individual math and reading trajectories, where better nonacademic skills compensate for lower academic skills.

As we highlight the ways in which the current study expands our understanding of links between children's early ATL and achievement, it is important to recognize its limitations. First, we cannot draw causal conclusions from this investigation, as we cannot reduce omitted variable bias completely. Classroom processes, child IQ, and other developmental phenomena not captured by the ECLS-K may confound the associations we detected. Second, the ECLS-K includes neither observational measures nor in-depth teacher and parent reports of global ATL or components of ATL. Future availability of hybrid data would allow us to test our questions using rich, longitudinal measures of both academic achievement and developmental phenomena collected from a large-scale, nationally representative sample. Such designs would help us pinpoint whether ATL as a whole or a specific component of ATL plays a more influential role in shaping children's academic trajectories.

Until such data are available, we must face the trade-offs of using large-scale, nationally representative studies versus relatively smaller, locally focused studies. To create the most robust measure of ATL available to us, we combined brief teacher and parent report versions of the ECLS-K Approaches to Learning and Self-Control scales. Though this measure has its drawbacks, it is noteworthy that this gross measure of ATL emerged as a significant predictor, suggesting that the link between ATL and academic achievement is robust. Our upper bound estimate of the relation between early ATL and academic achievement is that it is moderate to large in magnitude by the end of fifth grade. Future studies using in-depth measures of ATL may yield even stronger associations. Having acknowledged the limitations of the current study, we conclude with reflections on how it sheds light on school readiness intervention programs.

## Implications for Intervention Efforts to Enhance Children's School Readiness

In recent years, early childhood intervention studies have targeted the improvement of specific dimensions of ATL, where randomized intervention programs have successfully enhanced early socioemotional and academic competence among low-income children. The Chicago School Readiness Project, for example, a multicomponent mental health intervention that included teacher training and coaching on behavior management strategies, improved executive functioning, attention and impulse control, and academic skills among children attending Head Start programs (Raver et al., in press). Additionally, the Tools of the Mind program, which focuses on enhancing flexibility, inhibitory control, and working memory, improved low-income children's executive functioning (Diamond et al., 2007). Other successful intervention programs have taken a broader approach. The Head Start REDI (Research-based, Developmentally Informed) program, for instance, involves language- and literacy-specific components (e.g., interactive reading, phonological awareness games, and print activities), as well as techniques to improve children's control of impulsive behavior and organization of goal-directed activity (Bierman et al., 2008).

Our results suggest that findings from these interventions and others that are effective at improving dimensions of children's early ATL may yield academic impacts that endure across elementary school. Moreover, to the extent that ATL is malleable for children in general and not just for low-income children, we may see long-term academic improvements for all children if we place an early emphasis in school on fostering better ATL.

In addition, the current study directs our attention to risk beyond economic disparities in achievement. Our findings suggest that if we are able to replicate treatment effects across broader populations of young children, even greater impacts on long-term achievement may emerge among certain groups. For example, we may be able to narrow academic disparities related to gender by fostering girls' more adaptive approaches to learning math and boys' more positive approaches to learning reading. Nurturing better early ATL in these specific ways might help long-term initiatives to encourage girls to enter science, technology, engineering, and math fields, and to foster boys' interest in reading for enjoyment. Importantly, we may be able to narrow achievement gaps between children who start school with and without basic reading and math skills, regardless of their gender, SES, and race/ethnicity. By improving approaches to learning reading among children who lack basic literacy skills and by fostering better approaches to learning math among children who lack basic quantitative skills, we may help reduce achievement gaps related to differences in school readiness. As such, early ATL and components of ATL are worthy of continued attention as targets of interventions that aim to set children on pathways of school success, despite the risks they may face.

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