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Abstract

This study aimed to test a four-wave sequential mediation model linking mother–child attachment to children’s school readiness through child executive functioning (EF) and prosociality in toddlerhood and the preschool years. Mother–child attachment security was assessed when children (N = 255) were aged 15 months and 2 years, child EF at age 2, prosocial behavior at age 4, and finally cognitive school readiness in kindergarten (age 6). The results revealed three indirect pathways linking attachment to school readiness: one through EF only, one through prosocial behavior only, and a last pathway involving both EF and prosocial behavior serially. These findings suggest that secure attachment may equip children with both cognitive and social skills that are instrumental to their preparedness for school.

Keywords: school readiness, attachment, serial mediation, executive functioning, prosocial behavior

From early relationships to pre-academic knowledge: A sociocognitive developmental cascade to school readiness

Entering school is recognized as one of the most important developmental transitions of childhood (Pianta & Rimm-Kaufman, 2006). Consequently, there has been mounting interest in the notion of school readiness, which refers to the set of skills acquired during the preschool years that equip children to benefit from schooling (Carlton & Winsler, 1999). While socioemotional competence plays an important role in children's adjustment to school entry (Blair & Raver, 2015), pre-academic knowledge is considered an especially salient component of school readiness because it is a more powerful predictor of subsequent school achievement (Duncan et al., 2007). Pre-academic knowledge refers to the basic knowledge (e.g., recognizing letters, numbers, shapes, etc.) that the early school curriculum assumes that a child possesses at school entry and builds on. As a result, children who lack this initial knowledge base may experience difficulty meeting learning expectations. Indeed, measures of cognitive school readiness, which assess pre-academic knowledge, have been found to predict school grades throughout much of elementary school (Chew & Morris, 1989; Kurdek & Sinclair, 2000). Overall, entering school with the cognitive skills and knowledge components needed to succeed is crucial for children's school trajectories; consequently, high priority should be placed on identifying the factors that foster cognitive school readiness (Lemelin et al., 2007).

Working in this direction, this study examined a five-year developmental cascade leading up to school readiness. Research has often proceeded in silos with, on one hand, studies investigating the cognitive skills subsuming child academic performance, and on the other hand, research focusing on early relationships and their implications for social adjustment. Yet, there is increasing consensus that relationships and cognition are inextricably intertwined spheres of

child functioning. There is evidence that the quality of parent–child interactions is predictive of child cognitive functioning (Valcan, Davis, & Pino-Pasternak, 2017) and brain development (Bernier, Calkins, & Bell, 2016). Conversely, adequate cognitive skills and neural integrity are essential for optimal social functioning in children (Beauchamp & Anderson, 2010). As cascading effects from one domain of adaptation to another are expected to produce longitudinal linkages among various forms of competence (Masten et al., 2005), one may expect school readiness to result from cyclical influences between social and cognitive factors throughout early childhood. Accordingly, this study sought to investigate a developmental pathway unfolding in the preschool years, which begins with parent–child attachment, continues with child executive functioning and then with prosocial behavior, and culminates in cognitive school readiness.

Executive Functioning and School Readiness

One set of skills that has received a great deal of attention in the search for the contributors to school readiness is executive functioning (EF), a set of higher order cognitive processes that allow for conscious, goal-directed control of thought, emotion and behavior (Zelazo & Carlson, 2012). Foundational executive functions in young children include inhibition, set shifting, and working memory (Diamond, 2013). These functions are presumed to be critical for school readiness, both directly and indirectly. First, they are expected to provide the self-regulatory skills necessary for learning, such as sitting still in class, persisting during challenging tasks, or resisting distraction (Blair & Raver, 2015). Second, EF is also expected to promote learning directly, by facilitating children’s capacity for information processing and updating, problem solving, and complex reasoning (Blair & Diamond, 2008).

Much of the research supporting these claims is cross-sectional; though, there is also increasing evidence from longitudinal studies showing that higher preschool EF predicts better

subsequent academic skills (Blair & Razza, 2007; De Franchis, Usai, Viterbori, & Traverso, 2017) and cognitive school readiness (Willoughby et al., 2017). However, previous studies have assessed EF starting at the ages of 4 or 5 (see Willoughby et al., 2017 for one exception, age 3), despite evidence that EF emerges much earlier and can be measured reliably as early as 2 years of age (Carlson, 2005). Accordingly, this study investigated the role of age-2 EF in the prediction of individual differences in school readiness assessed four years later in kindergarten.

Social Mediation

The predictive relations between early EF and school readiness, if significant, would nonetheless provide only a partial picture of the developmental pathway leading to school readiness. Notably, an exclusive focus on EF overlooks social mechanisms, an important oversight considering that EF is important not only for academic skills, but also for social competence. Indeed, the self-regulation skills that represent the core of EF are often argued to be essential tools to form and maintain positive social relationships (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Blair & Raver, 2015). A key aspect of social competence is prosocial behavior, consisting of selfless actions intended to help others, such as cooperating, comforting, and sharing that emerge in the preschool years (Denham et al., 2003). As highlighted by Masten et al. (2012), the thoughtful and empathic behaviors that are central to prosociality require the ability to take the perspective of another individual (theory of mind), which shows strong connections to EF in young children (Devine & Hughes, 2014). Prosociality also sometimes requires children to inhibit a dominant response (e.g., eating all their snacks) in favor of a less salient yet prosocial one, such as sharing their snacks or toys with a peer. Consistent with this, there is mounting evidence suggesting that preschool EF relates to indicators of social competence both concurrently (Di Norcia, Pecora, Bombi, Baumgartner, & Laghi, 2015) and

prospectively (Razza & Blair, 2009), with some evidence of longitudinal relations to prosocial behavior specifically (Masten et al., 2012).

Associations between EF and prosocial behavior are likely to provide another pathway by which EF can promote school readiness, in that prosocial behavior has been identified as an important predictor of academic achievement (Caprara, Barbaranelli, Pastorelli, Bandura, & Zimbardo, 2000; Gerbino et al., 2017). Different reasons could explain why prosocial children do better in school: greater acceptance from peers that contributes to children's inclusion in group-based learning experiences, greater reciprocal support from peers for solving problems, or teachers' preferences for prosocial children producing higher-quality individualized instruction (Palermo, Hanish, Martin, Fabes, & Reiser, 2007; Wentzel, 1993). Although this literature is still meager, there is evidence that indeed, child prosocial behavior relates to concurrent school readiness and achievement in the preschool and kindergarten years (Curby, Brown, Bassett, & Denham, 2015; Ladd, Birch, & Buhs, 1999; Palermo et al., 2007 – see also Vitiello & Williford, 2016 for longitudinal, albeit indirect, predictive links). This raises the possibility that prosocial behavior might account for part of the association between EF and school readiness. In a rare study considering these three constructs jointly, Baptista, Osório, Martins, Verissimo, and Martins (2016) observed that a composite of child social adjustment including prosocial behavior mediated the relation between EF and cognitive school readiness in preschool, based on concurrent assessments of these constructs.

In sum, studies suggest that EF may have direct effects on school readiness, and indirect effects through child prosociality. Important knowledge gaps remain, however. Research has yet to address whether the earliest manifestations of EF in toddlerhood are predictive of school readiness, and if so, through which mechanisms these effects occur. Also, the literature on child

prosociality and academic readiness in the preschool years is scant and based almost exclusively on concurrent data – this considerably constrains our understanding of the developmental processes linking EF, prosocial behavior, and school readiness. Prospective longitudinal designs entailing early assessment of EF are needed to address these gaps.

Stepping Back Earlier in Development: Parent-Child Attachment as an Antecedent to EF

A developmental sequence involving EF and prosocial behavior in the prediction of school readiness, albeit theoretically and empirically sensible, is probably incomplete, as EF is unlikely to represent the true beginning of any developmental process. Indeed, it is now clear that child EF is under biological and social influences, including the emotional quality of parent–child interactions (Valcan et al., 2017). In this study, we focused specifically on mother–child attachment security due to both theoretical and empirical reasons. It has been proposed that a secure attachment relationship provides a safe relational context in which children can learn to master the self-regulated thought and action that define EF (Kochanska & Aksan, 1995), for instance through joint problem solving (Perez & Gauvain, 2010). Through repeated experiences of successful task mastery guided by a competent caregiver who acts as a secure base, securely attached children are thought to gradually integrate the learned skills in their own repertoire of independent self-regulation skills (Calkins, 2004). In line with this, we previously found, on a preliminary subsample included in the current larger sample, that mother–child attachment explained the variance in child EF otherwise accounted for by specific aspects of maternal behavior (blinded for review). Attachment also shows robust links to child social competence including prosociality (Pallini, Baiocco, Schneider, Madigan, & Atkinson, 2014), and there is some evidence to suggest that secure attachment might (when combined with continuing maternal sensitivity) forecast school readiness as well (Belsky & Fearon, 2002a – but see Belsky

& Fearon, 2002b). Hence, mother–child attachment security appears to be a candidate of choice to constitute the beginning of the developmental chain examined here, in that it has been found predictive of child EF, prosocial behavior, and to an extent, school readiness.

The Current Study

Findings from mostly separate literatures suggest the presence of bivariate associations among mother–child attachment security, child EF, prosocial behavior, and cognitive school readiness. Moreover, the literature tends to suggest that attachment precedes EF, which precedes prosocial behavior, which itself may precede cognitive school readiness – although this latter link has mainly been examined in cross-sectional studies. Yet, it is unknown whether early EF, assessed in toddlerhood, predicts school readiness, and if so, whether this link a) originates in mother–child attachment, and b) operates partly through child prosocial behavior. The current study aimed to test a serial mediation model (Figure 1) by which mother–child attachment security in toddlerhood predicts child EF (age 2), which in turn predicts prosocial behavior (age 4), which finally predicts cognitive school readiness in kindergarten (age 6). In addition to the longitudinal design that is useful in suggesting directionality, we used a multimethod assessment approach to diminish shared method variance and hence the risk of finding inflated associations. Attachment was rated by observers, EF was assessed with experimental tasks, child prosocial behavior was reported by the teacher, and school readiness was assessed with a test battery.

Given the well-established bivariate links between most model variables, we expected an overall significant serial mediation, such that mother–child attachment security would predict school readiness in kindergarten, significantly mediated by child EF and subsequently through prosocial behavior (path abc, Figure 1). Based on the large bodies of literature supporting these associations, we also expected that attachment would be linked directly to prosocial behavior

(path d), and EF to school readiness (path e). Consequently, we also examined whether any other indirect effects operated outside of the hypothesized overall mediated pathway.

Method

Participants

Participating families were recruited from birth lists of (blinded for review), randomly generated and provided by the Ministry of Health and Social Services. Families were eligible to participate if their child was born after a full-term pregnancy and was free of any physical, developmental, or cognitive disability known to the parents. These families were part of an ongoing longitudinal study. In this report, we focus on four assessments conducted when children were aged approximately 15 months (T1; $M = 15.51$ months, $SD = 0.76$), 2 years (T2; $M = 25.40$ months, $SD = 1.15$), 4 years (T3; $M = 48.83$ months, $SD = 0.82$), and 6 years (T4; $M = 72.48$ months, $SD = 2.55$). The initial sample (T1) consisted of 255 children (128 girls, 127 boys) and their mothers. Of those, 222 had T2 data, 200 had T3 data, and 192 had T4 data (corresponding to approximately 5.2% of attrition per year). Little's test revealed that data were missing completely at random, $X^2 = 108.59$, $p = .22$. Nonetheless, because Little's test has low power (Enders, 2010), we also examined whether complete and incomplete cases differed on any available data. Families lost to attrition had lower socioeconomic status scores (standardized average of maternal education, paternal education, and family income) than those with complete data, $t(241) = 2.47$, $p = .021$. No other significant differences were found between these two groups on initial attachment scores or sociodemographic characteristics (maternal and paternal age, child sex, number of siblings). Families with missing data were included in analyses by imputing the missing values while taking into account the SES bias, as described below.

Mothers were aged between 20 and 45 years ($M = 31.5$) at the onset of the study, and had 8 to 23 years of education ($M = 15.7$). Fathers were between 21 and 52 years old ($M = 33.7$) and their education ranged from 6 to 21 years ($M = 15.4$). The majority of parents (88.5%) were of European descent. Family income was in the \$60,000 to \$79,000 bracket on average, varying from below \$20,000 to above \$100,000.

Procedure

The T1 and T2 visits took place in the families' homes and lasted between 70 and 90 minutes. These home visits were mostly aimed at assessing mother–child attachment security, and thus were modeled after the work of Pederson and Moran (1995). The visits (described in more detail in [blinded for review]) aimed at reproducing the multitasking challenge that is characteristic of parenting a toddler, and were thus intended to place mothers in a context where their attention had to be divided between child demands and research tasks (e.g., answering interview questions, completing questionnaires). Extensively trained research assistants (see [blinded for review]) observed mother–child interactions throughout these two visits and subsequently rated the Attachment Behavior Q-Sort (described below). At T2, the battery of EF tasks described below was also administered.

When children were aged 4 years (T3), their preschool teacher was asked to report on their prosocial behavior. All children were in different preschools, and thus no teacher evaluated more than one child. Teachers were invited to complete the questionnaire and to mail it back to our team in a prepaid envelope. Finally, in the spring of children's kindergarten year (T4), their cognitive school readiness was assessed by an experimenter during a home visit. Whereas the T1 to T3 visits were scheduled around the child's birthday to maintain a restricted age range for the toddlerhood and preschool visits, the kindergarten visit was planned around the school calendar

so that children would have comparable exposure to kindergarten when their school readiness was assessed. Nevertheless, we tested if length of schooling (i.e., time elapsed in weeks since the start of the academic year) was related to cognitive readiness scores. School readiness was not associated with length of schooling, $r = .09$, $p = .182$, which consequently was not covaried in further analyses.

Average delay between consecutive time points was 9.9 months between T1 and T2 ($SD = 1.15$), 23.5 months between T2 and T3 ($SD = 1.24$), and 23.5 months between T3 and T4 ($SD = 2.68$).

Measures

Mother–child attachment security. Child attachment to mother was assessed at both 15 months and 2 years with the Attachment Behavior Q-Sort (AQS; Waters, 1995), which was rated by trained observers immediately following the home visits, based on observations performed over the course of the visits. The AQS is comprised of 90 items describing potential child behaviors. An observer sorts the 90 items into nine piles based on the degree to which each item reflects the behavior of the child under observation. Each cluster of items then receives a score ranging from 1 (*very unlike the child*) to 9 (*most similar to the child*). Finally, this observed sort is correlated with the security criterion sort (Waters, 1995), which depicts the prototypically securely attached child. Attachment scores thus vary from $-1 = \textit{most insecure}$ to $1 = \textit{most secure}$.

Interrater agreement was satisfactory at T1 (ICC [intraclass correlation] = .71; 21.9% of children independently double coded by two home visitors) and T2 (ICC = .70; 19.3% of independent double coding). Considering its excellent construct validity, the observer version of the AQS is considered one of the gold-standard measures of attachment security (Van IJzendoorn, Vereijken, Bakermans-Kranenburg, & Riksen-Walraven, 2004). This measure also

shows moderate stability (meta-analytic $r = .28$; Van IJzendoorn et al., 2004). Consistent with this, the correlation between child attachment at 15 months and 2 years in this study was $r = .22$, $p = .003$. Consequently, with the aim of reducing measurement and situational error, these two scores were averaged into a composite score of child attachment, used in all subsequent analyses. In cases where the attachment score was missing at 2 years, the 15-month score was used.

Child executive functioning. The EF tasks were chosen based on Carlson's (2005) measurement guidelines in order to maximize detection of interindividual variation in three dimensions of EF recognized as critical in preschool years: inhibition, set shifting, and working memory (Diamond, 2013).

Spin the Pots (Hughes & Ensor, 2005). Children were asked to search for six stickers that were placed in front of them in eight opaque pots of different visual appearances. Each time the child found one of the stickers, the pots were covered and rotated in front of the child before he or she was asked to search for the next sticker. The score, representing working memory, was computed as 16 minus the number of errors made (i.e., looking in a pot in which there was no sticker).

Delay of Gratification (Kochanska, Murray, & Harlan, 2000). The experimenter placed a treat under a transparent cup and asked the child to wait until she rang a bell before taking it. Four trials were used, where the child had to wait for increasingly longer periods (5, 10, 15 and 20 seconds). The time waited on each trial was summed into a total behavioral inhibition score.

Shape Stroop (Kochanska et al., 2000). Children were first shown six separate cards portraying three small fruits and three large fruits, and were asked to point to each in turn (e.g., "Show me the big apple") to ensure they knew the names and sizes of the fruits. The experimenter then placed three cards in front of the child. Each card depicted one of the small

fruits embedded in one of the noncorresponding larger ones. The child was asked to point to each of the small fruits in turn (e.g., “Show me the *small* banana”). The score, tapping into cognitive inhibition and set shifting, was computed as the number of small fruits correctly pointed to (0 – 3).

Baby Stroop (adapted from Hughes & Ensor, 2005). Children were first taught a rule according to which a “mommy” doll had to be fed with a larger spoon whereas a “baby” doll was fed with a smaller spoon. As soon as the child understood the rule, it was inverted such that the smaller doll had to be fed with the larger spoon, and vice-versa. Scores thus ranged from 0 to 2, representing cognitive inhibition and set shifting.

Studies suggest that whereas EF becomes fractionated with age, individual differences in EF during toddlerhood and the preschool years are best represented by a single unitary factor (Hughes, Ensor, Wilson, & Graham, 2010; Wiebe et al., 2011; Willoughby, Blair, Wirth, Greenberg, & Family Life Project Investigators, 2010 – see Lee, Bull, & Ho, 2013, for review). Accordingly, we standardized and averaged child performance on the four above tasks (r s from .17 to .41) to derive a global EF score ($\alpha = .71$).

Child prosocial behavior. The Socio-Affective Profile (LaFrenière, Dumas, Capuano, & Dubeau, 1992) assesses children's skills and difficulties in interaction with peers or adults. In this study, the 10-item social competence subscale, which mainly refers to child prosocial behavior (e.g., *comforts or assists another child in difficulty*), was completed by preschool teachers ($\alpha = .84$). Teachers rated the items on a 6-point Likert scale varying from 1 (*almost never occurs*) to 6 (*almost always occurs*). This subscale shows satisfactory convergent validity, predictive validity, and temporal stability (Tremblay, Vitaro, Gagnon, Piché, & Royer, 1992).

School readiness. When children were in kindergarten, their cognitive school readiness was assessed using the Lollipop test (Chew & Morris, 1984). The Lollipop taps into the cognitive skills and knowledge components that make up cognitive school readiness. It consists of four subscales: colors and shapes, letters, spatial notions, and numbers. Scores on these scales are summed to yield the total readiness score (maximum = 71; $\alpha = .73$). The Lollipop shows excellent convergent validity with the Metropolitan Readiness Tests (Chew & Morris, 1984) and is predictive of academic achievement over and above general cognitive ability (Lemelin et al., 2007) and up to 4th grade (Chew & Morris, 1989).

Analytic Plan

We first used the multiple imputation procedure in SPSS 24 to estimate the missing data. We included a wide set of auxiliary variables in the imputation model (including family SES as per the analysis above) to make the missing-at-random assumption tenable and maximize the precision of imputed data (Enders, 2010). All analyses were conducted on each of the 10 imputed data sets, and results subsequently pooled following Rubin's (1987) rules of combination.

Next, data were screened and Pearson's correlations were used to estimate bivariate associations among main study constructs. Then, the theoretical mediation model presented in Figure 1 was tested by computing direct and indirect effects with Hayes' (2013) bootstrapping procedure. This procedure generates bias-corrected confidence intervals (CIs) for all indirect effects, taking into account their non-normal distribution. An indirect (i.e., mediated) effect is corroborated as significant when the 0 value is not contained within the bias-corrected bootstrapped (BCB) CI. We used the PROCESS macro in SPSS 24 (10,000 bootstraps with 95% CI) to conduct these analyses. PROCESS allows for testing serial multiple mediator models (or

sequential mediation models). This method was used to test the theoretical mediation model depicted in Figure 1, while controlling for family SES and child sex by modeling these two covariates to both mediators and to the outcome. Given that PROCESS does not provide standardized coefficients, all scores were first converted to Z scores, so that the estimates of effects would be interpretable as though standardized. Note that we use causal terminology such as “effects” in order to respect conventions, but that this study cannot demonstrate causal processes.

Results

Preliminary Analyses

Table 1 displays the descriptive statistics for the core study variables. All distributions were within the bounds of moderate normality (skewness < 3.0; kurtosis < 7.0; Curran, West, & Finch, 1996). Scores were next screened for outlying values. No multivariate outlier was identified. However, one univariate outlier was found on attachment, one on EF, and two on school readiness (these were four different individual children). Systematically, these scores were at the lower end of the distribution; accordingly, following Tabachnick and Fidell’s (2013) recommendations for winsorizing, they were substituted with the highest observed value that fell within -3.29 standard deviations of the mean.

Table 2 displays the bivariate correlations between key study variables. Early mother–child attachment was unrelated to school readiness, $r = .09$, $p = .194$. While this lack of a direct association does not preclude mediation (Hayes, 2013), it does indicate that only indirect effects of attachment on school readiness can be uncovered. Otherwise, the predictor, mediators and outcome were interrelated (ps varying from < .001 to = .034), providing a sound basis on which to test the hypothesized serial mediation. Given that child EF was assessed at the same time point

(T2) as the second attachment assessment, we considered using only T1 attachment as the initial predictor in the model. However, as is usually the case with composite scores given their psychometric superiority, the composite attachment score was more strongly related to other model components than its T1 or T2 constituents considered alone (except, as expected, for T2 attachment and concurrent EF). Accordingly, the composite attachment score was used in all further analyses.

Main Analyses

Figure 2 depicts the results of the sequential mediation model. Above and beyond the effects of family SES and child sex, early mother–child attachment security predicted child EF (path $a = .24, p < .001$), which in turn predicted prosocial behavior (path $b = .15, p = .009$), which predicted school readiness (path $c = .14, p = .031$). These coefficients represent unique links, above and beyond all other paths. The overall indirect effect linking attachment to child school readiness via EF and prosocial behavior in sequence, after adjusting for the two covariates, was significant (path $abc = .005$, BCB CI = .001 – .013).

As mentioned above, we were also interested in examining whether attachment was linked directly to prosocial behavior, and EF directly to school readiness. The results (also displayed in Figure 2) indicated that this was the case: over and above the effects already mentioned, attachment had a direct effect on prosocial behavior (path $d = .37, p < .001$), and EF had a direct effect on school readiness (path $e = .23, p < .001$).

In addition to the full mediation process described above, analyses revealed that the other possible indirect effects linking attachment to school readiness were also significant. The indirect effect of attachment on school readiness through age-2 EF only was significant (path $ae = .06$, BCB CI = .020 – .119), as was its indirect effect transiting only through age-4 prosocial behavior

(path $dc = .05$, BCB CI = $.007 - .092$). Together, the three indirect effects yielded a total indirect effect of attachment on school readiness of $.112$ (BCB CI = $.052 - .180$), and the overall model explained 12.6% of the variance in school readiness.

Discussion

It is frequently suggested that research investigating the factors that contribute to a successful transition to school ought to follow child-by-environment models and consider both child and social-environmental influences (Palermo et al., 2007). Yet, research generally considers either child factors, such as EF, or social factors, such as peer or parent-child relationships, and rarely bridges these two sets of influences (Baptista et al., 2016). Likewise, there is mounting interest in the early social factors that promote child EF on one hand, and in EF's contribution to school achievement on the other hand. Yet, very few studies bring these constructs together in a developmentally informative manner, for instance by investigating whether EF provides a bridge linking early relationships to later school performance. Addressing these gaps, the purpose of this study was to test a sequential mediation model consistent with a developmental process by which early mother-child attachment security would promote children's cognitive school readiness in kindergarten through its intermediate impact on child EF in toddlerhood and then on prosocial behavior in preschool.

The results revealed that although there was no significant direct effect of attachment on school readiness, three indirect pathways significantly linked the two: one sequential pathway transiting first through EF and then through prosocial behavior in serial, as well as two single-mediator pathways, one via EF only and one via prosocial behavior only. It is noteworthy that these three pathways were net of each other, and thus provided three empirically independent developmental mechanisms linking attachment to school readiness. Hence, children who were

securely attached to their mother in toddlerhood are likely to enter school with better cognitive and behavioral dispositions for learning (EF), which facilitates their school readiness directly. In addition, these children are likely to show better capacity to cooperate with others, due both to the quality of their early attachment relationships and their higher EF. These social qualities, in turn, can promote their capacity to learn in a social context and as a result, these children arrive in school with greater pre-academic knowledge (Palermo et al., 2007). Hence, early attachment security may equip children with sets of both cognitive and social skills that are instrumental to their cognitive preparedness for school learning. Yet, the non-significant initial direct link observed between attachment and school readiness suggests that other indirect pathways probably play a different role, counterbalancing the positive effects of the pathways analyzed here and producing a non-significant association between attachment and school readiness, as observed by Belsky and Fearon (2002b).

While most bivariate links between model components are already established as explained in the introduction, few studies have brought them together, and studies that have done so have involved only three steps (predictor – mediator – outcome), often in cross-sectional designs. We would argue that developmental models involving not only both relational and cognitive mediators, but also the interplay between these factors, provide a more accurate reflection of the complex nature of early development than models focusing either on social or cognitive influences alone. Yet, modelling complexity is challenging, and the model presented here is no doubt incomplete, as suggested notably by the reliable yet modest direct and indirect links uncovered and somewhat low amount of variance in school readiness explained by the model. While part of these modest predictions can be attributed to the rigorous design (five-year

time span, multimodal assessments), the results also indicate that other developmental cascades may be as, or more important, to school readiness than the one tested here.

There are countless other ways in which social and child factors (cognitive or other) could operate jointly to link early parent–child relationships to school readiness. For instance, we previously reported on a developmental cascade linking early maternal mind-mindedness to child school readiness through child language and effortful control (blinded for review). Certainly, other aspects of both mother–child and father–child early relationships (e.g., mutuality, parental sensitivity, cognitive stimulation) could play equally important roles, and other developmental cascades may begin with other family factors (e.g., family alliance, quality of the marital relationship) or child factors (e.g., temperament). In addition, there is increasing evidence that different aspects of child functioning influence each other in dynamic, transactional ways. Thus, bidirectional links involving reciprocal influences are likely operative, as are interactive effects by which relational contexts magnify or dampen the effects of child factors – or are more influential for some children than others. Overall, the developmental processes suggested by this study’s results, while novel and developmentally rich, are undoubtedly partial. The identified processes provide a preliminary account of the ways in which early relational factors may set in motion different developmental cascades involving cognitive and social skills, which culminate in young children’s cognitive preparedness for school learning.

One potentially important additional intervening factor is child brain development. Indeed, there are robust links between child EF and the structure and function of frontal brain areas (Moriguchi & Hiraki, 2013) that are also linked to quality of early mother–infant interactions (Bernier et al., 2016). In addition, there is emerging evidence that aspects of parental behavior with close connections to attachment, such as maternal sensitivity, are linked to child

subsequent prosocial behavior through the intervening effect of child brain morphology (Kok et al., 2017). Other studies have shown that mother–child attachment security predicts the volumetric development of brain regions of high relevance to social and emotional functioning such as the amygdala (Moutsiana et al., 2015) and superior temporal sulcus (Leblanc, Dégeilh, Daneault, Beauchamp, & Bernier, 2017). Thus, given its links to both earlier parent–child relationships and child subsequent EF and social adaptation, child brain development is likely involved in the chain linking attachment to school readiness via EF and prosocial behavior.

The estimates yielded by the model, albeit modest, are arguably robust, in that there was little shared method variance between the measures, with attachment rated by observers in the home, EF assessed behaviorally, prosocial behavior reported by teachers as observed daily at preschool, and school readiness assessed with a well-validated battery. Thus, while the causal nature of the observed links remains to be demonstrated, it appears very improbable that the mediated processes identified here were inflated by the methodology. All estimates also constitute unique links, net of all other paths in the model; accordingly, their size can be considered conservative. The longitudinal design is also helpful in suggesting the directionality of the underlying developmental process. Yet, the nonexperimental nature of the design and the lack of assessment of the mediators and outcome at earlier time points preclude strong claims to be made about directionality or causality. Future studies combining experimental manipulation and longitudinal assessments are needed to test the causal nature of the longitudinal links observed here. Other study limitations include the low-risk community sample that precludes generalization to risk populations known to present deficits in school readiness (Fitzpatrick, McKinnon, Blair, & Willoughby, 2014).

Overall, the current findings raise the possibility that an inherently relational factor, namely mother–child attachment, initiates developmental cascades of different natures that unfold throughout the preschool years and culminate in higher cognitive competence, specifically greater cognitive school readiness. The results revealed a cognitive cascade involving early executive skills, a relational cascade implicating child prosociality with peers at preschool, and a mixed, sociocognitive cascade comprising an intermediate effect of EF on prosocial behavior. These three processes made unique, distinct contributions to school readiness. These findings are congruent with contemporary views on child developmental competence, according to which adaptation takes the form of dynamic relations among multiple spheres of child competence, producing direct and indirect influences across domains of adaptive functioning (Masten et al., 2005). The results observed here are also consistent with intervention programs (e.g., Early Head Start) based on the notion that promoting the quality of early relationships provides a foundation for learning and school success (Bierman et al., 2008). Given evidence that attachment security, child EF and social competence all can be improved with evidence-based intervention (Bierman et al., 2008; Flook et al., 2015; Steele & Steele, 2018), this study’s findings suggest that there are several ways in which one could trigger adaptive developmental cascades with long-term benefits for children’s academic, social, and behavioral competence.

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Table 1

Descriptive Statistics for Key Study Variables

Variable	Mean	Standard deviation	Observed range
Attachment security	0.41	0.25	-0.46 – 0.79
Executive functioning	-0.02	0.58	-1.95 – 1.08
Spin the Pots	9.99	3.62	3 – 16
Delay of Gratification	39.00	13.47	5 – 50
Shape Stroop	1.48	1.11	0 – 3
Baby Stroop	0.47	0.74	0 – 2
Prosocial behavior	4.27	0.68	2.5 – 5.8
School readiness	62.66	6.04	16 – 69

Table 2

Zero-Order Correlations among Study Variables

	2.	3.	4.
1. Attachment security	.22***	.44***	.09
2. Executive functioning	----	.13*	.20**
3. Prosocial behavior	----	----	.17**
4. School readiness	----	----	----

* $p < .05$. ** $p < .01$. *** $p < .001$.

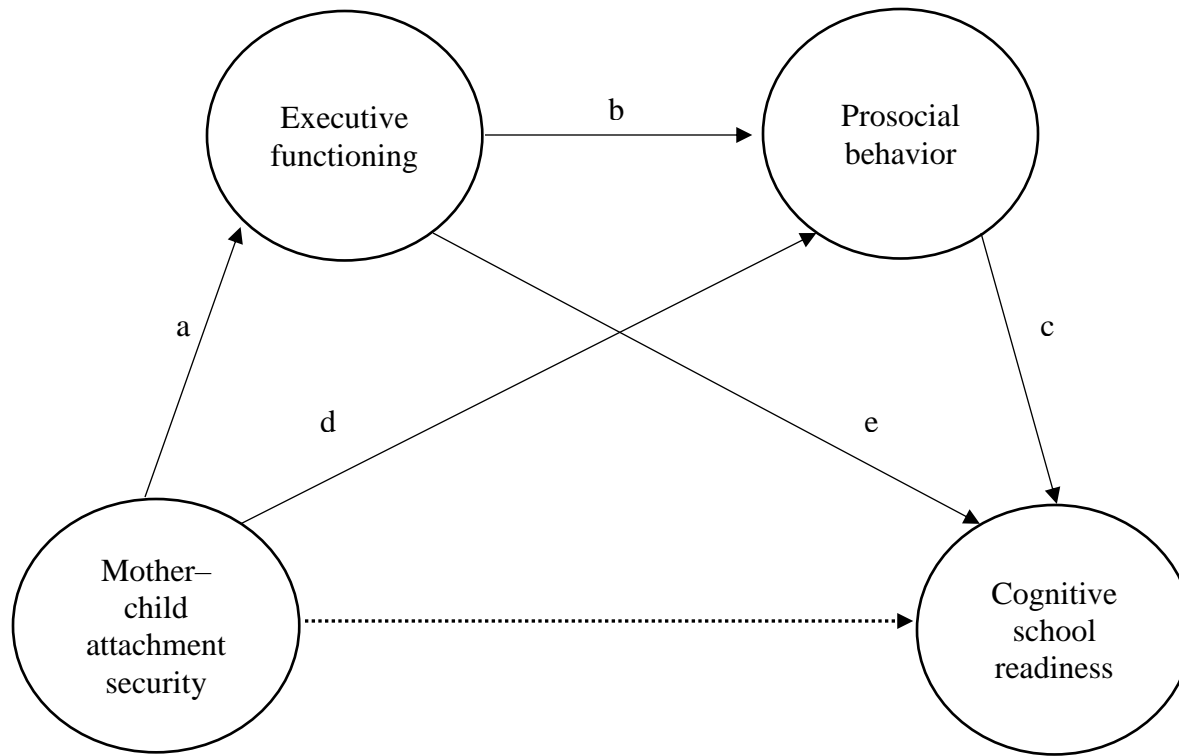


Figure 1. Proposed theoretical model

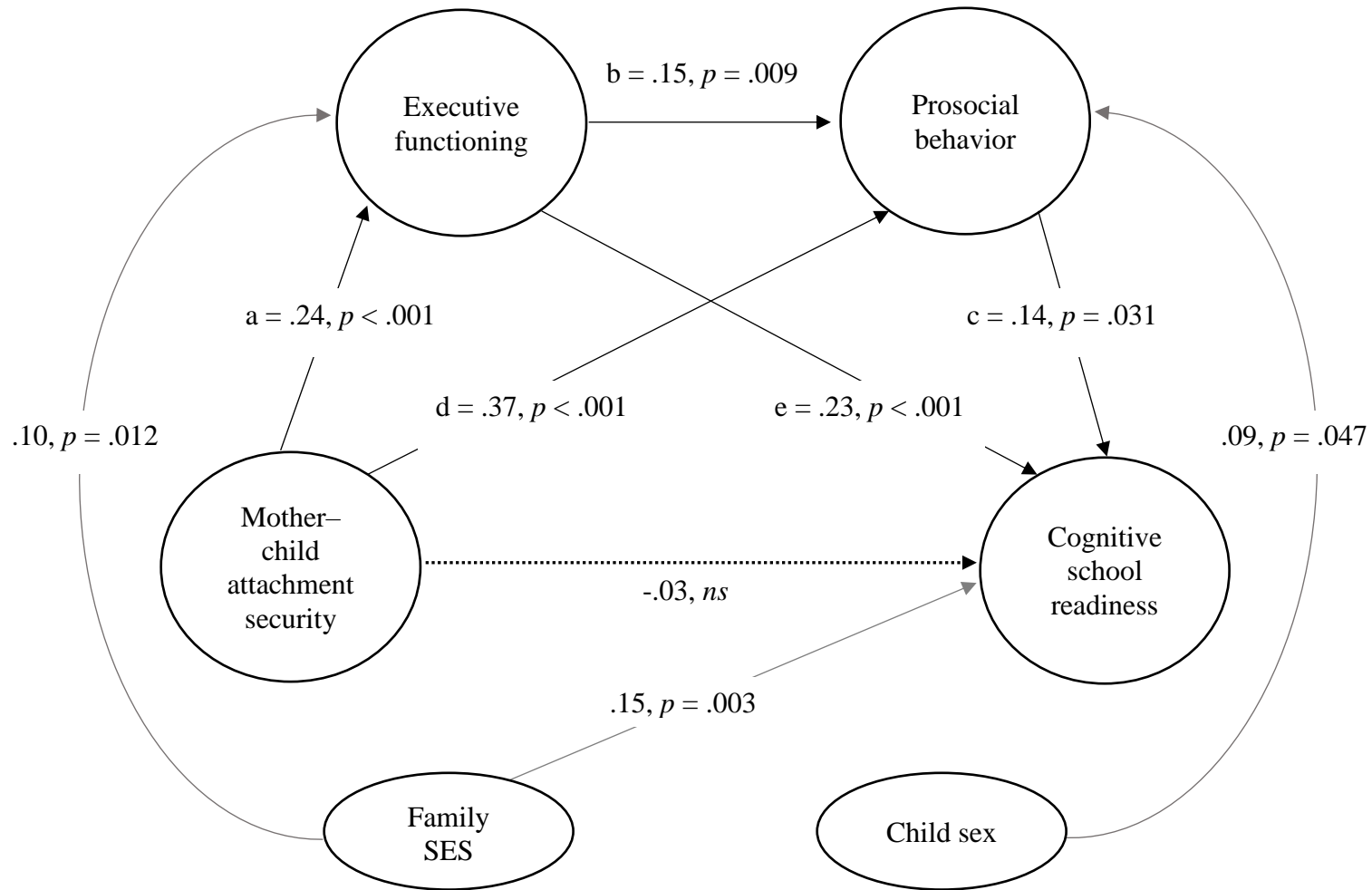


Figure 2. Final model with standardized path estimates. Only significant paths ($p < .05$) are displayed.