Mother–child attachment styles and math and reading skills in middle childhood: The mediating role of children's exploration and engagement

Meghan P. McCormick [a,*], Erin E. O'Connor [b], Sophie P. Barnes [c]

[a] *Families & Children Policy Area, MDRC, United States*
[b] *Department of Teaching and Learning, New York University, United States*
[c] *Harvard Graduate School of Education, Harvard University, United States*

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ABSTRACT

Research suggests that early mother–child attachment styles are predictive of cognitive skill development in middle childhood. Yet, little work has considered the differential associations of varying attachment styles on reading and math skills in middle childhood, and the mechanisms explaining those relationships across time. Using data from the first three phases of the National Institute of Child and Human Development Study of Early Child Care and Youth Development, this study examined associations between early mother–child attachment styles and math and reading skill development in middle childhood (i.e., ages 54 months to fifth grade). In addition, using a multilevel mediation approach, we considered children's task engagement and engagement/exploration in the classroom as mechanisms explaining gains in cognitive skills. Findings revealed that insecure/other attachment predicted lower average levels of reading and math skills in fifth grade, while ambivalent attachment was associated with lower average levels of math skills in fifth grade. Children's task engagement partially mediated associations between insecure/other attachment and reading skills, as well as associations between ambivalent attachment and math skills. Task engagement also partially mediated associations between insecure/other attachment and math skills in middle childhood. Implications for attachment theory and educational practice are discussed.

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1. Introduction

Associations between insecure mother–child attachment patterns and social skill difficulties in middle childhood have been documented in numerous large-scale studies (Bergin and Bergin, 2009; Greenberg, 1999). The explanatory mechanisms linking attachment and social skills are similarly well studied and understood. In comparison, limited research exists on mother–child attachment styles and *cognitive skills* in middle childhood. Yet, associations between early mother–child attachment and later cognitive outcomes would be expected given that children's attachment relationships with their mothers relate to their abilities to engage with and explore their world, and consequently learn necessary information from their environments (Bretherton, 1985). Given the salience of academic skills in middle childhood for suc-

cess in elementary school and beyond (Kautz, Heckman, Diris, Ter Weel, & Borghans, 2014), it is critical to understand the potential role that early attachment relationships have on cognitive skill development during middle childhood. Moreover, by identifying potential mechanisms linking early attachment and cognitive outcomes, researchers can inform efforts to develop interventions and support cognitive development. Using a large national longitudinal dataset, the current study examines relations between early mother–child attachment styles and math and reading skills in middle childhood, and uses a rigorous framework to consider whether children's engagement and exploration mediate those associations.

1.1. Attachment theory and early attachment styles

Attachment theory posits that children develop attachment relationships with primary caregivers during the first years of life. Within these relationships, children seek feelings of safety and security (Bowlby, 1980). Attachment relationships compose a motivational control system that regulates children's wishes to maintain proximity to caregivers and explore the environment. When chil-

* Corresponding author at: MDRC, 16 East 34th St., 19th Floor, New York, NY 10016, United States.
E-mail address: meghan.mccormick@mdrc.org (M.P. McCormick).

dren are anxious, their attachment systems are activated, and their exploratory systems are deactivated. In contrast, when children are comfortable, their attachment systems are deactivated and their exploratory systems activated, leading to use of attachment figures as secure bases from which to explore the environment (Ainsworth, Blehar, Waters, & Wall, 1978).

All children, except those who experience severe neglect, develop attachments to their primary caregivers, typically mothers. However, children demonstrate varying patterns of attachment that may reflect *differences* in caregiver sensitivity and responsivity (Ainsworth et al., 1978). Children's attachment styles may then affect how their caregivers interact with them. In this way, attachment relationships are inherently bidirectional. At the most basic level, children develop either secure or insecure attachments. Secure children trust that they will be attended to in times of need and, thus, effectively use caregivers as secure bases from which to explore their surroundings. In contrast, caregivers of insecure children tend to be inappropriately responsive in regards to children's attachment-related behaviors. Insecure children do not trust that they will receive support when threatened. Accordingly, insecure children's attachment systems are more frequently activated and their exploratory systems are more deactivated than those of secure children. Insecure children are not as effective as secure children in their use of caregivers as secure bases. Yet, there is variation in the behaviors of insecure children's caregivers and in insecure children's attachment strategies. Thus, several subcategories of insecure attachment have been identified among children: ambivalent, avoidant, controlling, and insecure/other (Cassidy, Marvin, & the MacArthur Working Group on Attachment, 1992).

Caregivers of ambivalent children tend to be inconsistently responsive. As such, ambivalent children are hypervigilant to signs of impending caregiver unavailability and are dependent and clingy with caregivers to ensure their caregivers' physical proximity in times of stress and/or danger (Ainsworth et al., 1978; Cassidy & Berlin, 1994; Weinfeld, Sroufe, Egeland, & Carlson, 2008). Ambivalent attachment correlates with inconsistent caregiver availability. Avoidant attachment, in contrast, is associated with caregiver unavailability. More specifically, avoidant children do not expect to receive caregiver support when mildly stressed. Thus, they often inhibit affect, avoid extensive contact with caregivers when mildly stressed and focus on the immediate environment to prevent feeling rejected by caregivers (Weinfeld et al., 2008).

More recent research with preschool children has identified controlling and insecure/other styles of attachment, which are both types of disorganized attachment (Teti, 1999). Controlling and insecure/other attachment styles are associated with fearful caregiver behaviors (Main and Hesse, 1990). Controlling children manage fearful behavior by controlling their caregivers, taking charge over caregivers by assuming either a punitive or a caregiving role (Teti, 1999). Through controlling behaviors, they are capable of regulating their caregivers' fearful actions. Controlling children, however, do have organized behaviors to get some of their attachment needs met and are thus somewhat able to use their caregivers as secure bases (Teti, 1999; Main & Cassidy, 1988). Children with controlling attachments have models of the mother as someone capable of being manipulated, and insecure/other children have disjointed and unintegrated models (Moss, Cyr, Bureau, Tarabulsy, & Dubois-Comtois, 2005; Teti, 1999). Generally, children use these models to organize behavioral strategies to regulate their emotions, and to ensure that at least some of their attachment needs are met. However, children with insecure/other attachments appear to lack a representational strategy to regulate their emotions effectively or to develop stable and enduring feelings of safety and security (Teti, 1999). As such, insecure/other children may exhibit anomalous and unorganized attachment behaviors, which appear to prevent them from using caregivers as secure bases (Humber and Moss, 2005; O'Connor, Scott, McCormick, & Weinberg, 2014).

Accordingly, the controlling attachment pattern may be more optimal than the insecure/other pattern (Moss, Bureau, St-Laurent, & Tarabulsy, 2011; Teti, 1999). For example, Moss, Cyr, & Dubois-Comtois (2004) found that controlling children scored higher on dyadic coordination and communication with their mothers than did insecure/other children. Furthermore, the insecure/other pattern is more prevalent than the controlling patterns among high-risk samples, including maltreated preschool (Cicchetti and Barnett, 1991) and orphanage-reared, adopted children (O'Connor et al., 2003).

1.2. Attachment and cognitive development

Relative to children with insecure mother–child attachments, children with secure attachments are more willing to approach and persist in tasks, better able to elicit and accept their caregivers' assistance, and more likely to experience a greater flow of information between themselves and their caregivers (De Ruiter and Van IJzendoorn, 1993). In addition, security of attachment is hypothesized to affect children's metacognitive processes, or knowledge about cognition and regulation of cognition. Secure internal working models of attachment are coherent, noncontradictory, and nondefensive, which are more likely to relate to successful metacognitive monitoring. Given these advantages, theory suggests that children with secure attachments are likely to exhibit higher levels of cognitive skills than their insecure peers (De Ruiter and Van IJzendoorn, 1993).

There is a relatively large empirical literature demonstrating associations between attachment and cognitive skills including ability, intelligence, memory, and reasoning in samples of children ages two to five (Spieker, Nelson, Petras, Jolley, & Barnard 2003). Additional work has considered associations between specific insecure attachment styles and cognitive outcomes in middle childhood. (Aviezer, Sagi, Resnick, & Gini, 2002; Jacobsen and Hofmann, 1997; Kerns, Klepac, & Cole, 1996; Kerns, Tomich, Aspelmeier, & Contreras, 2000; Moss and St-Laurent, 2001; O'Connor & McCartney, 2007). Most recently, West, Matthews, and Kerns (2013) found that early ambivalent and disorganized attachments were associated with a composite measure of cognitive ability, composed of a combination of an achievement and early cognitive ability measure, in third and fourth grade.

Additional research, however, is needed to determine whether there are links between specific attachment styles and reading and math skills across the full period of middle childhood. Indeed, the majority of past studies have measured cognitive skill outcomes with an IQ test outcome, or an aggregate measure of school performance across varied domains of learning. Yet, genetic factors are the primary predictors of children's IQ (Lemelin, Tarabulsy, & Provost, 2006). As such, it may not be completely accurate to identify links between attachment and IQ and argue that such a finding is similar to finding an association between attachment styles and cognitive skills. While IQ generally describes a score on a test that rates cognitive ability relative to the general population, cognitive abilities more broadly represent the brain-based skills and mental processes needed to carry out tasks (Nisbett et al., 2012). In their review of mother–child attachment and cognitive skills, De Ruiter and Van IJzendoorn (1993) argued that the research between attachment quality and IQ was the least compelling and unequivocal, and attachment quality was more strongly related to behaviors and general problem-solving skills across extant literature. Assessing cognitive outcomes with a standardized achievement measure may thus be warranted.

In this vein, some studies have considered how different attachment styles may predict cognitive skills, operationalized

specifically as either reading or math skills. For example, in a sample of six year old children, Main, Kaplan, and Cassidy (1985) found that disorganized or controlling children evidenced the most verbally dysfluent communication styles. In a study that focused on math as an outcome, Dobbs, Doctoroff, Fisher, and Arnold (2006) found that low-income preschool children with insecure attachments were more likely than their secure peers to exhibit poor math skills. Yet, little work has considered whether there are *differential* effects of early attachment styles on cognitive outcomes in middle childhood. In fact, we know of no study that has considered the effects of attachment styles on math and reading skills separately, among the same group of children.

1.3. *Chil*dren's exploration and engagement

Lastly, there is the need to consider the specific mechanisms explaining associations between early mother–child attachment styles and math and reading skill development. Information on mechanisms can help guide theory and practice to disrupt negative cognitive trajectories of children with insecure mother–child attachments. Children's exploration and engagement have been hypothesized by van IJzendoorn, Dijkstra, and Bus (1995) as salient mechanisms linking early mother-child attachment and later cognitive development (see West et al., 2013). Indeed, the attachment system serves a regulatory function based in how comfortable children are in engagement and exploring their environment. When they are comfortable, children can use their caregivers as a secure base from which to physically and mentally explore the environment and to regulate any stress they might encounter when engaging in those endeavors (O'Connor & McCartney, 2007).

Exploration involves investigation of and engagement in the environment (Bergin and Bergin, 2009). Such investigation enhances cognitive skills in early childhood as children learn from interactions with people and objects (Matas, Arend, & Sroufe, 1978). Exploration and engagement takes place across settings. The two most salient contexts for children in early and middle childhood are home – with parent caregivers – and school, with teacher caregivers (Galindo and Sheldon, 2012). In general, children with secure attachments take part in much higher levels of investigation and gain more cognitive stimulation from their investigations than insecure children (Bus & Van Ijzendoorn, 1988; Bus & Van Ijzendoorn, 1995; Bretherton, 1985). Yet, the extent and quality of children's investigations and task engagement vary among insecure children. Avoidant children often investigate the environment and engage in tasks at the expense of interacting with caregivers (O'Connor & McCartney, 2007; West et al., 2013). Ambivalent children, perhaps because of their anxiety over caregiver availability and their clingy behaviors with caregivers, exhibit limited investigation and task engagement in early childhood (Ainsworth & Bell, 1970; Bowlby, 1988; Frosch, Cox, & Goldman, 2001).

Previous studies of attachment and exploration/engagement, however, have mostly considered samples of young children ages one to five and have not examined outcomes in middle childhood (Stams, Juffer, & van IJzendoorn, 2002). In addition, little research has been conducted on exploration and engagement among controlling and insecure/other children. There is evidence, however, that disorganized children exhibit behaviors that lack a goal, making it difficult for them to actively participate in tasks and learn (Moss et al., 2011). For example, because of their behaviors requiring extensive contact with caregivers, controlling children exhibit significantly lower levels of engagement and exploration than their secure peers. Further, insecure/other children would also be expected to participate in low levels of investigation and engagement because they may be less likely to use caregivers as a secure base, thus limiting the likelihood that they will engage in independent exploration (Moss and St-Laurent, 2001; Solomon & George,

2011). There is some evidence linking attachment to children's cognitive skills through exploration and engagement at the beginning of middle childhood. O'Connor and McCartney (2007) found that in first grade, children with insecure/other attachments performed worse, on average, on a composite scale of cognitive skills, partially due to lower levels of exploration and engagement. The findings, however, did not consider mediation across the full span of middle childhood, nor did the authors examine math and reading outcomes separately.

1.4. *The present study*

We investigated relationships between mother–child attachment patterns and cognitive skills with data from the first three phases of the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (NICHD SECCYD). This data set allowed us to examine multiple attachment styles, including insecure/other attachment, and to ensure that a sufficient number of children represented each attachment style to detect differential effects. Two previous studies (O'Connor & McCartney, 2007; West et al., 2013) have engaged in similar endeavors. For example, O'Connor and McCartney (2007) used these same data to examine associations between early attachment and a composite cognitive skill outcome at first grade, finding that: (1) ambivalent and insecure/other attachment patterns were negative predictors of cognitive skills; (2) the association between ambivalent attachment and cognitive skills was mediated by children's behaviors related to testing; and (3) the association between insecure/other attachment and cognitive skills was mediated by children's exploration and behaviors related to testing. West et al. (2013) then extended this analysis by examining cognitive outcomes in grades 3 and 4, establishing zero-order correlations between disorganized and ambivalent attachment and lower school performance or IQ in middle childhood. Further regression analyses suggested that that quality of parental assistance and child cooperation mediated those associations. Although many of West et al.'s (2013) analyses did not allow for inferential statistics, correlational findings are helpful for extending research linking early mother-child attachment to cognitive outcomes.

We argue that the current study extends these previous works in a number of critical ways. First, although quite comprehensive, West et al. (2013) study did not consider children with an insecure/other attachment in their analyses. Given previous research by O'Connor and McCartney (2007) demonstrating the strongest associations between insecure/other attachment and cognitive outcomes, it is important to explicitly address this limitation in new work. Additionally, although De Ruiter and Van IJzendoorn (1993) argue that it is essential to control for maternal IQ in studies of mother–child attachment and cognitive skills, West et al.'s (2013) study did not adjust for this potentially important confounding variable. More broadly, the current study addresses limitations in previous work by: (1) using comprehensive models with a host of critical controls, including early measures of maternal education and proxies for mother and child IQ, to examine links between mother–child attachment and cognitive skills; (2) explicitly considering the multilevel structure of the longitudinal data (time nested within individuals) in order to disaggregate average effects from time-varying effects; (3) evaluating cognitive outcomes across the full period of middle childhood (i.e., through fifth grade); and (4) examining reading and math achievement outcomes separately, given literature suggesting that attachment may affect the development of these skills differently (De Ruiter & Van IJzendoorn, 1993). In doing so, this study will answer two research questions, conceptualized broadly: (1) Do early avoidant, ambivalent, controlling, and insecure/other attachment styles predict math and reading skills in middle childhood? and (2) Are associations between early

mother–child attachment styles and math and reading skills in middle childhood mediated through children's exploration and engagement?

2. Method

2.1. Participants and procedures

Participants in the NICHD SECCYD were recruited through 1991 from 24 hospitals near the following sites: Little Rock, AK; Irvine, CA; Lawrence and Topeka, KS; Boston, MA; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Morganton and Hickory, NC; Seattle, WA; and Madison, WI. Potential participants were selected from 8986 mothers giving birth during selected 24-h sampling periods. Participants were selected in accordance with a conditional random sampling plan that was designed to ensure that the recruited families reflected the demographic diversity (economic, educational, ethnic) of the catchment area at each site. Notably, mothers who did not speak English were excluded from the sampling for this study. A total of 1364 families enrolled in the study. The demographic distribution of the sample is 24% ethnic minority (13% African-American, 6% Latino-American, 1.4% Asian-American, and 3.4% of ethnic or racial backgrounds classified as other); 11% of the mothers did not have a high school education and 14% were single (NICHD ECCRN, 2001). The sample for this study consists of 1023 children who had completed the assessment of mother–child attachment patterns at 36 months and had cognitive assessment data for at least one follow-up time point (at 54 months, 1st grade, 3rd grade, or 5th grade). Please refer to NICHD ECCRN (1997) for additional information related to the sampling procedure used to recruit study participants.

2.2. Measures

Below, we describe each of the measures and note whether they were collected when children were 24 months, 36 months, 54 months, or in first, third, or fifth grade.

2.3. Cognitive skills

Children's cognitive skills at 54 months, first grade, third, and fifth grade were assessed using cognitive ability subscales of the Woodcock Johnson Psycho-Educational Battery–Revised (WJ–R) (Woodcock, McGrew, & Mather, 2001). For the purposes of this article we examined the Letter Word ID and Applied Problems subscales to measure reading and math skills respectively. We used W ability scores to operationalize the constructs. The Letter-Word Identification subscale consists of 57 items, with higher values indicating better reading identification skills and word decoding. The Applied Problems subscale includes 60 items with higher scores indicating better skills to analyze and solve mathematical problems. The WJ–R is a nationally normed and widely used achievement test with demonstrated internal consistency. Average internal consistency from 54 months through fifth grades in the NICHD sample is .90 for Letter-Word Identification and .83 for Applied Problems (Belsky et al., 2007). The WJR has excellent test–retest reliability and predictive validity across the life span (McGrew and Kopnick, 1995). Notably, on average, math and reading skills are only moderately correlated in the current study (54 months, $r = .55$; 1st grade, $r = .57$; 3rd grade, $r = .61$; 5th grade = .60). In addition to the conceptual argument for considering these separate outcomes, it is also empirically important to examine math and reading separately in analytic models.

2.4. Child and family controls

2.4.1. Child gender

Parents reported children's gender during study enrollment. Child gender was dummy coded such that males were assigned a value of 0 and females a value of 1.

2.4.2. Race/ethnicity

Two dummy variables for race/ethnicity were created: child black vs. child white (black = 1; white = 0), and child Hispanic vs. child white (Hispanic = 1; white = 0).

2.4.3. Early cognitive skills

At 24 months, the Bayley Mental Development Index was used to assess children's cognitive skills (Bayley, 1993). This index measures toddlers' sensory–perceptual, memory, and problem-solving abilities. Higher scores indicate greater skills. The Bayley has very good reliability and predictive validity (Gagnon and Nagle, 2000). In the current study the 24 month measure of the Bayley is used as a control variable to account for early levels of cognitive skills.

2.4.4. Income to needs ratio

At 36 months, the ratio of family income to needs was computed by dividing total family income by the poverty threshold for the appropriate family size. Income-to-needs ratios less than 1 indicate poverty status. A continuous variable for income to needs ratio in early childhood (at 36 months) was included as a covariate to account for differences in cognitive skills attributed to family income (Burchinal et al., 2011; Welsh, Nix, Blair, Bierman, & Nelson, 2010). We only included an early measure because, on average, income to needs ratios were relatively stable in middle childhood (average $r = .74$).

2.4.5. Maternal education

Level of maternal education was obtained during interviews with parents and dummy coded based on level of education completed. Variables for maternal education less than a h.s. degree, h.s. graduate/GED equivalent, some college, and four-year college graduate were included as covariates (referent group: mothers who had attended or graduated from graduate school), given documented links between maternal education and children's cognitive skills in middle childhood (Duncan and Magnuson, 2012).

2.4.6. Maternal cognitive skills

Mother's PPVT-R score was measured at 36 months and included as a covariate in models as a proxy for maternal cognitive ability. This is an important covariate as maternal cognitive ability has been linked to children's cognitive skills (Berger, Brooks-Gunn, Paxson, & Waldfogel, 2008).

2.5. Mother–child attachment

A modified Strange Situation procedure, based on recommendations by Cassidy et al. (1992), was used to assess children's attachment styles at 36 months. In this procedure, designed to be moderately stressful for the child, the mother and child were separated from each other for two brief periods. After 3 min together in the laboratory, the mother was signaled to leave. The first separation lasted 3 min, unless the child was overly distressed. After a 3-min reunion, the mother left again. The second separation lasted 5 min. The children's behaviors during the assessment were classified according to the system developed by the MacArthur Working Group on Attachment (Cassidy et al., 1992). Children were classified as secure, ambivalent, avoidant, controlling, or insecure/other on the basis of their reunion behaviors with their mothers. Secure

children resume calm, comfortable interactions with their mothers on reunion. Avoidant children maintain extreme neutrality toward their mothers and rarely express positive or negative emotion toward their mothers, even after reunion. Ambivalent children exhibit fussy, helpless, whiny, and/or resistant behavior toward their mothers when reunited with them. They may seek contact but find it unsatisfactory. Controlling children take charge of the reunion, usually in either a caregiving (role-reversal) or punitive manner. Insecure/other children do not demonstrate a coherent attachment behavioral strategy during reunion. Intercoder agreement (before conferencing) was 75.7% (κ = .58) (McCartney, Owen, Booth, Vandell, & Clarke-Stewart, 2004).

In the current analyses, dichotomous variables for avoidant, ambivalent, controlling, and insecure/other mother–child attachment styles were created. The referent group was secure attachment. The attachment measure of 36 months was preferred over the 24 month measure in the NICHD SECCYD because it explicitly allows one to examine attachment styles and sub-types of disorganized attachment, including the insecure/other group categorization. Given previous research demonstrating that children with an insecure/other attachment are at higher risk than children with other types of disorganized attachment for poor cognitive skills (O'Connor & McCarthy, 2007), it was critical that this study include an attachment measure that allowed for consideration of children with an insecure/other attachment. In addition, previous work has demonstrated that the 15 and 36 month measures of attachment are only modestly correlated (Drake, Belsky, & Fearon, 2014; McCartney et al., 2004). Because attachment patterns tend to be more stable after 36 months, we used the 36 month measure to relate mother–child attachment to cognitive development in middle childhood.

2.6. Measures of children's exploration

2.6.1. Task engagement

Children's engagement in a task with their mothers was assessed at 54 months, first grade, and fifth grade. Trained assessors were responsible for conducting the tasks with children and mothers. Tasks took place in the lab or at home. Interaction activities included two tasks that were too difficult for the child to carry out independently. Behaviors were rated using 7-point global rating scales modified from Egeland and Hiester (1995). Task orientation/engagement is the sum of two behaviors: agency and persistence. *Agency* measures the child's self-initiated participation in the activity and active exploration of the activity. *Persistence* assesses the child's engagement in the activity even when frustrated. The range of values for this composite is 2–14, with higher scores indicating higher levels of engagement. Intercoder reliability was calculated using an intraclass correlation. Reliability across time ranged from .87 to .89. Cronbach's α for child exploration ranged from .81 to .88.

2.6.2. Engagement/exploration in classroom

Similar to previous research on the NICHD SECCYD (O'Connor & McCartney, 2007; West et al., 2013), engagement/exploration in the classroom was measured at first, third, and fifth grades through observational ratings from the Classroom Observational System (COS) (NICHD ECCRN, 2000). During the COS, the study child was observed in the classroom for two 44-min cycles. All observations took place in children's elementary school classrooms, and were conducted by trained observers who were graduate students in each study site. In each cycle, observers made time-sampled recordings for three 10-min periods of 30-s "observe" and 30-s "record" intervals. Thus, there were 30 different minutes in which discrete behaviors were sampled across each of the two observation cycles for a total of 60 different minutes (i.e., 60 intervals)

in which codes were completed. Child engagement/exploration is the sum of two individual behavior scales: active engagement and passive engagement. *Active engagement* is coded when the child explores the classroom, interacts with others, seeks out activities, and actively participates in activities during the interval. *Passive engagement* is coded when the child does not seek out activities in the classroom on his or her own but is engaged in them. Scores range from 0 to 60, with higher scores indicating higher levels of engagement/exploration. All observers had to pass a videotaped reliability test involving six 44-min cycles for behavioral coding. Criteria for passing were at least 60% match with a master coder on time-sampled codes. All coders passed at this level on a reliability test before being certified to conduct observations in the field. Average exact agreement with the gold-standard videotape test for the time-sampled codes was .70. Observers also conducted paired visits for the purposes of estimating live reliability. Correlations between observers exceeded .60.

3. Data analysis plan

3.1. Missing data

This analysis relied on outcomes collected at 54 months and in first, third and fifth grade, and included the 1023 children and families who had data for the main predictor (attachment) and outcome data for at least one of the time points. Excluded families appeared to drop out at or before kindergarten. Mothers of attriting children had about a year less education, on average, and they used 11 fewer hours of childcare per week, relative to non-attriting mothers. Although one might expect, given the education differences, that these mothers would have a lower income/needs ratio, for the half of the attriting sample for which we had income/needs ratio data, there were no significant differences compared to the non-attriters. In addition, there were no significant differences in attachment patterns at 24 or 36 months between the attriters and non-attriters. We decided that we could make the assumption that data were missing at random because the probability of missing data at one time point, on variables collected at multiple time points, was unrelated to their values at other times. Given the assumption that data were MAR, a multiple imputation procedure was thus employed, and 20 separate datasets were imputed by chained equations, using STATA MICE in STATA version 12 (Schafer & Graham, 2002; Enders, 2013). MI replaces missing values with predictions based on all other information observed in the study. Unlike single imputation methods, MI accounts for uncertainty about missing data by imputing several values for each missing value, generating multiple datasets. For this paper, STATA ran each set of analyses 20 times and aggregated the findings across the datasets.

3.2. Multi-level modeling

Data for the current study are longitudinal, with repeated measures nested within children. As such, the observations are not likely to be independent, a critical assumption of OLS regression (Raudenbush and Bryk, 2002). In this way, longitudinal data are considered to be multi-level (Singer and Willett, 2003). We used STATA XTMIXED to examine multi-level models, with intercept shifts representing differences between subjects (Diggle, Heagerty, Liang, & Zeger, 2002; Singer and Willett, 2003). This is a mixed model where repeated measures are modeled at Level 1 and time-invariant person-level variables are modeled at Level 2 (Raudenbush and Bryk, 2002). Because there are multiple observations per subject, the notation for describing each person-period in this model is given by:

$$Y_{it} = X_{it}\beta + \alpha_{0i} + \varepsilon_{it}$$

where Y_{it} is the response (reading or math cognitive skills) for subject i at occasion t, X_{it} is a $1 \times p$-vector of predictor variables for subject i at occasion t (some may be time-independent, in which case they repeat for all t), β is a $p \times 1$-vector of population-average coefficients, also known as fixed effects, α_{0i} is an individual-specific random effect capturing the systematic, time constant, between-subject differences and ε_{it} is an individual, time-dependent residual.

We included a variable for time where Time 1 ($T1$) refers to 54 months, Time 2 ($T2$) is first grade, Time 3 ($T3$) is third grade, and Time 4 ($T4$) is fifth grade. Importantly, we centered time at the final time point so that the effect of attachment would represent the difference between the insecure attachment style and the reference group (secure attachment) in fifth grade. We also included fixed effects for site in all predictive models. The more general form of this model (provided below) allows a correlation between intercept and slope, which we found was justified.[1]

$$Y_{it} = X_{it}\beta + \alpha_{0i} + \alpha_{Ti}\text{Time}_{it} + \varepsilon_{it} \text{ with } \alpha_{0i} \sim N(0, \sigma^{2\alpha}{}_{0i}), \alpha_{Ti} \sim (0, \sigma^{2\alpha}{}_T) \text{ and } \text{corr}(\alpha_{0i}, \alpha_{Ti}) = \rho_{0T}, \text{with}(\alpha_{0i}, \alpha_{Ti})' \text{independent of } \varepsilon_{it} \sim N(0, \sigma^2{}_\varepsilon)$$

We ultimately decided to fit a linear time trend, as models including quadratic and cubic trends did not appear to be warranted.[2]

3.2.1. Model 1

First, we ran a baseline model (Model 1) to examine how time and key demographic predictors related to cognitive skills. We anticipated that the baseline model would help us determine how well the variables of interest in the study – mother–child attachment and children's engagement/exploration – explained additional variation in the outcomes, over and above demographic shifts and normative developmental trajectories. In addition to time, Model 1 includes time-invariant (Level 2) measures for child female, child black, child Hispanic, maternal education less than h.s., maternal education h.s. grad, maternal education some college, maternal education 4 year college graduate, income to needs ratio at 36 months, maternal PPVT score at 36 months, and child cognitive skills at 24 months. A random intercept and slope in this model pick up unexplained differences between the level and slope of individuals' trajectories.

3.2.2. Model 2

In Model 2 we examined whether a significant association existed between attachment styles (avoidant, ambivalent, controlling, insecure/other) and average cognitive skills in fifth grade. If we did find that an attachment style was statistically significant, we calculated an effect size by dividing the coefficient for the variable by the pooled standard deviation for the outcome. This is similar to the method used in previous studies from the NICHD SECCYD that have examined Woodcock Johnson W scores as outcomes (Belsky et al., 2007; Vandell, Belsky, Burchnial, Steinberg, & Vandergrift, 2010). Calculating such an effect size allows for comparison of the magnitude of effects across attachment styles. Finally, in this step we tested whether the effect of the four attachment styles on reading and math skills varied across time by including interactions between time and the attachment styles in the predictive models.

3.2.3. Model 3

Third, we added children's task engagement and engagement/exploration in the classroom to the models to test for initial evidence of mediation. Importantly, we modeled each time-varying predictor at both Level 1 and Level 2. If one does not explicitly model time-varying predictors at multiple levels, the effect actually becomes a weighted average of the within and between-subject effect (Bolger and Laurenceau, 2013). To correct for this potential confounding, we created time-invariant child means of these predictors. We centered the time-invariant child means around the sample mean and included those variables as Level 2 predictors. These variables represented children's average level of task engagement and engagement/exploration in the classroom across the full period of middle childhood. In contrast, we included time-varying measures of task engagement and exploration in the classroom as predictors in the Level 1 models. We centered the time-varying predictors for task engagement and exploration in the classroom around the individual children's mean across the full study period (i.e., person-centered means). A positive effect of these time-varying predictors represents an increase over and above a child's average level of task engagement and exploration having an effect on change in math and/or reading skills. We would expect that a reduction in the magnitude of the association between attachment styles and cognitive skills after including these mediators in the model would provide some initial descriptive evidence of mediation (Baron and Kenny, 1986).

3.2.4. Mediation tests

We used the framework for multi-level mediation recommended by Zhang, Zyphur, and Preacher (2009) to test whether the proposed mechanisms for the study explained any significant relationships between mother–child attachment styles and cognitive skills. This multi-level mediation approach allows one to test for mechanisms while maintaining the multi-level structure of the data. Indeed, by examining mediation with multi-level data and failing to account for the multi-level structure, one may bias the standard errors of the coefficients of interest (Singer and Willett, 2003). It is particularly helpful when independent variables (X) are operationalized at different levels than the mediator (M) and outcome (Y) variables. In the current study, the main predictors – attachment styles – are Level 2 variables. The mediators and outcomes, however, are time-varying Level 1 variables. Zhang et al. (2009) refer to this as a 2-1-1 framework. In their paper, they recommend the following procedures. First, establish the association between X and Y in a typical random intercept model. Next, test whether the Level 1 predictor for M is related to the time-varying outcome. Finally, to fully test for mediation (the C′ path), examine the effect of X on Y, controlling for the group mean of the mediator. We used this framework and included children's task engagement and engagement/exploration in the classroom as predictors concurrently (to account for their intercorrelation, although at $r = .08$, it was quite small). In the cases where we did find evidence of mediation, we then calculated the indirect effect of X on Y through M and determined if the indirect effect was statistically significant by using a Sobel's test.

4. Results

4.1. Descriptive statistics

Means and standard deviations for all continuous variables and frequencies for dichotomous variables are presented in Table 1.

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[1] As we were primarily interested in the fixed effects parameter estimates as they relate to our main research questions, we concentrate on those in the discussion of findings and do not provide an in-depth discussion of random effects estimates. Random effects and goodness of fit statistics, however, are included in the analytic Tables 2 and 3.

[2] The quadratic and cubic time trends were non-significant in the unconditional models. Future work might consider quadratic and cubic trends in cases where more time points of data are available.

Table 1
Descriptive statistics for study variables.

Attachment styles, mediators, and outcomes	24 or 36 mos.		54 months		1st grade		3rd grade		5th grade	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Child female	0.48	–	–	–	–	–	–	–	–	–
Child black	0.13	–	–	–	–	–	–	–	–	–
Child Hispanic	0.06	–	–	–	–	–	–	–	–	–
Maternal education, less than h.s.	0.10	–	–	–	–	–	–	–	–	–
Maternal education, h.s. grad	0.21	–	–	–	–	–	–	–	–	–
Maternal education, some college	0.33	–	–	–	–	–	–	–	–	–
Maternal education, college grad	0.21	–	–	–	–	–	–	–	–	–
Income to needs ratio	3.52	3.12	–	–	–	–	–	–	–	–
Maternal PPVT score	99.01	18.35	–	–	–	–	–	–	–	–
Cognitive skills at 24 mos.	92.15	14.63	–	–	–	–	–	–	–	–
Avoidant (strange situation)	0.05	0.21	–	–	–	–	–	–	–	–
Ambivalent (strange situation)	0.17	0.38	–	–	–	–	–	–	–	–
Insecure/other (strange situation)	0.07	0.26	–	–	–	–	–	–	–	–
Controlling (strange situation)	0.09	0.29	–	–	–	–	–	–	–	–
Literacy skills (letter word ID)	–	–	369.99	21.98	452.96	24.11	493.86	18.73	510.12	17.52
Math skills (applied Problems)	–	–	425.05	19.49	470.99	15.74	497.33	13.19	509.83	12.85
Task engagement (7–21)	–	–	16.35	3.04	16.47	2.95			16.52	2.27
Engagement/exploration in classroom (COS)	–	–	–	–	55.91	4.73	39.85	8.40	40.92	8.44

$N = 1023$.

Attachment distributions were comparable to those found in other studies (Van IJzendoorn, Goldberg, Kroonenberg, & Frankel, 1992). The largest attachment group was secure ($N = 627$; 62%), followed by ambivalent ($N = 173$; 17%), controlling ($N = 92$; 9%), insecure/other ($N = 71$; 7%), and avoidant ($N = 51$; 5%). As expected, there were normative trajectories in cognitive skills over time. Notably, classroom engagement/exploration decreased markedly between first and third grades and then stabilized in fifth grade.

4.2. Multi-level models

4.2.1. Reading skills

Table 2 displays the results for multi-level models predicting reading skills from covariates (Model 1), attachment styles (Model 2), and the theorized mediators (Model 3). Non-significant findings are listed in the tables but not outlined in the text below. With respect to Model 1, children with mothers at the two lowest levels of education had lower levels of average reading skills in fifth grade (less than h.s. $B = -11.83$, $p < .01$; h.s. grad. $B = -3.93$, $p < .05$). In addition, higher income to needs ratio at 36 months ($B = 2.26$, $p < .01$), maternal PPVT scores at 36 months ($B = 3.75$, $p < .01$), and cognitive skills at 24 months ($B = 3.71$, $p < .01$) predicted higher levels of reading skills in fifth grade. Results of Model 2 revealed that children with insecure/other attachments had lower average reading skills in fifth grade ($B = -3.91$, $p < .05$; E.S. $= .19$), relative to children with secure attachments. This finding is illustrated in Fig. 1. Associations between the remaining attachment styles and reading skills were non-significant. In addition, there was no evidence that the effects of any of the four attachment styles on reading skills varied across time.

As shown in the results of Model 3, after accounting for task engagement and engagement/exploration in the classroom, the association between insecure/other and reading skills was non-significant ($B = -2.50$, $p = .66$). There were overall associations between task engagement and reading skills in fifth grade ($B = .87$, $p < .01$) as well as engagement/exploration in the classroom and reading skills in fifth grade ($B = .12$, $p < .05$). In addition, positive changes in engagement/exploration in the classroom ($B = .52$, $p < .01$) were associated with concurrent increases in reading skills across middle childhood. Given these findings, we further explored our hypotheses that task engagement and engagement/exploration in the classroom mediated associations between insecure/other attachment and reading skills.
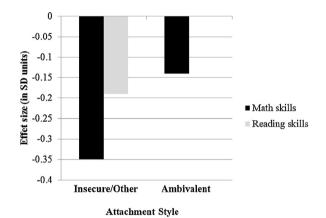

Fig. 1. Statistically significant effects of attachment styles on fifth grade reading and math skills.

The test of the A path demonstrated that insecure/other attachment predicted task engagement ($B = -.51$, SE $= .24$, $p = .04$), but not children's engagement/exploration in the classroom ($B = -24$, SE $= .67$, $p = .72$). There was no evidence for engagement/exploration in the classroom as a mediator in this analysis. The B path test for task engagement, however, was significant ($B = .58$, SE $= .18$, $p < .01$). In addition, the magnitude of the effect for insecure/other attachment predicting reading skills was reduced after accounting for the group mean of task engagement ($B = -3.20$, SE $= 1.57$, $p < .05$). A Sobel's test further suggests that the effect of insecure/other attachment was partially mediated through task engagement ($t = 3.22$, $p < .01$).

4.2.2. Math skills

Table 3 displays the results for multi-level models predicting math skills from covariates (Model 1), attachment styles (Model 2), and children's engagement and exploration (Model 3). Non-significant findings are listed in the tables but not outlined in the text below. With respect to Model 1, children with mothers at the lowest level of education had lower levels of math skills in fifth grade ($B = -6.36$, $p < .01$). Female ($B = -1.97$, $p < .01$) and black ($B = -5.68$, $p < .01$) children had lower average math scores, relative to boys and non-black children. In addition, higher income to needs ratio at 36 months ($B = 1.23$, $p < .01$), maternal PPVT scores at 36 months ($B = 2.43$, $p < .01$), and cognitive skills at 24 months ($B = 4.74$,

Table 2
Multilevel models predicting letter word ID skills in middle childhood.

Fixed effects	Model 1		Model 2		Model 3	
	B	SE	B	SE	B	SE
Intercept	527.58**	2.12	527.99**	2.16	527.81**	2.16
Time	46.57**	0.34	46.61**	0.35	44.75**	0.40
Child and family controls						
Child female	0.45	0.97	0.85	0.99	1.24	1.04
Child black	−2.63	1.74	−3.04***	1.77	−2.35	1.87
Child Hispanic	0.99	2.18	0.95	2.2	0.14	2.31
Maternal education, less than h.s.	−11.83**	2.60	−11.87**	2.65	−12.63**	0.28
Maternal education, h.s. grad	−3.93*	1.94	−4.32*	1.97	−5.39**	2.07
Maternal education, some college	−0.73	1.64	−1.05	1.66	−1.70	1.74
Maternal education, college grad	0.50	1.56	0.27	1.59	0.59	1.67
Income to needs ratio at 36 mos.	2.26**	0.57	2.08**	0.57	2.01**	0.61
Maternal PPVT score at 36 mos.	3.75**	0.64	3.68**	0.65	2.80**	0.69
Cognitive skills at 24 mos.	3.71**	0.57	3.60**	0.59	3.40**	0.62
Attachment styles (Level 2 variables)						
Avoidant (strange situation)			2.42	2.31	2.74	2.41
Ambivalent (strange situation)			−1.84	1.36	−1.65	1.43
Insecure/other (strange situation)			−3.9*	1.96	−3.15*	1.55
Controlling (strange situation)			−0.05	1.67	−0.21	1.76
Children's exploration (Level 1 variables)						
Task engagement (structured interaction)					0.24	0.26
Engagment/exploration in classroom (COS) 0.52**					0.52**	0.04
Children's exploration (Level 2 variables)						
Task engagement (Structured interaction)					0.87**	0.27
Engagment/exploration in classroom (COS)					0.24*	0.09
Random effects						
Random child-level intercept	61.14**	13.39	61.60**	13.63	5.71	9.10
Random slope for time	0.44	0.55	0.41	0.53	0.16**	0.04
Correlation between intercept and slope	−5.19	2.84	−5.01*	2.91	−0.95	0.76
Residual error	587.10		551.54**	14.87	524.11**	0.76
AIC	34753.44		34011.40		24890.70	
Log likelihood	−17351.72		−16976.70		−12414.35	

$N = 1023$.
* $p < .05$.
** $p < .01$.
*** $p < .10$.

$p < .01$) predicted higher overall levels of math skills. Results of Model 2 revealed that ambivalent ($B = −2.21$, $p < .01$, $E.S. = .14$) and insecure/other attachments ($B = −5.33$, $p < .01$; $E.S. = .35$) had lower levels of math skills than children with secure attachments in fifth grade. These findings are illustrated in Fig. 1. Associations between controlling and avoidant attachment and math skills were non-significant. In addition, there was no evidence that the effects of any of the four attachment styles on math skills varied across time.

As shown in the results of Model 3, the coefficients for insecure/other ($B = −5.13$, $p < .01$) and ambivalent ($B = −1.73$, $p < .05$) attachment decreased slightly after accounting for task engagement and engagement/exploration in the classroom. Task engagement ($B = .53$, $p < .01$) and engagement/exploration in the classroom ($B = .13$, $p < .05$) were associated, on average, with greater math skills in fifth grade. Changes in engagement/exploration in the classroom ($B = .26$, $p < .01$) were associated with concurrent changes in math skills across middle childhood.

Given this initial evidence for the hypothesized mechanisms, we formally tested the mediation pathways in line with Zhang et al.'s (2009) framework. The test of the A path revealed that ambivalent attachment predicted task engagement ($B = −.33$, $p < .05$), but not children's engagement/exploration in the classroom ($B = −.34$, $p = .46$). Given the non-significant A path for engagement/exploration, there was no evidence for this variable as a mediator in this analysis. Subsequent tests demonstrated that task engagement did predict math skills (B path: $B = .33$, $p < .01$). The effect of ambivalent attachment predicting math skills was reduced in magnitude after including the group level mean for task

engagement ($B = −1.94$, $p = .03$). A Sobel's test further suggests that the effect of ambivalent attachment on math skills was partially mediated through task engagement ($t = 2.94$, $p < .05$).

As discussed above, insecure/other attachment was a significant predictor of task engagement, but not engagement/exploration in the classroom. As such, we only tested for task engagement mediating the effect of insecure/other attachment on math skills. There was evidence that task engagement did predict math skills ($B = .33$, $p < .01$). Moreover, the magnitude of the effect of insecure/other attachment on reading skills was reduced after accounting for the group level mean of task engagement ($B = −5.15$, $p < .01$). A Sobel's test further suggests that the effect of insecure/other attachment on math skills was partially mediated by task engagement ($t = 2.47$, $p < .05$).

5. Discussion

Results from the current study indicate that both insecure/other and ambivalent attachment styles are related to lower level math skills in fifth grade, at the end of middle childhood, while only insecure/other attachment is related to lower level reading skills in fifth grade. Negative associations between both ambivalent and insecure/other attachments and math skills were partially mediated through lower levels of task engagement. Negative associations between insecure/other attachment and reading skill development were also partially mediated through lower task engagement. There was no evidence that children's exploration in the classroom helped to explain associations between insecure/other and

Table 3
Multilevel models predicting applied problems skills in middle childhood.

Fixed effect	Model 1		Model 2		Model 3	
	B	SE	B	SE	B	SE
Intercept	519.91**	1.38	520.29**	1.39	520.01**	1.4
Time	28.24**	0.2	28.29**	0.21	27.28**	0.23
Child and family controls						
Child female	−1.97**	0.63	−1.68**	0.64	−1.48*	0.7
Child black	−5.68**	1.14	−5.87**	1.15	−6.00**	1.26
Child hispanic	0.04	1.43	−0.14	1.43	−1.2	1.55
Maternal education, less than h.s.	−6.36**	1.7	−6.13**	1.72	−6.67**	1.87
Maternal education, h.s. grad	−1.1	1.27	−1.23	1.28	−1.8	1.39
Maternal education, some college	−0.53	1.07	−0.74	1.08	−1.18	1.16
Maternal education, college grad	0.34	1.02	0.1	1.03	−0.12	1.12
Income to needs ratio at 36 mos.	1.23**	0.37	1.08**	0.37	0.92*	0.41
Maternal PPVT score at 36 mos.	2.43**	0.42	2.32**	0.42	2.15**	0.46
Cognitive skills at 24 mos.	4.74**	0.37	4.62**	0.38	4.96**	0.42
Attachment styles						
Avoidant (strange situation)			−1.82	1.51	−1.15	1.62
Ambivalent (strange situation)			−2.21**	0.89	−1.73*	0.86
Insecure/other (strange situation)			−5.33**	1.28	−5.13**	1.4
Controlling (strange situation)			−0.54	1.09	0.36	1.19
Children's exploration (Level 2 variables)						
Task engagement (structured interaction)					0.16	0.15
Engagement/exploration in classroom (COS)					0.26**	0.02
Children's exploration (Level 1 variables)						
Task engagement (structured interaction)					0.53**	0.18
Engagement/exploration in classroom (COS)					0.13*	0.06
Random effects						
Random child-level intercept	25.68**	0.98	24.89**	1.08	13.29**	4.68
Random slope for time	1.53**	0.39	1.45*	0.44	1.73*	0.79
Correlation between intercept and slope	−6.28**	1.03	−6.00**	1.23	−4.80**	0.79
Residual error	189.87**	1.98	183.71**	2.01	180.65**	5.41
AIC	30925.44		30257.91		22198.29	
Log likelihood	−15441.7		−15104		−11068.2	

†p<.10.
* p<.05.
** p<.01.

ambivalent attachment and lower levels of cognitive skills. Notably, however, there were robust associations between changes in children's exploration/engagement in the classroom and changes in both math and reading skills at the end of middle childhood.

Results are largely in line with those identified by O'Connor and McCartney (2007). However, the findings make a number of additional contributions to the current literature base on attachment styles and cognitive outcomes. Specifically, findings show that ambivalent attachment only predicts math skills, and insecure/other attachment relates to both reading and math skill development across the full range of middle childhood, a time period critical for academic success during adolescence and adulthood (Duncan et al., 2007). We have identified these associations after adjusting for critical control variables, such as an early measure of the child's early cognitive ability and maternal education. Given these factors and the longitudinal nature of the analysis, this study provides more rigorous evidence for associations between particular attachment styles and math and reading skill development across the full period of middle childhood. Moreover, we were able to leverage additional data to identify children's task engagement as a critical mechanism explaining these associations.

5.1. Attachment pattern classification and math and reading skills in middle childhood

A key finding from this analysis is that there is indeed variation in cognitive skill development in middle childhood among children who have insecure attachment styles. Yet, there were no significant differences between avoidant and secure children in terms of math

or reading skill development in middle childhood. In line with previous studies, two of which used the same sample as the current work (O'Connor & McCartney, 2007; Moss & St-Laurent, 2001; West et al., 2013), it does not appear that having an avoidant attachment is a risk factor for lower level cognitive skills across the full range of middle childhood. Rather, the attachment strategies that avoidant children develop appear to be sufficient to support their cognitive development. In particular, avoidant children's focus on the environment to prevent attachment related stress may support their development of age-appropriate cognitive skills.

In line with a previous study conducted by O'Connor and McCartney (2007), there were also no differences in the math or reading skills between children with controlling and secure attachments. Through their efforts to manipulate their caregivers, it is plausible that controlling children may develop age-appropriate cognitive skills. This finding runs contrary to Moss and St. Laurent's work with six year olds (2001) identifying controlling attachment as a risk factor for poor cognitive skills. Given that these past studies did not examine associations between attachment and skills *at the end of childhood* however, it may be that controlling attachment is important for outcomes measured upon school entry but less so across time.[3] Once controlling children adjust to the school environment, they may be able to use their manipulation skills to meet their needs in the classroom setting.

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[3] Although we did test time *x* attachment style interactions, we may not have had sufficient power to detect differential effects of attachment styles on cognitive skills over time.

On the other hand, as anticipated, ambivalent and insecure/other children demonstrated significantly lower scores than their secure peers on cognitive skills at the end of childhood (Ainsworth et al., 1978; Van IJzendoorn, Dijkstra, & Bus, 1995). Moreover, statistically significant effect sizes from the current study are of considerable magnitude. Indeed, the effect sizes for the associations between insecure/other attachment on average reading and math skill development were calculated as .19 and .35, respectively, suggesting that insecure/other children were scoring about .2–.35 standard deviations below secure children in cognitive skill tests in fifth grade. This difference represents about a half a year of learning in reading and three quarters of a year of learning in math (Hill, Bloom, Black, & Lipsey, 2007). Overall, children with insecure/other attachments appear to be at the highest risk for poor cognitive development in both the reading and math domains (Moss and St-Laurent, 2001). The mediation analysis findings, discussed below, further elucidate the challenges facing the cognitive skill development of children with insecure/other attachments.

Ambivalent children, on average, scored about .14 standard deviations below secure children on math skill development at the end of childhood (i.e., about a third of a year of learning). Ambivalent attachment, however, was not associated with lower reading achievement in middle childhood. During the transition to formal schooling, ambivalent children's tendency to be dependent and clingy with caregivers (i.e., parents and teachers) may not negatively affect their reading skill development as they are still likely to engage in shared reading activities with peers and teachers. However, the development of math skills may require a more complex set of initial numeric processing skills (Simmons, Willis, & Adams, 2012). Children typically must develop these skills in conjunction with help from caregivers, but also independently (Morrison, Ponitz, & McClelland, 2010). More so than with reading, children need to develop self-regulated learning strategies to process the knowledge necessary for math development (McClelland and Cameron, 2012). Thus, ambivalent children may be reluctant to work independently through challenging and complex mathematical tasks necessary for development of math skills in middle childhood.

5.2. *Children's* exploration and engagement as mediating mechanisms

In line with O'Connor and McCartney (2007) we found that associations between insecure/other attachment and reading and math skills were mediated through lower levels of task engagement. Task engagement also partially mediated associations between ambivalent attachment and math skills. There are a number of lessons from this examination. With respect to task engagement, continually activated attachment systems may pose a special risk as children's exploratory systems, which encourage interactions with people and objects in the environment, are inactivated when their attachment systems are activated. Additionally, a continually activated attachment system leads to anxiety, which may interfere with children's abilities to perform tasks in a testing situation. Difficulties attending to tasks within a learning environment pose challenges for developing critical reading and math skills in middle childhood for those students with insecure/other and ambivalent attachments. Results suggest the importance of supporting engagement within the classroom for those children who may be at risk for lower cognitive development as a result of their attachment style.

Although the findings for task engagement were quite robust, we did not find evidence that classroom engagement mediated associations between attachment style and cognitive skills. This finding differs from other studies also using the NICHD SECCYD. Yet, it may be that classroom engagement *does* mediate effects of attachment, but only during the beginning of elementary school

(O'Connor & McCartney, 2007; West et al., 2013). Indeed, O'Connor & McCartney only considered first grade, and West et al. (2013) examine outcomes through third and fourth grade. As children move through elementary school and develop the competencies necessary for adjusting to the school environment, they may be better able to develop the ability to form relationships with teachers and peers and engage in the classroom setting, in turn supporting cognitive development, even without having a secure attachment base. Even so, given that classroom engagement inherently occurs outside of the supervision of the mother, it may manifest itself differently with respect to attachment styles than task engagement observed during a mother–child interaction.

5.3. Limitations and directions for future research

There are a number of limitations to the interpretation of findings. First, results cannot be interpreted causally and all effects identified between early mother–child attachment and later skill development must be framed as associations. Even given the robust set of controls used in this study, there are still a host of time-varying and time-invariant unobservable characteristics that we may not have taken into account. Similarly, although we did not find significant time x attachment style interactions in this study, future work with more time points may be better suited for such an examination. Future research should also consider how to test for causal effects between attachment and math and reading skills and how to test the causal pathways we explored. Second, we were limited by measurement given that we wanted to consider repeated measures across a fairly broad developmental time frame (54 months to fifth grade). For example, we used the Woodcock Johnson Letter Word ID and Applied Problems assessments to measure reading and math skills. More comprehensive measures of such cognitive skills should be considered in future work. Relatedly, we only assessed attachment styles at one point in time. Future research that considers multiple assessments of attachment styles over time may be better able to assess effects of cognitive skills across middle childhood. Third, given the literature base available, we only considered children's exploration and engagement as mediators in this study. In line with work by Van IJzendoorn et al. (1995), it may be important to consider maternal assistance, children's social relationships, and children's executive functioning as mediators in future work. Next, the group of children comprising the insecure/other group is small ($N = 71$). Future research should explicitly aim to collect information on a larger sample size of insecure/other children in order to replicate these findings with a more sizeable group.

It is also necessary to examine the direction of effects between attachment and cognitive skills. It is possible that children with lower level cognitive skills have more difficulty engendering sensitive and responsive caregiving from their mothers and are thus more likely to develop ambivalent and insecure/other attachments. Directionality may be less of a concern in the study, however, as we did consider an early measure of children's cognitive skills. The final limitation is that the current sample is a product of the recruitment and enrollment methods of the NICHD SECCYD. Specifically, children with disabilities, children who lived in dangerous areas, and children whose mothers did not speak English were excluded. The current sample may contain relatively few high-risk children, thus reducing the magnitude of association between insecure/other attachment and cognitive skills.

6. Conclusions

The current study utilizes a range of methods to consider the role of early attachment patterns on math and reading skill development in middle childhood and the key mechanisms explaining

those associations. The study addresses critical limitations in the extant literature related to quantitative methodology, operationalization of cognitive outcomes, and consideration of the full developmental period of middle childhood. Indeed, findings demonstrate the value of examining the effects of specific insecure attachment patterns on children's cognitive outcomes and the hypothesized mechanisms explaining those relationships, de-aggregated by skill type. This study has implications for interventions with children and for teacher education. Intervention efforts for both ambivalent and insecure/other children would be well served by helping these children become better able to attend to tasks and sustain attention across the critical elementary school period. Early schooling contexts may be one particular setting where such interventions can be implemented. In reference to teacher education, these results point to the value of helping children develop the task engagement skills that may not be supported through attachment patterns, in order to facilitate more adaptive cognitive development. Informing teachers as to the influence of mother–child attachment on the development of task engagement – a mediator that teachers can actively support – may increase teachers' awareness of their potential role in helping to ameliorate risks posed to children with insecure/other and ambivalent attachments.

Funding

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