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Associations Among Parental Education, Home Environment Quality, Effortful Control, and Preacademic Knowledge

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Abstract

This study used a longitudinal design to examine whether effortful control mediated the associations of parental education and home environment quality with preacademic knowledge in toddlers and young preschoolers. The sample consisted of 226 children (2 to 4 years of age at T1) from socioeconomically disadvantaged backgrounds. Parents provided data on parent education and home environment quality. Children completed effortful control, early literacy, and early math assessments. T2 effortful control partially mediated the associations of T1 parental education and T1 home environment quality with T3 emergent literacy after accounting for child age, gender, race/ethnicity, T1 effortful control, and T2 early literacy. T2 effortful control partially mediated the association between T1 parental education and T3 emergent math after accounting for child age, gender, race/ethnicity, T1 effortful control, and T2 early math. Prior to entry into preschool, parental education and home environment quality may shape effortful control which in turn influences preacademic knowledge.

Successful school performance is important for children's emotional and behavioral health and future occupational status. Preacademic knowledge gained prior to school entry is a core component of school readiness measures and a strong predictor of later academic performance (Cunningham & Stanovich, 1997; Duncan et al., 2007). Specifically, emergent literacy skills, such as print knowledge and phonological awareness, equip the preschooler to learn to read upon school entry (Justice, Bowles, & Skibbe, 2006), and emergent math skills, including counting and knowledge of numbers, quantities, and shapes, prepare children to learn mathematical concepts like addition and subtraction (Geary, Hoard, Byrd-

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Craven, Nugent, & Numtee, 2007). Thus, it is important that children acquire preacademic knowledge during the preschool years. The period of toddlerhood and transition into preschool provides young children with many opportunities for acquiring informal academic knowledge that serves as a foundation for further learning in the preschool years. A better understanding of the factors that affect this early learning is important in order to find effective ways of supporting children's acquisition of preacademic knowledge prior to or as they enter preschool.

Low socioeconomic status (SES) indicators, such as the level of parental education or family income, and a low quality home environment are significant risk factors for poor acquisition of preacademic knowledge and early school disadvantage (Son & Morrison, 2010).

However, few studies have tested specific hypotheses regarding the processes involved in the association of SES and home environment quality with preacademic skills. One process model that could be applied to these associations is a mediation model which specifies that a mediator accounts for the association between a predictor and an outcome (MacKinnon et al., 2002). Specifically, SES and home environment quality may be associated with the development of particular cognitive or social-emotional skills, which in turn are important for facilitating the acquisition of preacademic skills. Effortful control is a likely candidate for a developmental skill that may partly explain the association between contextual factors and preacademic knowledge in young children. Effortful control refers to a set of self-regulatory skills including attention modulation, response inhibition, persistence, and delay of gratification (Rueda, Posner, & Rothbart, 2005). Under supportive conditions, these skills show rapid growth during the toddler and preschool years (Garon, Bryson, & Smith, 2008). However, children exposed to contextual risks, such as low SES or a low quality home environment, show poorer development of effortful control (Lengua, Honorado, & Bush, 2007). Effortful control is linked with children's acquisition of early literacy and math skills perhaps due to the role of attention and self-regulatory skills in supporting on-task behavior during learning activities (Espy et al., 2004). Therefore, family SES and home environment quality may lead to individual differences in young children's effortful control skills which in turn contribute to variation in preacademic knowledge.

The current study examined direct and indirect effects of parental education and home environment quality on preacademic skills in toddlers and young preschoolers from lower SES backgrounds. It was hypothesized that effortful control would mediate associations of parental education and home environment quality with early literacy and math skills.

SES and Home Environment Quality as Predictors of Children's Preacademic Knowledge

Testing a mediation model must be based on prior evidence of associations among the putative predictor, outcome, and mediator variables (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Indeed, previous studies have yielded evidence to suggest that children's effortful control may play a mediating role in the associations of SES factors and home environment quality with preacademic knowledge.

SES indicators, such as parental education or family income, represent indices of global environmental resources. An extensive literature has demonstrated socioeconomic disparities in preschool-age children's early development (McLloyd, 1998) as well as their emergent literacy and math skills (Bracken & Fischel, 2008; Cadima, McWilliam, & Leal, 2010; Evans & Shaw, 2008; Justice, Bowles, & Skibbe, 2006; Mistry, Benner, Biesanz, Clark, & Howes, 2010). In addition, home environment quality, composed of a range of characteristics including parental sensitive responsiveness, language stimulation, and access to educational materials and activities, has been linked to variability in children's acquisition of preacademic knowledge (Belsky & Fearon, 2002; Britto, Brooks-Gunn, & Griffin, 2006; Connell & Prinz, 2002; Son & Morrison, 2010; Stipek & Ryan, 1997). Some studies have examined these aspects of the home environment individually whereas others have used a composite reflecting the overall quality of the home environment (Anders et al., 2012).

Furthermore, these predictors are found to be linked such that children in lower SES families experience a poorer quality home environment, including fewer educational materials and resources, fewer enrichment opportunities, and more stressors, than children in higher SES families (Bradley & Corwyn, 2002; Bradley, Corwyn, McAdoo, & Garcia Coll, 2001). Differences in home environment quality may partially explain associations between SES and cognitive development (Dilworth-Bart, Khurshid, & Vandell, 2007; Foster, Lambert, Abbott-Shim, McCarty, & Franze, 2005; Hoff, 2003; Sarsour et al., 2011).

SES and Home Environment Quality as Predictors of Children's Effortful Control

Self-regulatory skills facilitate voluntary, purposeful, or goal-directed behavior. Effortful control is a multidimensional framework for examining self-regulation and is considered to reflect the regulatory domain of temperament. Effortful control encompasses the abilities to focus and shift attention, inhibit a dominant response to perform a subdominant response, monitor conflict, detect errors, and persist in challenging tasks (Rothbart & Bates, 2006; Rothbart, Sheese, & Posner, 2007). Effortful control also includes the ability to delay gratification or inhibit the urge to approach motivationally or emotionally salient stimuli, such as desirable rewards (Kochanska, Murray, & Harlan, 2000; Raver et al., 2011). Effortful control is often assessed using experimental tasks that provide a direct measure of the child's self-regulatory skills (Rothbart & Bates, 2006).

Another framework for examining self-regulation is executive function, which refers to a similar set of skills, including inhibitory control, working memory, and attentional set-shifting (Hughes, 2011). Whereas there are numerous similarities between these constructs, there can be some differences in their component skills. For instance, executive function composites usually include measures of working memory. Although working memory may be needed to accomplish many effortful control tasks, it is not considered to be a core component of effortful control (Zhou, Chen, & Main, 2011).

Effortful control emerges during the first year of life and develops rapidly during early childhood (Rueda, Posner, & Rothbart, 2005) suggesting that early childhood may constitute a period of heightened susceptibility to environmental influences. In fact, SES is associated

with effortful control in preschool-age children (Evans & English, 2002; Li-Grining, 2007; Mezzacappa, 2004; Noble et al., 2005; Rhoades, Greenberg, Lanza, & Blair, 2011). For example, poverty, single parenthood, and living in an unsafe neighborhood were associated with poorer performance on delay of gratification and inhibition tasks (Li-Grining, 2007). Parenting and home environment quality are also associated with effortful control development (Bernier et al., 2010; Kochanska, Murray, & Harlan, 2000; Lengua, Honorado, & Bush, 2007). For instance, parental limit-setting and scaffolding predicted changes in preschool-age children's effortful control over a 6-month period (Lengua et al., 2007).

The Association Between Effortful Control and Preacademic Knowledge

Effortful control is found to be related to the acquisition of early literacy and math skills (Blair & Razza, 2007; Espy et al., 2004; McClelland et al., 2007; Welsh, Nix, Blair, Bierman, & Nelson, 2010; Willoughby, Kupersmidt, Voegler-Lee, & Bryant, 2011). For example, inhibitory control was positively associated with math knowledge after accounting for child IQ, age, and maternal education in a preschool-age sample (Espy et al., 2004). In addition, a classroom-based intervention targeting preschoolers' self-regulation led to improved school readiness outcomes (Raver, Jones, Li-Grining, Zhai, Bub, & Pressler, 2011). Effortful control may relate to preacademic competence because skills such as focusing and shifting attention and inhibiting impulsive behavioral responses may influence children's engagement with teachers and approaches to learning (Li-Grining et al., 2010). That is, children high in effortful control are likely to demonstrate adaptive behavioral regulation, planning, persistence, attention, flexibility, and organization during learning activities. In addition, effortful control may support the regulation of emotional reactivity (e.g., frustration, fearfulness) such that children experiencing these emotions may persist in challenging activities and engage with teachers. Effortful control skills may be particularly important early in development as children must rely on them to encode the correct foundational literacy and math knowledge into long-term memory to be retrieved automatically in future learning tasks (Wass, Scerif, & Johnson, 2012).

Several studies have examined self-regulatory skills as mediators of the associations of SES and home environment quality with preacademic skills. Broadly speaking, these studies generally found support for mediation by self-regulatory skills (Dilworth-Bart, 2012; NICHD ECCRN, 2003; Razza, Martin, & Brooks-Gunn, 2010; Swanson, Valiente, & Lemery-Chalfant, 2012). For example, preschoolers' concurrent and kindergarten self-regulation mediated the relation between preschoolers' home risks and first grade academic achievement (Sektan, McClelland, Acock, & Morrison, 2010).

Despite their similarity to the current study, these prior studies differ from this study in several important ways. First, these studies all focused on older preschoolers, kindergarteners, or school-aged children (e.g., Swanson, Valiente, & Lemery-Chalfant, 2012). Second, previous research was conducted in higher SES or nationally representative samples (e.g., NICHD ECCRN, 2003; Sektan et al., 2010) and therefore generalizability to lower SES populations is questionable, especially given differences in these relations between poor and near-poor groups (Razza, Martin, & Brooks-Gunn, 2010). Third, although these studies address self-regulation as a mediator, only one study specifically focused on

effortful control (Swanson, Valiente, & Lemery-Chalfant, 2012). Other studies tested the mediating role of related constructs of executive function (Dilworth-Bart, 2012), general behavioral self-regulation (Sektan et al., 2010), or sustained attention and impulsivity (NICHD ECCRN, 2003; Razza et al., 2010). In some studies, self-regulation was measured solely by parent or teacher report (Sektan et al., 2010). Finally, outcome measures were variable and not all focused specifically on emergent literacy and math knowledge, which are the best predictors of later academic performance (Forget-Dubois et al., 2009). Also, there were limitations in terms of using cross-sectional designs and having small sample sizes (Dilworth-Bart, 2012).

Current Study

The current study used a longitudinal design (1 ¼ years) to examine whether effortful control mediated associations of parental education and home environment quality with preacademic knowledge in toddlers and young preschoolers (2 to 4 years of age at time 1) from socioeconomically disadvantaged backgrounds. We hypothesized that parental education and home environment quality would have an indirect influence on preacademic knowledge via shaping the ways in which children approach learning activities in terms of controlling attention, inhibiting automatic responses, adapting to the demands of the situation, persisting in challenging tasks, and waiting for rewards. Parents were interviewed with regard to a range of home environment characteristics including toys and resources, learning opportunities, language stimulation, and parental warmth and responsiveness, and these items were summed to create a measure of global home environment quality. Children completed effortful control tasks assessing inhibitory control, delay of gratification, sustained attention, and persistence as well as early literacy and math assessments.

First we examined total associations of parental education and home environment quality with early literacy and math. Then we investigated whether effortful control accounted for any part of these associations. It was predicted that these associations would hold over and above effects of child age, gender, and race/ethnicity. These child characteristics have been shown in previous research to be associated with effortful control and preacademic knowledge. For instance, research on self-regulation has indicated that girls demonstrate better self-regulation than boys throughout development (Kochanska, Murray, & Harlan, 2000; Li-Grining, 2007). In addition, the longitudinal design of the study allowed us to conduct autoregressive models in which change over time is analyzed by predicting later outcomes independent of earlier outcomes (Cole & Maxwell, 2003).

Method

Participants

Sample characteristics—Participants in the present study were 2- to 4-year-old children (48% male, mean age = 3.21 years) who were primarily of racial/ethnic minority status (e.g., 78% African American). They were from families in Texas (53%) and Florida (47%). None of the children had any significant visual/auditory impairments or cognitive/language deficits. Descriptive statistics for child and family characteristics are presented in Table 1.

Recruitment—Children were recruited for a large, two-site childcare center-based intervention project, which had three cohorts (Landry et al., 2014). Databases from the Texas Department of Family and Protective Services and Florida Department of Children and Families were used to recruit childcare centers in which 50% of children in the center used federal or state childcare subsidies to attend. One classroom per center was invited to participate, and informed consent was obtained from childcare teachers. Approximately 8 children were randomly selected from each classroom to participate in the study, and informed consent was obtained from parents. Childcare classrooms were randomized into three conditions: business-as-usual control, Responsive Early Childhood Curriculum (RECC), and RECC plus explicit social-emotional classroom activities (RECC+). Teachers in the RECC intervention were trained to use responsive teaching practices and implement a comprehensive curriculum including circle time and small-group activities promoting print knowledge, phonological processing, and early math concepts. Teachers in the RECC+ intervention received the same training as well as training on conducting a daily social-emotional activity. Results of the intervention impact study (Landry et al., 2014) indicated that children in the interventions outperformed control children in areas of social and emotional development (emotion knowledge and teacher-reported emotional and behavioral functioning), although the groups did not differ in terms of cognitive skills (language, literacy, and math). Given that the current study was not focused on intervention effects, intervention status was examined for inclusion as a covariate in main analyses.

Participation rate—Of the 542 children who had pre- and/or post-intervention data (Landry et al., 2014), approximately 324 parents (60% of the original sample) completed the parent questionnaire and interview. Multilevel logistic regression indicated that the likelihood of parental participation in the study was *not* significantly predicted by child age, gender, race/ethnicity, time 1 early math, time 1 effortful control, intervention status, or cohort, $F(1-2, 288-532) = .08-2.15, ns$. However, children with higher early literacy at time 1 ($b = .03, SE = .01, t(489) = 2.01, p = .04$, odds ratio = 1.03) were more likely to have parent report data. Also, children in Texas were more likely to have parent report data than children in Florida ($b = -.48, SE = .23, t(55) = -2.05, p = .04$, odds ratio = .62).

Attrition—Of the 324 children with parent-report data, approximately 226 (70%) had follow-up data. Children who had follow-up data did not differ from those without follow-up data in terms of child age, gender, race/ethnicity, parental education, home environment quality, parent marital status, number of parents in the household, time 1 effortful control, time 1 early literacy, or time 1 early math, $F(1-2, 276-306) = .03-1.57, ns$.

Procedure

Assessments were conducted by trained, professional examiners at four time points over two academic years. The first three assessments occurred during the beginning, middle, and end of the first academic year (time 1: September-October; time 2: January; time 3: March-April). The fourth, follow-up assessment occurred towards the end of the following year, which was the end of the first preschool year for most children. Parents completed the parent questionnaire and an interview about the home environment at the child care center at time 2. Children participated in videotaped administrations of the effortful control tasks in their

child care centers at times 1–3. Research assistants coded the tapes in the laboratory. Interrater reliability was assessed by calculating intraclass correlations (ICCs) on approximately 25% of the effortful control batteries. Children participated in assessments of their early literacy and math knowledge at each time point.

The current study uses data from times 2, 3, and 4. We use parental education, home environment quality, effortful control, early literacy, and early math data from time 2. We use effortful control, early literacy, and early math data from time 3, and we use literacy and math data from time 4. For the purposes of this study, we re-named these time points to times 1, 2, and 3.

Measures

Parental education—Parents reported on the educational attainment of the first and second main caregivers (in 90% of cases, first main caregiver was the mother; see Table 1) on a 10-point scale: 1=middle school; 2=some high school; 3=high school diploma or GED; 4=vocational or technical training; 5=some college but no degree; 6=associate's degree; 7=bachelor's degree; 8=graduate school but no degree; 9=master's degree; and 10=doctorate. For analyses, parent education categories were translated into approximate years of education. For two-caregiver households, the higher level of education was used. As expected, parental education was significantly positively correlated with home environment quality (see Table 2).

Home environment—Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984) ratings were made by interviewing the parent and observing parent and child interact at the childcare center. The Early Childhood HOME includes the following seven subscales: Academic Stimulation, Acceptance, Language Stimulation, Learning Materials, Modeling, Responsivity, and Variety, which consist of items that are scored yes or no. An eighth subscale, Physical Environment, was not included in this study. The Learning Materials subscale (11 items) assesses toys, books, and activities directed towards the cognitive development of the child. The Language Stimulation subscale (7 items) assesses verbal communication between child and caregiver that is intended to facilitate language development. The Responsivity subscale (7 items) items included caregiver praise of child, responding to child's vocalizations, physical affection toward child, and expression of positive feelings toward the child. The Academic Stimulation subscale (5 items) assesses whether the parent encourages the child to learn basic reading concepts, colors, and numbers. The Modeling subscale (5 items) assesses behavior management, consequences of child non-compliance in terms of parental harshness, and parental manners in front of child. The Variety subscale (9 items) assesses child enrichment opportunities (e.g., trips to the museum) and choices in daily life. The Acceptance subscale (4 items) measures physical punishment and criticism of child. The total HOME score is computed as the sum of items scored as present, with higher values denoting a more stimulating and supportive home environment.

The HOME has adequate reliability and validity. For example, HOME scores have inter-rater reliability coefficients ranging from .75 to .95 (Elardo & Bradley, 1981) and correlate

with cognitive competence in young children (Bradley et al., 2001a; 2001b). In the present sample, the Acceptance scale did not correlate highly with the other scales and was removed; therefore, the total HOME score used in the current study consisted of 44 items. Cronbach's α for the total HOME score was .60. Although this is low, similar internal consistency results have been reported in previous studies (e.g., Son & Morrison, 2010).

The usual HOME procedure consists of observational ratings and an interview with the parent during a home visit (Bradley et al., 2001). In the current study, rather than conducting home visits, administration of the HOME consisted of interviewing the parent and observing parent and child interact at the childcare center. This approach is similar to procedures used by other studies that have adapted the HOME for use as a parent interview or questionnaire in a lab or doctor's office setting (e.g., Frankenburg & Coons, 1986) or have developed office-based assessments of home environment quality that consist of a parent interview or questionnaire (Casey, Bradley, Nelson, & Whaley, 1988; Dreyer, Mendelsohn, & Tamis-LeMonda, 1996). These methods of assessing home environment quality have been found to correlate highly with the original administration of the HOME and to predict children's development (e.g., Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; Camp & Headley, 1994; Leech, Larkby, Day, & Day, 2006).

Effortful control—Children completed the gift delay-wrap, gift delay-bow, snack delay, rabbit-turtle, yarn tangle, and continuous performance tasks. Scores for each task were standardized and averaged to create an effortful control composite as described below.

Snack delay: In the snack delay task (Kochanska et al., 2000; Spinrad et al., 2007), children were asked to place their hands flat on a table and to withhold from eating or touching a piece of candy placed in front of them until the experimenter rang a bell. In the middle of each trial, the experimenter picked up the bell as if to ring it but did not ring it. There were 1–2 practice trials followed by 4 real, timed trials (20 s, 30 s, 40 s, and 60 s in length). Trial scores ranged from 1 to 9 (1 = child eats snack during part 1; 2 = child eats snack during part 2; 3 = child touches snack during part 1; 4 = child touches snack during part 2; 5 = child touches glass and/or bell during part 1; 6 = child touches glass and/or bell during part 2; 7 = child waits until bell is rung. Up to two extra points were given if the child kept his/her hands on the table). Snack delay total scores were averaged across trials and therefore the final raw score ranged from 1–9. (interrater reliability: time 1 ICC = .98; time 2 ICC=.98).

Gift delay - wrap: In the gift delay - wrap task (Kochanska et al., 2000; Li-Grining, 2007), children were told that they would be receiving a present but that they could not peek while the present was being wrapped. Children were then instructed to turn their backs to the experimenter as the experimenter noisily wrapped the present for 60 seconds. Scores for strategy (1 = child turns around and does not turn back; 2 = child turns around and turns back; 3 = child looks over shoulder enough to see; 4 = child turns head to side but not over 90 degrees; 5 = child does not try to peek) and latency to peek were standardized and averaged (interrater reliability: time 1 ICC = .96; time 2 ICC=.93).

Gift delay - bow: In this task (Kochanska et al., 2000), the wrapped gift was placed on the table in front of the child and the child was told to wait in his/her chair and not to touch or

open the gift until the experimenter returned with a bow. The delay lasted two minutes. Strategy scores ranged from 1 to 4 (1 = child takes the gift out of the box; 2 = child opens the box; 3 = child touches the box but does not open it; 4 = child never touches the box; interrater reliability: time 1 ICC = .94; time 2 ICC=.99). Scores for strategy and latency to touch were standardized and averaged.

Rabbit-turtle: In this task (Kochanska, Murray, & Harlan, 2000; Li-Grining, 2007), the experimenter presented each child with a picture of a curved path leading to a barn and asked the child to make a turtle travel the path to the barn slowly and a rabbit travel the path to the barn quickly. The child completed an untimed trial with a boy/girl figurine followed by two timed trials with the rabbit and two timed trials with the turtle. Coders assessed how well the child stayed on the mat and within the lines while following paths. The child was given a baseline score of 1 for each trial. To that score, the child was given credit for each of 6 curves of the path that he/she negotiated with the figure. Each curve was scored as follows: child keeps the figure on the mat and stays within the lines of the path – 2 points; child has the figure above the mat or follows general curvature of path – 1 point; child ignores this particular curve – 0 points. Total scores were averaged across trials and thus the final raw score ranged from 1–13 (interrater reliability: time 1 ICC = .99; time 2 ICC=.98).

Yarn tangle: During this task (Goldsmith, Essex, Aksan, & Lemery, 2003; Goldsmith, Reilly, Lemery, Longley, & Prescott, 1993), the child was asked to untangle a ball of yarn while the experimenter left the room for two minutes. Coders assessed the child's persistence in untangling the yarn for every 10 second interval (1=child did not attempt or actively refused to engage in the task, 2=child was minimally engaged in the task, either briefly or sporadically, showing little effort, 3=child was engaged in the task for about half of the interval and then quit, or worked at it on and off, 4=child was engaged in the task for most to all of the interval, 5=child was intensely and actively engaged in the task for most to all of the interval, and never actively quit task; interrater reliability: time 1 ICC = .84; time 2 ICC=.95).

Continuous performance task (CPT): In this computerized task (originally designed by Rosvold et al., 1956), children are asked to press the space bar on a keyboard as quickly as possible each time a target stimulus (a fish) appears on the computer screen. There were 80 trials and 16 trials in which the target stimulus was presented. Pictures were on screen for 3 seconds and off for 1 second. The proportion of errors of omission (i.e., failing to press the space bar in response to the target stimulus) was calculated (range: 0–1). Scores were reverse coded such that higher scores reflect greater effortful control.

CPTs used with preschool-age children have adequate reliability (e.g., test-retest, split-half) and validity. CPT scores are correlated with parent-report attention measures as well as other performance-based measures of attention. Performance improves with age, and clinical groups (e.g., ADHD) demonstrate more errors of omission than age-matched, typically-developing children (Mahone & Schneider, 2012).

Composite: Effortful control composites for time 1 and time 2 were created based on both theoretical and empirical grounds. Prior studies with toddlers and preschoolers have

combined these tasks into an effortful control composite (Kochanska et al., 2000, 2001) and have indicated that effortful control measures load onto a single latent construct (Allan & Lonigan, 2011; Sulik et al., 2010; Wiebe et al., 2008). Composite scores were calculated by averaging standardized task scores for children with 3 valid task scores. At both times 1 and 2, the majority (91–95%) of children had valid scores for 5 or 6 tasks. Correlations among the six effortful control tasks ranged from .19 to .45 ($p=.004$ to $<.001$) at time 2. At time 1, they ranged from .13 to .38 ($p=.02$ to $<.001$) with the exception of the correlation between the gift delay - bow and yarn tangle scores, which was .09. We kept the composites the same across time points and included all six tasks. Cronbach's α for the effortful control composite was .70 at time 1 and .73 at time 2.

Self-regulation tasks have adequate test-retest reliability (e.g., Beck, Schaefer, Pang, & Carlson, 2011) as well as validity. Performance on these tasks is consistently found to improve with age during the preschool period (Garon, Bryson, Smith, 2008), be poorer in clinical groups compared to typically-developing preschool-age children (Hughes, 2011), and correlate with parent-report measures and other performance-based measures (Allan & Lonigan, 2011; Spinrad et al., 2007; Wiebe et al., 2008).

Test of Preschool Early Literacy (TOPEL)—The Print Knowledge and Phonological Awareness subtests from the Test of Preschool Early Literacy (TOPEL; Lonigan, Wagner, Torgesen, & Rashotte, 2007) were used to evaluate early literacy skills. The Print Knowledge subtest (36 items) assesses letter knowledge and letter-sound correspondence in both a multiple choice and free response format. In addition, children's knowledge of book and print concepts (e.g., title of a book, discriminating letters or words) is assessed. Internal consistency (Cronbach's α) of the Print Knowledge subtest ranged from .86 to .93 in this sample.

The Phonological Awareness subtest (27 items) includes 12 elision items and 15 blending items. The elision items require children to remove a sound from a word to make a new word (e.g., "Point to team without /m/" and "Say playground without ground"). The blending items require children to combine word sounds to make a new word (e.g., "What word do these make: Hot - dog?" and "What word do these sounds make: F - ox?"). Each subsection begins with items utilizing a multiple-choice response format and moves to items requiring free responses. To ensure that children understand the tasks, the elision and blending sections each include four practice items on which children receive feedback to their responses. Cronbach's α for the Phonological Awareness subtest ranged from .86 to .87 in this sample. Prior research has demonstrated that the Print Knowledge and Phonological Awareness subtests predict children's later reading achievement (Duncan et al., 2007; Lonigan, Burgess, & Anthony, 2000; Welsh et al., 2010). Internal consistency reliabilities for these TOPEL subtests are high for preschool-age children (i.e., $\alpha = .85-.95$), and both subtests are correlated with other measures of emergent literacy (Lonigan, Farver, Phillips, & Clancy-Menchetti, 2011). Print Knowledge and Phonological Awareness subtest scores were standardized and averaged to produce the early literacy score that was used in analyses.

Child Math Assessment (CMA)—A downward extension of the Child Math Assessment (CMA-DE; Starkey, et al., 2004) was used to evaluate the mathematical knowledge of children in the project. The CMA-DE is comprised of 16 tasks (with multiple problems per task) that assess informal mathematical knowledge in the areas of number, arithmetic, space and geometry, measurement, and patterns. Good reliability for pre-kindergarten aged children has been reported (i.e., Cronbach's $\alpha = .84$ at the beginning of the school year; Starkey et al., 2004). Cronbach's α was in the acceptable range for the current sample (.72 to .74).

Other child and family characteristics—Parents also reported child birth date, gender, and race/ethnicity. Race/ethnicity was coded such that African American and Hispanic/Latino groups were compared to the Caucasian/White group, the reference group. They were also asked about their child's lunch program at the childcare center and indicated free, reduced, regular, or N/A. Parent marital status was dichotomized into 1=married and 0=never married, divorced, or separated. Parents also reported on whether the household included one or two parents.

Statistical Analyses

Because the sample consisted of children nested within childcare centers, we conducted multilevel modeling via SAS (version 9.3) PROC MIXED to accommodate this clustered data structure (Raudenbush & Bryk, 2002). Multilevel modeling captures the correlations across children (level 1) within childcare centers (level 2) through the estimation of random effects.

We estimated the direct and indirect effects of parental education and home environment quality on preacademic knowledge through effortful control using multilevel mediation procedures suggested by Bauer, Preacher, and Gil (2006). These analyses are referred to as lower level mediation analyses because they did not involve any level 2 variables. Figures 1–3 illustrate the mediation model. The upper diagram represents the total effect (c path) of parental education/home environment quality on preacademic knowledge. The lower diagram shows the two paths involved in the mediated or indirect effect (the a path from parental education/home environment to effortful control and the b path from effortful control to preacademic knowledge controlling for parental education/home environment) along with the direct effect (c' path) from parental education/home environment to preacademic knowledge representing influence that is independent of effortful control.

In the Bauer et al. (2006) approach, the a and b paths are estimated simultaneously in a single model, and therefore, one can directly estimate the covariance of the random effects that are encompassed in different level 1 equations. Consequently, this approach is preferable to a step-by-step multilevel mediation approach which makes the implicit assumption that each of the steps is independent.

Potential covariates, including child age, child gender, race/ethnicity, and intervention condition were considered for inclusion in main analyses. We estimated random effects for the intercepts of the mediator and outcome variables. To test the significance of the indirect effect, we used the Monte Carlo method, which has been recommended for multilevel

mediation (Preacher & Selig, 2012). Selig and Preacher's (2008) interactive tool requires point estimates of the *a* and *b* paths and their standard errors to generate 95% CIs. An indirect effect is significant when the CI does not contain zero.

For mediation with longitudinal research designs, researchers have recommended conducting an autoregressive model by accounting for prior levels of the mediator and outcome variables (Cole & Maxwell, 2003). Controlling for autoregressive effects helps reduce bias in parameter estimates and allows for conclusions about changes in the mediator or outcome variables over time. Thus, in our mediation analyses, the effect of the time 1 predictor on the mediator at time 2 (*a* path) accounts for the mediator at time 1, and the effect of the time 2 mediator on the outcome at time 3 (*b* path) accounts for the outcome at time 2.

Results

Results from testing the total effect of parental education and home environment quality on preacademic knowledge (*c* paths) are presented first. Then we present the results of analyses of *a*, *b*, and *c'* paths as well as significance tests of the indirect effects.

Preliminary Analyses

Descriptive statistics and zero-order correlations are presented in Table 2. Inspection of the distributional properties of each variable indicated that all variables used in the analyses met the assumptions of normality.

Clustered data structure—There were significant intraclass correlations (ICCs) attributable to childcare center for effortful control ($ICC=.21, p=.001$), early literacy ($ICC=.20, p=.002$), and early math ($ICC=.23, p=.001$). There was an average of 3.9 children ($SD=2.07$; range: 1–8; $N=228$ children from 58 childcare centers) per childcare center. We included level 2 variance components for the mediator and outcome variables in analyses. We present results for the residual level 2 variability in the conditional models.

Covariates—We examined whether to include the following potential covariates in main analyses: child age, gender, race/ethnicity, parent marital status (currently married, not currently married), one- or two-parent household, intervention condition, site (Texas or Florida), and cohort. We analyzed whether these variables were associated with predictor (parental education, home environment quality), mediator (effortful control), and outcome (early literacy, early math) variables. Child age was significantly correlated with home environment, effortful control, early literacy, and early math, $r=.12-.55, p=.03$ to $<.001$, but not with parental education, $r=-.06, ns$. Child gender was significantly correlated with effortful control, early literacy, and early math, $r=.18-.20, p=.005$ to $<.001$, but not with the home environment, $r=.03, ns$, or with parental education, $r=-.05, ns$. Child race/ethnicity did not significantly predict home environment quality, $F(2,179)=.79, ns$, early literacy, $F(2,279)=1.28, ns$, or early math, $F(2,278)=.03, ns$. However, associations of race/ethnicity with parental education, $F(2,248)=2.79, p=.06$, and effortful control, $F(2,286)=2.41, p=.09$, approached significance.

Parent marital status (0=not currently married; 1=currently married) was correlated with parental education, $r=.38$, $p<.001$, but was not significantly correlated with the home environment, effortful control, early literacy, or early math, $r=.05-.11$, ns . The number of parents in the household was correlated with parental education, $r=.27$, $p<.001$, but was not significantly associated with the home environment, effortful control, early literacy, or early math, $r=.01-.09$, ns . Intervention status, site, and cohort were not significantly associated with parental education, home environment quality, effortful control, early literacy, or early math, $F(1-2,63-287)=.09-1.63$, ns . Based on these preliminary analyses, child age, gender, and race/ethnicity were included as covariates in the main analyses. In addition, autoregressive effects were controlled as described above.

The Total Effects of Parental Education and Home Environment Quality on Preacademic Knowledge

Early literacy—As shown in Table 3, children in families with higher parental education at time 1 had higher early literacy skills at time 3. Similarly, children with a higher quality home environment at time 1 had significantly greater early literacy skills at time 3. Time 1 home environment quality continued to significantly predict time 3 early literacy after accounting for time 1 parental education, $b=.10$, $SE=.05$, $t(195)=2.04$, $p=.03$.

Early math—As shown in Table 3, children in families with higher parental education at time 1 had higher early math skills at time 3. However, time 1 home environment quality was not associated significantly with children's time 3 early math.

Mediation Models

Based on the analyses of the total effects (c paths), we tested whether time 2 effortful control mediated the associations between time 1 parental education and time 3 early literacy, time 1 home environment quality and time 3 early literacy, and time 1 parental education and time 3 early math. Because the total effect of time 1 home environment quality on time 3 early math was not significant, we did not test a mediational model for this association.

Time 1 parental education and time 3 early literacy—As shown in Figure 1, children in families with higher parental education at time 1 had greater effortful control at time 2 (path a: $b=.09$, $SE=.03$, $t(230)=3.23$, $p=.001$). Time 2 effortful control significantly predicted time 3 early literacy after accounting for time 1 parental education (path b: $b=.40$, $SE=.09$, $t(190)=4.24$, $p<.001$). The direct effect of time 1 parental education on time 3 early literacy was significant when time 2 effortful control was included in the model (path c': $b=.14$, $SE=.05$, $t(181)=3.00$, $p=.003$). Monte Carlo simulation indicated that the indirect effect of time 2 effortful control was significant (mean indirect effect = .04; 95% CI: .01 – .07).

Covariates and level 2 variance components: Child age, $F(1,240)=10.83$, $p=.005$, child gender, $F(1,248)=13.88$, $p<.001$, and time 1 effortful control, $F(1,247)=69.77$, $p<.001$, significantly predicted time 2 effortful control, but child race/ethnicity, $F(2,158)=.24$, ns , did not. Child age, $F(1,180)=4.73$, $p=.02$, and time 2 early literacy, $F(1,180)=37.97$, $p<.001$, predicted time 3 early literacy but child gender, $F(1,188)=1.92$, ns , and race/ethnicity, $F(2,180)=1.65$, ns , did not. The level 2 residual variability approached significance for

effortful control (variance component = .02, $SE = .01$, $z=1.50$, $p=.07$) but not for early literacy (variance component = .04, $SE = .03$, $z = 1.20$, ns).

Time 1 home environment quality and time 3 early literacy—As shown in Figure 2, children who experienced a higher quality home environment at time 1 had higher effortful control at time 2 (path a: $b=.07$, $SE=.03$, $t(247)=2.62$, $p=.006$)¹. Time 2 effortful control significantly predicted time 3 early literacy after accounting for time 1 home environment quality (path b: $b=.36$, $SE=.09$, $t(192)= 3.87$, $p<.001$). The direct effect of time 1 home environment quality on time 3 early literacy was not significant when time 2 effortful control was included in the model (path c': $b=.07$, $SE=.05$, $t(192)=1.50$, ns). Results of the Monte Carlo method indicated that the indirect effect of time 2 effortful control was significant (mean indirect effect = .03; 95% CI: .003 – .05).

Covariates and level 2 variance components: Child age, $F(1, 240)=8.95$, $p=.005$, child gender, $F(1, 249)=11.41$, $p<.001$, and time 1 effortful control, $F(1, 247)=70.05$, $p<.001$, predicted time 2 effortful control, but child race/ethnicity did not, $F(2, 163)=.21$, ns . Child age, $F(1, 182)=6.34$, $p=.01$, and time 2 early literacy, $F(1,181)=49.29$, $p<.001$, predicted time 3 early literacy, but child gender, $F(1, 185)=.94$, ns , and child race/ethnicity, $F(2, 106)=1.47$, ns , did not. The level 2 residual variability approached significance for effortful control (variance component = .02, $SE = .01$, $z=1.48$, $p=.07$) and early literacy ($b=.05$, $SE=.04$, $z=1.33$, $p=.08$).

Parental education as a covariate: We then examined whether mediation results for home environment quality remained significant after adding time 1 parental education as a covariate. Time 1 home environment quality was no longer associated significantly with time 2 effortful control after accounting for time 1 parental education (path a: $b=.05$, $SE=.03$, $t(246)=1.87$, $p=.06$). Time 2 effortful control continued to predict time 3 early literacy after accounting for time 1 parental education (path b: $b=.40$, $SE=.09$, $t(188)=4.17$, $p<.001$). The direct effect of time 1 home environment quality on time 3 early literacy was not significant with time 2 effortful control in the model (path c': $b=.02$, $SE=.05$, $t(189)=.38$, ns). The Monte Carlo method indicated that the ab path was not significant (point estimate = .02; CI: -.003 – .05).

Time 1 parental education and time 3 early math—As shown in Figure 3, children in families with higher parental education at time 1 had higher effortful control at time 2 (path a: $b=.08$, $SE=.03$, $t(243)=3.04$, $p=.003$). Time 2 effortful control significantly predicted time 3 early math after accounting for time 1 parental education (path b: $b=.25$, $SE=.09$, $t(192)=2.61$, $p=.01$). The direct effect of time 1 parental education on time 3 early math was

¹We then examined which specific aspects of the home environment predicted time 3 early literacy and time 2 effortful control. When examined individually, higher scores on the HOME Modeling ($b=.12$, $SE=.04$, $t(201)=2.83$, $p=.004$) and Language Stimulation subscales ($b=.10$, $SE=.05$, $t(208)=2.12$, $p=.03$) significantly predicted greater time 3 early literacy skills. When unique contributions were examined, Modeling scale scores significantly predicted time 3 early literacy skills ($b=.11$, $SE=.04$, $t(202)=2.47$, $p=.04$), but Language Stimulation scores did not ($b=.08$, $SE=.05$, $t(207)=1.63$, $p=.11$). In addition, when examined individually, higher scores on the HOME Language Stimulation ($b=.07$, $SE=.03$, $t(249)=2.21$, $p=.03$), Learning Materials ($b=.07$, $SE=.03$, $t(247)=2.52$, $p=.03$), and Variety subscales ($b=.07$, $SE=.03$, $t(249)=2.49$, $p=.03$) significantly predicted higher levels of time 2 effortful control. When unique contributions were examined, none of these predictors were significantly associated with time 2 effortful control ($b=.04-.05$, $SE=.03$, $t(244-248)=1.35-1.55$, ns).

significant when time 2 effortful control was included in the model (path c' : $b=.13$, $SE=.05$, $t(177)=2.74$, $p=.007$). Results of the Monte Carlo method indicated that the indirect effect of time 2 effortful control was significant (mean indirect effect = .02; 95% CI: .003 – .04).

Covariates and level 2 variance components: Child age, $F(1,247)=10.32$, $p=.002$, child gender, $F(1,251)=14.87$, $p<.001$, and time 1 effortful control, $F(1,256)=71.84$, $p<.001$, significantly predicted time 2 effortful control, but race/ethnicity did not, $F(2,167)=.34$, ns . Child age, $F(1,187)=18.18$, $p<.001$, and time 2 early math, $F(1,189)=46.09$, $p<.001$, predicted time 3 early math, but child gender, $F(1,193)=1.06$, ns , and race/ethnicity did not, $F(2,187)=.99$, ns . The level 2 residual variability approached significance for effortful control ($b=.01$, $SE=.01$, $z=1.43$, $p=.08$) but was not significant for early math ($b=.003$, $SE=.02$, $z=.15$, ns).

Discussion

The goal of this study was to examine whether effortful control mediated associations of parental education (an index of SES) and home environment quality with preacademic knowledge in toddlers and young preschoolers. Emergent literacy and math skills at preschool-age are strong predictors of children's later academic performance, and children exposed to contextual risks are less likely to acquire basic literacy and math concepts prior to school entry. Thus, elucidating the predictors and processes linked with the acquisition of preacademic knowledge is important to informing the design of effective interventions.

Results indicated significant total effects of parental education and home environment quality at 2–4 years on preacademic knowledge one year later. Parental education predicted both early literacy and math after accounting for child age, gender, race/ethnicity, and baseline preacademic knowledge. Home environment quality predicted early literacy but not math after accounting for the same variables. When effortful control was examined as a mediator, significant direct and indirect effects were observed. Specifically, effortful control was found to partially mediate the associations between parental education and early literacy, parental education and early math, and home environment quality and early literacy.

To our knowledge, this is the youngest age at which these mediation models have been examined. And, part of the novelty and contribution of this study comes from the young age of the participants. An increased understanding of the predictors of preacademic knowledge at preschool entry is important based on evidence that academic trajectories begin very early. Lower parental education, an indication of lower SES, predicted lower preacademic knowledge one year later consistent with previous studies (Mistry et al., 2010). Given that we found associations between parental education and preacademic skills early in life, these results align with the possibility of a cumulative effect over time explaining widening socioeconomic divisions in academic performance across the school years (Cunningham & Stanovich, 1997).

Children who experienced a lower quality home environment at 2–4 years had lower early literacy but not math one year later. Our global measure of home environment quality

included learning materials and activities, book reading, and language stimulation, as well as parental acceptance, responsiveness, and emotional support. This finding is consistent with previous research that has shown that a range of home environment characteristics influence children's early literacy skills (e.g., Connell & Prinz, 2002). Although parental education and home environment quality were moderately correlated, home environment quality was associated with early literacy after accounting for parental education consistent with research showing that there are influential aspects of the home environment that are independent of SES (Bernier, Carlson, & Whipple, 2010). It is important that future research continue to investigate the ways in which SES, a distal measure of the environment, influences children's early literacy via ecologically proximal environmental factors such as home, neighborhood, and preschool quality (Foster et al., 2005).

The finding that there was not a significant association between home environment quality and early math knowledge contrasts with prior research showing that the general quality of the home learning environment, including early literacy related activities, is related to early math knowledge (Anders et al., 2012). It is possible that specific aspects of the home environment that were not measured in this study contribute to the acquisition of early math skills. Specific mathematical activities such as counting or identifying shapes in the home and toys, games, and stimulation to learn numbers and spatial relations may be important to facilitating early math knowledge (Blevins-Knabe & Musun-Miller, 1996).

One way in which parental education and home environment quality may contribute to children's acquisition of preacademic knowledge is by influencing their effortful control development. This is consistent with previous studies showing that effortful control and related constructs such as sustained attention and executive function partially explain associations between contextual factors and academic achievement (Dilworth-Bart, 2012). The current study extends the existing research by demonstrating the mediating role of effortful control with 2- to 4-year-old children in regard to their emerging literacy and math. This pathway may be particularly important at this age because self-regulatory development is a primary developmental task of early childhood that is found to result from transactions with the home environment. Given the use of global environmental measures of parental education and home environment quality, the current research was not focused on teasing apart the unique contributions of specific features of the environment. Previous research has indicated that parental responsiveness, scaffolding, modeling, and behavior management contribute to children's effortful control and executive function (Bernier, Carlson, & Whipple, 2010; Lengua, Honorado, & Bush, 2007).

Effortful control may shape children's approaches to learning in the home and preschool settings. Even at this young age, their ability to focus, ignore distractions, persist in challenging tasks, and suppress responses to desirable rewards may influence their acquisition of preacademic knowledge. This research also focused specifically on an effortful control composite that included inhibitory control, delay of gratification, sustained attention, and persistence. It is pertinent that 3 out of 6 tasks in our effortful control composite assessed delay of gratification, or the inhibition of responses to emotionally or motivationally evocative stimuli. This may have led to a measure of effortful control that reflects what is demonstrated in naturalistic settings where social and relational factors are

likely to prompt emotional responses. In addition, it sets our mediator apart from studies that have measured self-regulation using primarily emotionally neutral tasks and working memory. Furthermore, it suggests that self-regulatory composites that heavily weight self-control in the context of reward or social-emotional stimuli may partially mediate the association between environmental factors and the acquisition of preacademic knowledge for this age group. However, we did not examine the unique contributions of different self-regulatory components and therefore cannot make conclusions regarding their relative contributions. Further research is needed to identify additional mediating mechanisms, such as planning, memory, reasoning, and language skills (Forget-Dubois et al., 2009).

In terms of other influences on effortful control and preacademic knowledge, child gender was found to influence effortful control in the expected direction with boys having poorer effortful control than girls, consistent with previous findings (Kochanska et al., 2000; Li-Grining, 2007). Gender differences in effortful control may be attributed to influences of biological factors and socialization processes (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006). Race/ethnicity was not found to have unique relations with the mediator or outcomes after accounting for other predictors (and it was only marginally significant in bivariate correlations, see preliminary analyses). This is consistent with previous research showing non-significant relations when SES indices are included in analyses (e.g., Li-Grining, 2007). However, it is important to note that this sample comprised children primarily from racial/ethnic minority groups (e.g., 78% African American; 14% Hispanic/Latino). Given this uneven distribution, the study may not have been equipped to detect effects of race/ethnicity. In other regards, this quality of the study was an advantage in terms of being able to generalize results to minority groups; whereas most prior samples tend to primarily consist of Caucasian/White children.

These results suggest that intervening to improve children's environments to better support effortful control development might facilitate children's acquisition of preacademic knowledge. Early childhood may be a time when effortful control is especially malleable and interventions have the potential to produce enduring benefits. These results suggest targets for intervention efforts in terms of working with parents to improve children's effortful control in the context of learning activities. Prior research has found that improving child care and preschool programs available to lower SES families to promote the development of self-regulatory skills leads to enhanced school readiness (e.g., Raver et al., 2011). However, there are few randomized, controlled trials examining whether home-based intervention targeting effortful control improves school readiness.

It should be noted that this study had numerous strengths. Specifically, the longitudinal design meant that we could test our hypotheses using the correct temporal ordering of predictor, mediator, and outcome and allowed us to control for autoregressive effects. Also, multilevel modeling was conducted to control for the nesting of children within childcare centers. Not controlling for this aspect of the study could have led to overestimates of these associations. In addition, an effortful control composite was created by averaging children's performance on six tasks; this method produces a more reliable measure. By not using a parent or teacher report measure of effortful control, we ruled out the possibility that

effortful control was influenced by perceptions of the relationship of the informant with the child.

However, these were also limitations to this study. One of the major limitations of studies of biologically-related parents and children is that associations between parent and child variables may be due to their genetic similarity instead of environmental influence. However, previous research equipped to account for genetic influences has still found significant environmental influences (Forget-Dubois et al., 2009; Roisman & Fraley, 2012; Stams et al., 2002). In addition, missing data due to the lack of parent participation or attrition over the course of the study could limit generalizability of the findings. This was a short-term longitudinal study in which times 1 and 2 were close together in time. Assessments across a longer developmental span would be needed to more adequately examine the effects of environmental factors on the developmental of effortful control and the role of effortful control in children's preacademic knowledge. Assessing home environment quality at the childcare center rather than during a home visit may have led to a less sensitive measure of this predictor. However, studies using similar methods have demonstrated effects of home environment quality on children's development (e.g., Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; Casey, Bradley, Nelson, & Whaley, 1988; Dreyer, Mendelsohn, & Tamis-LeMonda, 1996). Although all of the children in this study were in child care, effects of the home environment have been observed even in samples of children in child care (Adi-Japha & Klein, 2009). The low internal consistency of the home environment measure may have reduced the possibility of finding effects of home environment quality. However, the internal consistency was not inconsistent with prior studies (e.g., Son & Morrison, 2010).

In conclusion, this study investigated effortful control as a developmental process linking parental education and home environment quality with preacademic knowledge in 2- to 4-year-old children from lower SES backgrounds. Effortful control including attention modulation, response inhibition, and delay of gratification was of particular interest because it develops rapidly during early childhood under supportive environmental conditions and it correlates with academic performance. Findings indicated that effortful control partially explained associations of parental education and home environment quality with preacademic knowledge. The quality of the home environment may shape effortful control, which in turn influences the acquisition of preacademic knowledge. Interventions provided in the home environment prior to entry into preschool may increase the chances that children at risk will start school with the skills they need to succeed academically.

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Research Highlights

- Environment quality and preacademic skills were associated in 2- to 4-year-olds.
- T2 effortful control mediated the association of T1 SES with T3 emergent literacy.
- T2 effortful control mediated the association of T1 home quality with T3 literacy.
- T2 effortful control mediated the association of T1 SES with T3 emergent math.
- Analyses controlled for earlier levels of the mediator and outcome variables.

Figure 1.

Effortful control partially explains the association between parental education and early literacy. Standard errors in parentheses. In analyses that generated these estimates, all variables were standardized. Covariates were child age, gender, race/ethnicity, time 1 effortful control, and time 2 early literacy.

Figure 2.

Effortful control mediates the association between home environment quality and early literacy. Standard errors in parentheses. Covariates were child age, gender, race/ethnicity, time 1 effortful control, and time 2 early literacy.

Figure 3.

Effortful control partially mediated the association between parental education and early math skills. Standard errors in parentheses. Covariates were child age, gender, race/ethnicity, time 1 effortful control, and time 2 early math.

Table 1

Sample characteristics

	<i>M (SD) or %</i>	<i>Range</i>	<i>n</i>
Child age (years) at time 1	3.21 (.54)	2–4	308
Child gender (male)	48		308
Child race/ethnicity			299
African American	78		
Caucasian/White	8		
Hispanic/Latino	14		
First main caregiver's relation to child			305
Mother	90		
Father	5		
Grandmother	4		
Other	1		
First main caregiver marital status			307
Never married, divorced, or separated	62		
Married	38		
Single-parent household	45		304
First main caregiver education			305
High school diploma or less	28		
Some college	50		
Bachelor's degree or more	22		
First main caregiver education (years)	13.59 (2.13)	8–20	305
Qualified for free/reduced lunch program	58		237
Hours in childcare per week	40.42 (7.33)	7–50	278

Note. Age was calculated at January 15.

Descriptive statistics and bivariate correlations among parental education, home environment quality, effortful control, and preacademic skills

Table 2

	1	2	3	4	5	6	7	8	9	10	N	M	SD	Range
Time 1														
1. Parental education	--										305	13.59	2.13	8–20
2. HOME total score	.31	--									303	36.46	3.88	24–43
3. Effortful control	.10	.19	--								289	.02	.61	–1.50–1.66
4. Early literacy	.30	.28	.49	--							295	13.74	10.74	0–50
5. Early math	.24	.24	.62	.65	--						295	26.00	17.83	0–85.42
Time 2														
6. Effortful control	.14	.23	.68	.51	.59	--					308	.03	.64	–1.75–1.24
7. Early literacy	.34	.29	.52	.79	.61	.52	--				278	16.05	11.95	0–55
8. Early math	.23	.24	.61	.59	.79	.58	.66	--			280	32.70	19.93	0–85.42
Time 3														
9. Early literacy	.28	.34	.55	.59	.66	.56	.66	.67	--		227	30.92	15.17	1–63
10. Early math	.20	.24	.60	.57	.68	.62	.62	.72	.70	--	226	37.24	19.44	0–88.50

Note. *ns* for correlations ranged from .225–.305. Parental education was created by standardizing the highest years of parental education in the household. The early literacy score used for descriptive statistics is the sum of raw scores on TOPEL phonological awareness and print knowledge scales. Early math is the percent correct on the CMA. Correlations .14 are statistically significant ($p = .04$ to $<.001$).

Table 3

The total effect of time 1 parental education and home environment quality on time 3 preacademic skills (c paths)

Time 3 early literacy					Time 3 early math				
	<i>b</i>	<i>SE</i>	<i>t</i>	<i>df</i>		<i>b</i>	<i>SE</i>	<i>t</i>	<i>df</i>
Intercept	-.29 ⁺	.16	-1.78	206	Intercept	-.09	.18	-.50	110
Parental education	.22 ^{***}	.05	4.76	206	Parental education	.18 ^{***}	.05	3.68	195
Time 1 early literacy	.38 ^{***}	.06	6.75	206	Time 1 early math	.32 ^{***}	.06	5.66	205
Age	.32 ^{***}	.05	6.30	206	Age	.44 ^{***}	.06	7.11	191
Gender	.20 [*]	.09	2.34	206	Gender	.24 [*]	.10	2.53	203
Race/ethnicity					Race/ethnicity				
African American	.21	.16	1.26	206	African American	-.10	.18	-.56	124
Hispanic/Latino	.29	.19	1.51	206	Hispanic/Latino	.18	.22	.82	102
Variance component	<i>SE</i>	<i>z</i>			Variance component	<i>SE</i>	<i>z</i>		
--	--	--			.01	.03	.57		
Intercept	-.23	.18	-1.34	201	Intercept	-.06	.18	-.34	113
HOME total score	.12 ^{**}	.05	2.67	206	HOME total score	.05	.05	1.15	202
Time 1 early literacy	.44 ^{***}	.06	7.70	207	Time 1 early math	.37 ^{***}	.06	6.49	207
Age	.26 ^{***}	.05	5.02	165	Age	.39 ^{***}	.06	6.41	184
Gender	.13	.09	1.42	206	Gender	.18 ⁺	.10	1.88	207
Race/ethnicity					Race/ethnicity				
African American	.20	.18	1.10	108	African American	-.09	.19	-.49	126
Hispanic/Latino	.27	.21	1.31	91	Hispanic/Latino	.12	.22	.55	201
Variance component	<i>SE</i>	<i>z</i>			Variance component	<i>SE</i>	<i>z</i>		
.02	.03	.54			.02	.03	.59		

Note. Gender coded 1=female, 0=male.

⁺ $p < .10$,

* $p < .05$,

100: > *p*

'10: > *p*
**

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