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Executive Function in At-Risk Children: Importance of Father-Figure Support and Mother Parenting

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Abstract

Given the dearth of research about father-figures' influence on children's cognitive development, we investigated the impact of father support, together with maternal parenting, on children's executive function (EF) in the lab (42 and 54 mo.) and at school (K – 3rd grade) in a longitudinal, prospective, at-risk sample (N = 182) using path analysis. Both mother parenting and father-figure support significantly predicted child EF. In the final model, concurrent father-figure support was associated with child EF in both early and middle childhood, and mother parenting in early childhood predicted middle childhood EF. Attachment status moderated the path from mother parenting to early childhood lab EF; mother parenting significantly predicted early childhood EF only for securely attached participants. Findings suggest that both mothers and fathers are important for the development of EF in at-risk children, and point to the importance of including fathers in research and interventions.

Keywords

Executive Function; At-Risk Children; Parenting; Father-Figures

Early caregiving experiences are widely recognized as salient for children's cognitive development (Carlson, 2009; De Bellis, 2005; NICHD Early Child Care Research Network, 2000). An important aspect of cognitive development that has gained increasing prominence in recent years is executive function (EF). EF refers to the processes used when controlling one's own behavior to achieve a goal (Carlson, Zelazo, & Faja, 2013). Although research clearly indicates that specific mothering behaviors (e.g., sensitivity, autonomy support, socialization) predict EF development in middle class samples (e.g., Bernier, Carlson, & Whipple, 2010; Kochanska, Murray, & Harlan, 2000; Sethi, Mischel, Aber, Shoda, &

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Rodriguez, 2000), we know much less about these parenting behaviors in at-risk families, where they are also likely to be very important. Furthermore, despite the recognition of the importance of men in children's lives, we know very little about the role of father-figures in the development of children's EF. Also, attachment status has been hypothesized to affect cognitive development by moderating children's ability to learn skills from high quality parenting (De Ruiter & van IJzendoorn, 1993), but this has not been examined thoroughly with EF outcomes.

Given the current state of the field regarding parenting and the development of EF in children, the purpose of the present study is three-fold. First, we seek to clarify the effects of mother parenting on children's EF by examining them in an at-risk sample. Second, we examine whether the support that at-risk children receive from father-figures has an effect on the development of children's EF over and above mother parenting. Third, we consider the role of attachment status as a moderator in the relation between parenting and children's EF development.

Executive Function

Executive function is a group of cognitive processes that includes the higher-level skills of working memory, inhibiting undesired behaviors, and mental flexibility (Miyake et al., 2000). This construct encompasses earlier ideas about self-regulation, such as delay of gratification, impulsivity, and ego control - a psychoanalytic idea reflecting the degree to which a person exercises control over their desires and wishes (Block & Block, 1980). EF skills provide the basis for regulating one's own behavior to make progress toward a goal. EF shows rapid development in the preschool years and continues maturing through adolescence (Carlson, et al., 2013).

EF skills are important across development. Once a child enters school, a major developmental task is to apply their EF skills successfully to the school context (e.g., sitting still, following directions, staying focused on one's own work). Such skills have been identified as key components of school readiness. Teachers have identified EF skills as even more important than basic academic knowledge for children entering kindergarten (McClelland et al., 2007). Low EF is associated with decreased classroom adjustment and ability to learn in elementary grades (Masten et al., 2012). Furthermore, EF continues to be associated with outcomes across the lifespan, such as educational attainment, social skills, mental health, physical health, personal finances, and criminal offenses (Mischel et al., 2011; Moffitt et al., 2011), indicating that developing good EF skills in childhood is a crucial step toward long-term success.

Skills such as EF which have a protracted development may be especially affected by environmental influences, including parenting (Hughes & Ensor, 2009). Researchers have suggested that children develop EF by gradually internalizing self-regulation from their experiences of being externally regulated by soothing and calming efforts of caregivers (e.g., Bernier et al., 2010; Bowlby 1969; Carlson, 2009; Drake, Belsky, & Fearon, 2014; Moss, Gosselin, Parent, Rousseau, & Dumont, 1997). Mothers are a key source of caregiving, and maternal parenting quality is correlated with child EF (e.g., Brophy-Herb, Stansbury,

Bocknek, & Horodyski, 2012; Kochanska et al., 2000). Given that high-quality caregiving is a protective factor in stressful environments (Carlson, 2003), the role of caregiving may be particularly important for low SES children.

Characteristics of Mother Parenting that Promote EF

A body of research has identified various mothering characteristics that may facilitate the internalization of regulation, including sensitivity (warm, responsive caregiving), autonomy support (providing an appropriate level of independence while not controlling tasks or letting the child struggle), and structure/limit setting (setting consistent expectations for children and following through on rules). Sensitivity provides a basis for children to develop expectations of their environment as predictable and reliable. Autonomy support allows children to use their cognitive skills to their highest ability, and practice EF skills such as planning and monitoring their own errors. Structure and limit setting allows children a better opportunity to control their own behavior because they know what is expected from them. These dimensions of sensitivity (Bernier, et al., 2010; Brophy-Herb et al., 2012; Kochanska et al., 2000), autonomy support (Bernier, et al., 2010; Matte-Gagne & Bernier, 2011; Sethi et al., 2000) and socialization of self-regulation (Brophy-Herb et al., 2012; Kochanska et al., 2000) from mothers have all been linked to EF development across the preschool years. However, other caregiving figures are also likely to have an influence on the child; high quality support from father-figures may be especially beneficial for EF development because these relationships provide unique experiences for the child (Lamb, 2004).

Father-Figures and Executive Function

As with most parenting research, research on parenting and EF has tended to focus only on mothers, to the exclusion of male caregivers. Yet we know that including father-figures is necessary to fully understand the context of development, and improves prediction of child outcomes (Cabrera, Tamis-LeMonda, Bradley, Hofferth, & Lamb, 2000; Cowan, 1997, Cox & Paley, 2003; Lamb, 2004). Father-figures in the home may be important resources for children's developing self-regulation skills, and this may be especially important in at-risk families. There is evidence that father-child interactions provide children enriching experiences that are unique from mother-child interactions, and that the high-energy, unpredictable play facilitated by father-figures may be an important context for practicing self-regulation skills (Grossman, Grossmann, Kindler, & Zimmermann, 2008; Lamb, 2004). Children who interact with multiple caregivers, especially caregivers who differ in their parenting styles, may be exposed to a wider diversity of stimulation, requiring them to switch rule sets when interacting with different caregivers, thereby promoting EF (Cabrera et al., 2000). Therefore, it is important for research on the parenting antecedents of EF to include father-figures in addition to looking at mothers.

Although little research has focused on father-figures' influences on EF, high quality father parenting has been found to be related to various aspects of children's cognitive development more generally, including lower likelihood of cognitive delay in infancy (Bronte-Tinkew, Carrano, Horowitz, & Kinukawa, 2008), lower levels of behavior problems in school-aged children (DeKlyen, Biernbaum, Speltz, & Greenberg, 1998), and higher IQ,

math and reading scores, even independently of mother parenting (Amato & Rivera, 1999; Coley, Lewin-Bizan, & Carrano, 2011). The quality of father involvement has been shown to be more important for child outcomes than the amount of time a father spends with his child (Easterbrooks & Goldberg, 1984). Although the importance of father-figures for children's cognitive development has been established, the impact of father-figures on EF development in particular is yet to be thoroughly investigated.

Research on EF development is just beginning to include father-figures. Bernier et al. (2012) found that the quality of a father-child play interaction at 18 months was correlated with the child's conflict EF score at 3 years old. In another study, Roskam and colleagues (2014) obtained self-reports from both mothers and fathers in Belgium on parenting behaviors such as monitoring, discipline, and consistency. They found that mother and father parenting behaviors were both significantly related to 2- to 8-year-old children's inhibition capacities in laboratory tasks, although mother effects were stronger. Furthermore, Meuwissen and Carlson (2015) found that father autonomy support/control was related to concurrent EF skills for preschool children. Most of this work has been done with middle to high income samples. Only one study, to our knowledge, has investigated father contributions to child EF in a high risk sample, and this study found that father sensitivity with their toddlers did predict later preschool EF (Towe-Goodman et al., 2014). There is still much to learn about the role of fathers in varying contexts.

Low SES as a Risk Factor for Low EF

Socioeconomic status (SES) may be an especially important context for the development of EF. Children from low SES backgrounds appear to be at a higher risk for EF deficits (Clark et al., 2013; Hackman, Gallop, Evan, & Farah, 2015; Noble, McCandliss, & Farah, 2007; Rochette & Bernier, 2014). SES disparities in EF are apparent in children as young as 2 years old, and tend to persist through middle childhood. A significant portion of the association between SES and EF can be explained by the home and family environment (Hackman et al., 2015). For example, factors such as low parent education (Matte-Gagne & Bernier, 2011; Rafferty, Griffin, & Lodise, 2011), and having an adolescent mother (Rafferty et al., 2011) are more common in low SES families and have been associated with both lower quality of parenting and child EF deficits.

Indeed, the quality of parent-child relationships may be especially crucial for children in low SES families. In a sample of low-income adolescent mothers, Rafferty, Griffin, and Lodise (2011) found that the quality of mother parenting had a stronger effect on cognitive development than demographic risk factors. Mothers' sensitive caregiving predicts a variety of cognitive and social outcomes, and has been found to function as a buffer between children and stressful environments or social disadvantages (Carlson, 2003; Rochette & Bernier, 2014). In one important study that examined differences in how parenting influences EF in high- and low-SES families, Rochette and Bernier (2014) showed that mother parenting was more predictive of certain EF outcomes for lower-SES children than for higher-SES children, indicating that high quality parenting may be especially important in low-SES populations.

In addition to the importance of mother parenting, the quality of father-figure parenting is also a potentially important resource for low-SES children. The level of involvement by adult males in low-income families varies considerably, and fathers who are under high levels of life stress tend to be less involved with their children (Rosenberg & Wilcox, 2006). The Fragile Families study of low-income families in 20 US cities found that while most fathers were involved with their child's mother at the time of the birth, many faded from their children's lives in the next few years (Carlson & McLanahan, 2002). It is not clear in the literature, however, whether high quality, supportive relationships between children and father-figures in the early childhood years are important antecedents for children's developing EF skills. The few studies conducted on father-figure effects on EF development to date have used middle-class families as participants. One potential difficulty in conducting research on father-figures in low-SES households, however, is the high variability and transitions of males in the homes of some low SES families. Given this challenge, researchers need to include the range of male caregivers that a child interacts with, not only biological fathers. High-quality parenting from both mothers and father-figures in low-SES families early in a child's life may be a crucial factor to support children's EF development and ultimately their long-term success.

Attachment as a Moderator

Parenting encompasses both attachment-relevant and other behaviors, and studies have found that infant attachment security is only moderately correlated with later observed parenting in lab tasks (e.g. Englund, Kuo, Puig, & Collins, 2013; Raikes & Thompson, 2008). Therefore, in addition to parenting behaviors, the quality of mother-child attachment relationships may be another factor influencing child EF development. Although attachment has been most extensively studied in relation to social outcomes (e.g., personality, romantic relationships), attachment theory also makes predictions about cognitive outcomes such as EF, and some studies have shown relations between attachment security and EF (e.g., Bernier, Carlson, Deschenes, & Matte-Gagne, 2012; Drake et al., 2014). De Ruiter and van IJzendoorn (1993) hypothesized that attachment status may be important for cognitive outcomes as a moderator of the effects of parenting quality. These researchers suggest that secure attachment allows the child to better elicit and accept assistance from their caregiver, and increases the quality of communication between the parent and child, which could result in better learning for the child. In support of this hypothesis, secure mother-child dyads show higher levels of synchrony, harmony, collaboration, and sharing of responsibility (De Ruiter & Van IJzendoorn, 1993; Moss et al., 1993; 1997), and the mothers are more likely to encourage the child's sense of control over the task (Moss et al., 1997). However, this hypothesis that attachment security moderates the effect of parenting on cognitive development has not been extensively investigated with EF outcomes, and further research is needed, especially with low-income samples.

The Current Study

The current study examines the relations between child EF, maternal parenting, and support from father-figures in the home in a longitudinal, prospective study of at-risk low-SES children. Attachment is considered as a potential moderator in these relations. We

hypothesized that (a) high-quality maternal parenting in early childhood and (b) father-figure support in early and middle childhood would be associated with better EF skills in childhood. Our moderation analyses examined if these relations varied by attachment status. We hypothesized that children in secure mother attachment relationships would be better able to learn regulation from their mothers compared to insecure children, but the mother-child relationship would not affect learning from fathers. We measured EF in both the lab and the school context, given that the ability to apply EF in school has been shown to be critical for academic success (Blair & Razza, 2007).

Methods

Participants

Data are from the Minnesota Longitudinal Study of Risk and Adaptation (Sroufe, Egeland, Carlson, & Collins, 2005a), an ongoing, prospective longitudinal study that has followed low-income mothers and their first-born children for the past 39 years. The original sample was recruited from public health clinics in Minneapolis ($N = 267$) in the mid-1970's (Egeland & Brunnequell, 1979). The current study focuses on a subset of the participants who had data for at least one of the EF outcome measures ($N = 182$; 97 males and 85 females; birth – 3rd grade). T-tests showed that participants used in the current study did not differ from those excluded from the study on maternal age or education ($t_s = -.96$ and -1.69 , respectively, $p_s > .05$), and chi square tests also showed no differences for marital status, child sex, and race ($\chi^2_s = 4.70$, .44 and .77, respectively, $p_s > .05$). Mothers were earning incomes at or below the poverty level at the time of recruitment, and many of their lives were characterized by high levels of stress and instability (Egeland & Brunnequell, 1979). At the time of their children's birth, many of the mothers in the current sample were young (range = 15 – 34 years old, $M = 20.70$, $SD = 3.70$), had low educational levels (36% had not completed high school), and were single (61%; see Table 1). Fifty-eight percent of the children in this sample had two white parents, 16% were mixed race, and 14% had two black parents.

Measures

Data were collected at multiple time points using a variety of methods. These methods included observations of mother-child interactions, laboratory tasks, teacher ratings, and interviews. The order of data collection was as follows: mother demographics were collected before the child was born. The mother and child participated in the strange situation procedure in lab visits at 12 and 18 months. The mother was interviewed at 24, 30, 36, 42, 48, and 54 months about father-figure support for the child; these interviews were later collectively reviewed and one code was assigned for early childhood father-figure support to represent an overall measure of support during this time frame. At 42 months, the child participated in a lab visit in which the Barrier Box EF task was administered and mother parenting was assessed through observation of mother-child interaction. The child again came to a lab visit at 54 months where the Curiosity Box and Delay of Gratification EF tasks were administered. The mother was interviewed each year from Kindergarten to 3rd grade about father-figure support for the child; these interviews were later reviewed and one code was assigned for father-figure support in middle childhood. In each year from Kindergarten

to 3rd grade, the children's teachers completed the Devereux Elementary School Behavior Rating Scale for the target children.

Predictors: Parenting Measures

Mother Parenting (42 months)—Our measure of mother parenting was coder rated from videotaped mother-child interactions during semi-structured teaching tasks requiring the mother to assist the child in problem solving, completed when the child was 42 months of age. There were four tasks that the dyads completed: (a) building copies of a block tower using multiple smaller blocks, (b) having the child name as many things with wheels as he or she could think of, (c) sorting plastic objects by both color and shape simultaneously, and (d) navigating a maze that was traced onto an Etch-a-Sketch™ (For full descriptions of these tasks, see Erickson, Sroufe, & Egeland, 1985). After watching a video of all four tasks, raters coded mother's parenting on several dimensions, including *supportive presence* (emotional support, warmth, and encouragement), *quality of instruction* (the pacing, quality, and timing of instructions and hints), *respect for autonomy* (letting the child make choices and have an active role in the task), and *structure and limit setting* (appropriateness and effectiveness of behavior management techniques). Each of these dimensions was rated on a 7-point scale with higher values reflecting more positive parenting behavior across the four tasks. All ratings were summed across two observers, giving possible scores of 2 – 14. The intraclass correlations between raters for a randomly selected sample of 87 participants ranged from .86 to .89 for the four dimensions. Overall mother parenting quality at 42 months was computed by averaging scores of the four dimensions rated ($\alpha = .88$; supportive presence, quality of instruction, respect for autonomy, and structure and limit setting).

Father-Figure Support—Information on the level of emotional support given to the child from father-figures was extracted from repeated and extensive interviews with the mothers and coded by researchers who were unaware of other aspects of the child's history. Father-figures were defined as any adult male who lived in the home, including biological fathers, stepfathers, the mothers' romantic partners, uncles, grandfathers, and other males. Therefore, for some children, this variable represents multiple men in the home across the time period. The mothers were interviewed across early childhood (interviews given when the child was 24, 30, 36, 42, 48, and 54 months old) and middle childhood (interviews given when the child was in Kindergarten, 1st, 2nd, and 3rd grade). Mothers were asked questions about the man's relationship with the child, such as "Does he like being with the child?", "Does he play with the child?", and "Does he get along with the child?" If there were multiple men present in the home, the mother gave responses for each man. Support in early childhood was coded by reviewing all of the responses to the interviews conducted during this time frame and rating the overall level of support received from all father-figures, with one code assigned for early childhood father-figure support. The same coding procedure was conducted for middle childhood father-figure support.

The level of emotional support given to the child whenever a man lived in the home during the time period was coded (1 = no male in home; 2 = minimal; 3 = moderate/average; 4 = high quality). Minimal support was defined as "interaction between man and child is, at least occasionally, derogatory and belittling or there is little evidence of interaction between the

man and the child.” Moderate/average support was defined as “man seems available to child but there is a mixture of positive and negative interactions, or the man seems available to the child but the relationship is flat, not very expressive.” High quality support is defined as “relationship between man and child is characterized by warm, positive feelings along with attention to the child’s needs, or the man may be reserved but he is obviously available and attending to the child.” Raters took into account all the relevant information for each time period and gave an overall score. Support was rated for the early childhood period (24 – 54 mo.) and the middle childhood period (Kindergarten – 3rd Grade). Inter-rater reliability was assessed for 33 cases coded by two coders. Intraclass correlations were .90 for early childhood and .77 for middle childhood.

Outcomes: Child Executive Function Measures

Early Childhood Executive Function—Four laboratory tasks identified below (ego control at 42 months, delay of gratification at 54 months, impulsivity rating at 54 months, and ego control at 54 months) were entered into a factor analysis using principle component analyses. All loaded onto a single factor, .60 or higher, indicating satisfactory homogeneity (see Table 3). The factor score was used as our measure of early childhood EF (e.g., Bernier et al., 2010; Hammond, Muller, Carpendale, Bibok, & Liebermann-Finestone, 2012).

Ego Control Barrier Box (42 months): At 42 months, ego control was rated from video tapes of children interacting with a large clear Plexiglas box containing a set of toys. The box was latched with a series of fasteners that a young child could not open. The child was told that they could either play with the toys that were lying around the room (which were unattractive and uninteresting) or the toys inside the box (which were much more attractive). The child was left to engage with the objects for 10 minutes while the experimenter worked on papers in the corner of the room. Ego control was coded, reflecting the degree to which the child exercised control over wishes, impulses, desires, and feelings concerning the locked box. Children were scored on a scale from 1 – extremely under-controlled (child becomes disorganized, angry or panicked in response to frustration, including outbreaks of frustration or negative affect) to 7 – extremely over-controlled (the child shows no overt disappointment or upset at the unavailability of the toys and pays little or no attention to the locked box.)

Delay of Gratification (54 months): In this laboratory task, the child is shown a gift, which is then placed off to the side while the experimenter explains that the child may have the gift later. The experimenter then shows the child how to do a simple puzzle task, the child works on the task with some assistance from the experimenter. The experimenter then appears to be busy for 90 seconds, and after that time tells the child that he/she can have the present (Block & Block, 1973). The amount of time the child waited to open the present while the experimenter appeared busy was scored. Forty-eight percent of children waited 10 seconds or less, 8% waited between 11 and 89 seconds, 39% waited 90 seconds until they were told they could have the gift, and 3% continued to work on the task even after they were told they could have the present, and therefore had scores above 90 seconds.

Curiosity Box Impulsivity Rating (54 mo.): Child impulsivity was rated from observing a video-taped 10 minute interaction of the child with a brightly painted, attractive curiosity box affording a number of possible actions (hinges, locks, slinky, etc.). Impulsivity ratings reflected the extent to which the child inhibits motor behavior which interferes with the exploration of the box. Impulsivity was scored on a scale from 1 (child generally is able to control motor behavior that interferes with exploration of the box) to 7 (child's poor ability to inhibit motor behavior greatly inhibits exploration; child may flit from one thing to the next, activities are unplanned, disorganized, and unsystematic).

Ego Control Rating (54 months): At 54 months, ego control was again rated, this time for the entire 2 hour lab session the child completed at this time, including exploring the curiosity box, delay of gratification, and a number of other assessments. This rating measured the child's ability to control his/her emotions in order to respond with his or her best effort, which is shown in how difficult it is for a child to stay on task and make appropriate responses. Ego control was rated from 1- undercontrol (including fussing, anger, outbursts, negative affect, attempts to leave the room) to 5 – overcontrol (very compliant child, little emotion).

Middle Childhood Executive Function—To measure EF-related behaviors in school, teacher ratings on the Devereux Elementary School Behavior Rating Scale (Devereux, 1982) were used. This scale was filled out by the children's teachers each year from Kindergarten to 3rd Grade. This rating scale is designated for use by elementary teachers as a means of describing classroom behavior problems as well as for researchers who need a reliable measure of behaviors that appear in the classroom setting and are related to learning. The scale has a one week test-retest reliability correlation of .81, and is related to measures of achievement and IQ (Swift, 1982). The Devereux consists of a number of items (e.g., stay with task until completed) that are rated on a 7 point scale of how well they describe the child, from "not at all" to "extremely," based on comparison with the typical or "average" child in the normal classroom situation. For the purpose of measuring school behavior control, we selected the 8 items which have theoretical relevance to EF. Teachers were given slightly different versions of the Devereux each year, so not all questions were asked each year. Table 4 shows the questions used and the years in which they were completed. The teacher responses were put into a factor analysis using principle component analyses. All loaded onto the first factor, .46 or higher, indicating satisfactory homogeneity (see Table 4). The factor score was used as our measure of middle childhood behavior control.

Control Variables

Mothers' age and education level at the time of their child's birth, as well as the child's sex, were used as controls for the analyses.

Moderator: Attachment Classification

The children participated in the Strange Situation Procedure (Ainsworth, Blehar, Waters, & Wall, 1978) with their mothers at both 12 and 18 months of age. This procedure involves a series of separations and reunions between the infant and mother designed to activate infant attachment behaviors. These interactions allow coders to assess individual differences in the

quality of the attachment relationship between the infant and caregiver (i.e., secure or insecure). Table 2 shows information about participants who were secure at both times, changed from secure to insecure, changed from insecure to secure, and were insecure at both times. ANOVAs showed that these four groups did not differ on any of the mother parenting, father-figure parenting, or child EF variables (F s ranged from .36 to 1.36, all $ps > .10$). In order to test the hypothesis presented by De Ruiter and Van IJzendoorn (1993) that secure attachment increases the child's ability to learn cognitive skills from mother parenting, a pure securely attached group was required. However, given power considerations and non-significant differences between the groups on parenting and child EF measures, the remaining three groups, insecurely attached at one or two time points, were collapsed into one group. For all further analyses participants were divided into two groups: secure at both 12 and 18 months ($N = 69$), and insecure at one or more time points ($N = 100$).

Data Analysis Plan

A series of path analysis models were conducted to answer our research question regarding the relations between mother parenting, father support, and child EF. After reducing data into scales and investigating correlations, we fit and compared two nested models. Model 1 examined the relations between mother parenting and child EF. Model 2 added paths from father-figure support to child EF at both time points, to examine whether support from father-figures explained any variance above and beyond mother parenting. To investigate whether the relations between the variables differed by attachment status, we then tested the best-fitting model for moderation by attachment status.

Missing Data—Amount of missing data ranged from 0% to 6%, with a mean of 2% over all variables and all time points. To allow analysis of the same of 182 participants with outcome data, full information maximum likelihood estimation (FIML) using Mplus 7.11 (Muthén & Muthén, 1998–2012) was used.

Results

Correlations

Table 5 shows the bivariate correlations for the variables included in the model. Early childhood EF in the laboratory and middle childhood EF in school were moderately but significantly correlated, suggesting some continuity between these constructs across the transition from early childhood to middle childhood. Early childhood lab EF was also significantly correlated with mother parenting, early childhood father-figure support, mother age, and mother education. Middle childhood school EF was significantly correlated with mother parenting, middle childhood father-figure support, mother age, and child sex. Attachment status was significantly correlated with mother parenting and mother education.

To examine potential correlational differences by attachment status further, we ran the same bivariate correlations split by attachment status – always secure vs. insecure at one or more time points (see Table 6). For the children who were securely attached at both time points, early childhood EF was correlated with mother parenting, early childhood father support, middle childhood father support, and mother education. On the other hand, for those who

were insecurely attached, early childhood EF was not correlated with any of the variables in this model. For those who were securely attached, middle childhood EF was correlated with mother parenting, mother education, and child sex, while for those who were insecurely attached, it was associated with middle childhood father support and child sex.

Path Analyses

Two nested models were fit to the data. Model 1 included paths from mother parenting to child EF. Model 2 added paths from father-figure support to child EF at both time points. Model 2 (shown in Figure 1) was a significantly better fit to the data than Model 1. Model 2 fit the data well (see Table 7) and accounted for 7% of the variance in early childhood EF and 31% of the variance in middle childhood EF. In this model, early childhood EF was significantly predicted by early childhood father support. Middle childhood EF was significantly predicted by mother parenting, middle childhood father support, early childhood EF, mother education, and child sex.

We then tested whether any of the pathways from mother parenting or father-figure support to child outcomes were moderated by attachment status. We ran multiple group analyses constraining all paths to be equal, and then freeing the constraints on all of the paths. Finding a significant difference between these two models, we then systematically relaxed the equality constraint on each path one at a time to determine which paths were significantly different by attachment status. One pathway was found to be moderated: mother parenting to early childhood EF. When this path was allowed to vary by attachment status, the model fit significantly better than when fully constrained ($N = 169$, see Table 7). Mother parenting was significantly associated with early childhood EF for secure children ($r = .44$, $p = .001$), but not for insecure children ($r = -.06$, $p = .59$). When this path was freed to vary by attachment security, the model accounted for 23% of the variance in early childhood EF and 32% of the variance in middle childhood EF for secure children. The variances accounted for when looking at insecure children were 3% for early childhood EF and 24% for middle childhood EF.

Post Hoc Analyses

We chose to use child attachment as a two-level variable (always secure vs. insecure at any time) to test our hypothesis. However, given that some children had inconsistent classifications at 12 and 18 months, we also examined whether the results held when the attachment variable was treated as a three-level variable: always secure ($N = 69$), changed ($N = 53$), and always insecure ($N = 39$). When the model was re-run using this 3-way classification, the results were very similar to what we originally found when dividing children into two groups. For the always secure group, the path from mother parenting to early childhood EF was significant ($\beta = .031$, $p = .013$), but it was insignificant for the changed ($\beta = .000$, $p = .987$) and always insecure groups ($\beta = -.003$, $p = .886$). These results show that our original treatment of the attachment variable did not distort the findings.

Given the potential for distortion in the results due to outliers in the delay of gratification variable, we capped the value for this variable at 90 seconds and reran the path analysis

models. This re-analysis did not change the findings of the models, therefore we have confidence in the results reported based on the original variable.

Discussion

The purpose of this study was to investigate both mother and father-figure influences on child executive function in at-risk families. Because of the longitudinal nature of this study, we are in a unique position to address the questions of caregiving effects on child EF. We tested two nested path models; the first examining paths from mother parenting to child EF, and the second adding paths from father-figure support to child EF. We found that both the mother and father paths added unique prediction to child EF.

In our overall model, we found that the previously identified connection between mother parenting and child EF (e.g., Brophy-Herb et al., 2012; Bernier, et al., 2010; Kochanska et al., 2000) was replicated in an at-risk sample, supporting our first hypothesis. Our hypothesis that support from father-figures would add to the prediction of child EF above mother parenting was also supported. Concurrent support from father-figures predicted EF in both early and middle childhood. This study is one of the first to investigate longitudinal links between father-figure parenting and child EF. The finding that higher father-figure support was related to higher child EF at both time points supports the proposition that father-figure/child interactions play an important role in EF development. It may be that children who interact with multiple caregivers have more practice being mentally flexible (Cabrera et al., 2000), and that exciting, stimulating interactions with father-figures provide an important context to learn how to regulate one's self in highly arousing situations (Lamb, 2004). It will be important in further research to look more closely into the specific components of supportive fathering that are related to child EF.

The results of this study also align with previous research showing that characteristics of SES are related to both parenting and child EF (e.g., Hackman, Gallop, Evan, & Farah, 2015). Even within a sample that was recruited to be high risk, mother age and education at birth were related to quality of mother parenting at 42 months, and mother education to child EF in a school context in middle childhood. These results indicate that children of low-educated young mothers may be especially at-risk for difficulties with EF, and that early parenting may be one useful target for interventions designed to promote EF development in these children.

Results from our moderation analysis indicate that relation between mother parenting and early childhood EF was moderated by attachment status. Attachment status is known to be affected by contextual factors, such as mother life stress (Vaughn, Egeland, Sroufe, & Waters, 1979), and therefore may change over infancy. These potential changes are more likely in high risk populations, as was the case in our sample. However, viewed developmentally as a mode of relating to a caregiver, attachment has been shown to reflect important individual differences (Sroufe & Waters, 1977). Therefore, infant attachment status has the potential to moderate the association between later parenting and child outcomes (e.g., Kochanska, Askan, Knaack, & Rhines, 2004). Parenting quality is an important aspect of the formation of attachment in infancy, but as children develop, parents

have many new tasks that are quite distinctive from attachment functions (e.g. promoting autonomy, providing rich cognitive stimulation), therefore infant attachment status and parenting quality in early childhood are two distinct constructs (Sroufe, Egeland, Carlson, & Collins, 2005b). Consistent with attachment theory, we found that mother parenting predicted EF for secure children only. This suggests that securely attached children who have high quality parenting were better able to use the support provided by their mothers to develop internal regulation compared to the insecurely attached children where the quality of parenting did not have an effect on EF.

Although previous studies have found relations between early and middle childhood EF and both attachment (Drake et al., 2014) and quality of parenting (Blair, Raver, & Berry, 2014; Sulik et al., 2015), we are not aware of any studies that have looked at the effect of attachment as a moderator of the relationship between parenting and EF. It may be that attachment only moderated the effect of parenting on EF in early childhood compared to EF in middle childhood because of differences in developmental stage: children are more dependent on the regulation provided by their mothers in early childhood compared to middle childhood, and children in middle childhood have developed additional important relationships outside of the home (Sroufe et al., 2005). It is also possible that characteristics of the middle childhood EF measures (e.g., rated by teachers, in an applied school context) do not capture differences by attachment status. An additional possibility is that the timing of assessments was a factor given that we only had a measure of parenting in early childhood and not middle childhood; it may be that a relation between a parenting measure in middle childhood and the middle childhood EF may have been moderated by attachment. Our finding that quality of attachment moderates the relation between mother parenting and early childhood EF should be further investigated in other samples, including samples that are not at-risk.

Our moderation analysis further indicates that mother parenting predicted middle childhood EF for both secure and insecure children and that the relation between father-figure support and both early and middle childhood EF held for the entire sample. This latter result is notable and highlights the potential importance of fathers for children in a variety of caregiving contexts. It also shows that mother-child attachment specifically affects the relationship between mother parenting and the child's outcomes, as would be expected, but that the association between EF and father-figure support, despite being measured from mother reports, is not moderated. Further research should investigate whether attachment to the father-figure moderates the effect of father parenting.

Our study had a number of strengths. These strengths include tracking children from birth, and marshaling data from multiple sources, including rich observational measures, laboratory tasks, and reports from mothers and teachers. A multi-dimensional, observational approach was used to measure quality of mother parenting. Another significant strength of this study is the inclusion of all relevant father-figures across the time periods measured. Interviewing the mothers allowed us to track multiple men who were in the home, rather than focus on a single father-figure.

Despite these significant strengths, limitations of this study should also be acknowledged. The sample size was modest, at 182 children. However, given the richness of our data, we feel that this sample is in a unique position to address the research questions posed. Furthermore, our sample children came from high risk, low income families, and it will be important to also investigate these processes in middle and upper class families. However, since children from low SES backgrounds are at higher risk for EF deficits, research with high risk families should continue to be a priority.

The measures, in addition to providing a unique perspective and rich, detailed information, also created some limitations. The lab measures of EF used in this study were not created to specifically measure this construct, as they were used before the concept of EF had widespread popularity in research. Therefore, replicating this study with modern measures of EF is an important next step. Furthermore, given that these measures likely tap broad regulation abilities, and the study was not experimental, a causal link from parenting to child EF cannot be established. It is possible that bidirectional effects exist, in that it may be easier to demonstrate high quality parenting with a child who can self-regulate and focus on the tasks at hand. Also, mother parenting was only measured in early childhood. It would be informative to also have a measure of both mother and father parenting in middle childhood for a more complete comparison.

A further limitation of this study is our measure of father-figure support. Although the father-figure support variables were coded by impartial researchers, the information available was given by the mothers, who may not have provided unbiased information. The mothers' description of father-figure support to their child could be colored by a number of factors, including the mothers' mental health or depression, their current romantic relationship, or general stress about parenting. However, the mother-report method allowed us to gather information about all the men in the home across a specific time period, which may have only been possible in this sample with this methodology. Also, the effects of father parenting on child EF were not moderated by attachment, providing some support for the validity of the measure. Although these results may need to be interpreted with some caution, we hope that they will encourage future researchers to include better measures of father-figure support in their research. Ideally, father-figure support would be measured by directly observing interactions with the child; self-reports from father-figures would also be useful.

The findings of this study that both mother and father-figure parenting can influence EF have direct applicability to promoting success for low-income children. EF is increasingly being recognized as a key capacity of children that is crucial for personal and societal success (Heckman, 2006). This study indicates that early EF in the preschool years has relevance for later elementary school behaviors that are necessary for academic success. We found that both mother parenting in early childhood and concurrent father support were related to school behaviors. This finding has implications for how we should address the issue of increasing at-risk children's EF and academic success. Much of the research and interventions focusing on EF to this point have focused on the child alone, or on the mother-child relationship (e.g., Diamond & Lee, 2011; Lewis-Morrarty, Dozier, Bernard, Terracciano, & Moore, 2012). The present study shows that children's EF is influenced by

multiple levels of their environment, and that including both mothers and father figures in efforts to boost EF in children could lead to more effective interventions. Findings from this study also suggest that attachment interventions may be useful for promoting EF, as securely attached children may be able to benefit more from high quality mother parenting. Such research informs intervention and prevention, in that promoting EF can start very early in development within the home context.

Conclusion

Overall, we found that both mother parenting and support from father figures are important for the development of executive function in at-risk children across the preschool and grade school years. This study is an important step in investigating the parenting antecedents of EF due to its inclusion of both mothers and father-figures of children from an at-risk sample followed longitudinally across time. Many researchers have called for greater inclusion of fathers and father-figures in research (Cox & Paley, 2003; Lamb, 2004). To begin to fill this gap, this study showed that father-figures are likely to be a key component of family processes that support developing EF and allow children to become successful adults.

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Highlights

- We examined executive function (EF) in at-risk children using longitudinal data.
- Mother parenting predicted early and middle childhood EF.
- Father-figure support predicted child EF, controlling for mother parenting.
- The mother parenting – child EF link was moderated by attachment.
- Both mothers and father-figures contribute to EF development.

Figure 1.

Model 2 Results.

Solid lines show paths $p < .05$ with their standardized path coefficients, dashed lines show nonsignificant paths. Controls were included in all paths; nonsignificant paths from controls are omitted for clarity. * $p < .05$. ** $p < .01$.

Table 1

Descriptive Statistics for Variables in Models

Variable	Mean	Range	SD	N
Child Sex	1.47	1 = Male 2 = Female	.50	182
Age of Mother	20.67	15–34	3.70	182
Years of Mother Education	11.84	8–20	1.72	178
Mother Parenting	36.70	11–55	9.83	175
EC Father Support	2.41	1–4	.97	169
MC Father Support	2.61	1–4	.95	170
EC Lab EF (Factor)	0.00	–2.26 – 2.33	1.00	140
Ego Control Barrier Box-42mo	3.30	1–7	1.38	172
Ego Control Rating – 54mo	2.54	1–5	1.02	164
Delay of Gratification	42.57	0–212	45.50	155
Impulsivity Rating	3.00	1–7	1.86	168
MC School Behavior Control (Factor)	0.00	–2.27 – 2.01	1.00	160

Note: EC = Early Childhood, MC = Middle Childhood, EF = Executive Function

Table 2

Descriptive Statistics Separated by Four Attachment Groups

Variable	Full Sample			Secure at 12 & 18m			Secure at 12m only			Secure at 18m only			Insecure at 12 & 18m		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Child Sex	1.47	.50	182	1.51	.50	69	1.54	.51	26	1.41	.50	27	1.36	.49	39
Age of Mother	20.67	3.70	182	21.46	3.96	69	20.69	3.94	26	19.70	3.18	27	20.69	3.77	39
Years of Mother Education	11.84	1.72	178	12.26	2.00	69	11.46	1.36	26	11.38	1.20	26	11.85	1.77	39
Mother Parenting	36.70	9.83	175	38.47	9.83	68	34.92	10.33	26	34.81	10.31	26	36.42	8.56	38
EC Father Support	2.41	.97	169	2.42	1.06	65	2.58	.93	24	2.27	.78	26	2.33	.96	36
MC Father Support	2.61	.95	170	2.73	1.00	64	2.71	1.00	24	2.58	.90	26	2.56	.91	36
EC Lab EF (Factor)	0.00	1.00	140	.02	.92	56	.08	.94	18	.07	1.05	22	-.20	1.04	30
MC School Behavior Control (Factor)	0.00	1.00	160	.18	.90	59	-.07	.92	23	.004	.91	23	-.23	1.21	36

Note: EC = Early Childhood, MC = Middle Childhood, EF = Executive Function. Child Sex 1 = Male, 2 = Female

Table 3

Factor Loadings of the Tasks Used in the Early Childhood Lab EF Composite.

Task	Factor Loading
Ego Control – Barrier Box 42 mo.	.69
Ego Control Rating – 54 mo.	.73
Delay of Gratification	.72
Impulsivity Rating	–.60

Table 4**Devereux Rating Scale Items and Grades Used**

Item	Reverse Coded	K	1st	2nd	3rd
Stay with task until completed		--	--	.74	.72
Persist when something is difficult or demands more than usual effort		.52	--	.55	.59
Well organized about his work		--	--	.75	.72
Able to get to work when work is assigned		--	--	.69	.62
Make you doubt whether he is paying attention to what you are doing or saying (i.e. looks elsewhere, has blank stare or faraway look)	R	.46	.58	.71	.70
Quickly lose attention when teacher explains something to him (e.g., become fidgety, look away)	R	.47	.59	.67	.69
Break classroom rules (e.g., throw things, mark up desk or books)	R	.48	.50	.59	.50
Unable to attend to a task when other activities are going on	R	--	--	.65	.67
Have to be reprimanded or controlled by the teacher because of his/her behavior in class	R	.50	--	--	--
Unable to change from one task to another when asked to do so (e.g., has difficulty beginning a new task, may get upset or disorganized, etc.)	R	.49	--	--	--

Note: K = Kindergarten

Table 5

Bivariate Correlations

	1	2	3	4	5	6	7	8	9
1. EC Lab EF	--								
2. MC School Behavioral Control	.30**	--							
3. Mother Parenting	.16*	.29**	--						
4. EC Father Support	.17*	.10	.18*	--					
5. MC Father Support	.11	.23**	.32**	.50**	--				
6. Mother Age	.16*	.06	.29**	-.05	.006	--			
7. Mother Education	.18*	.20**	.30**	.11	.13	.56**	--		
8. Child Sex	.06	.35**	-.03	-.04	-.08	-.01	-.05	--	
9. Attachment (binary)	-.03	.14	.16*	.02	.09	.14	.19*	.06	--

* $p < .05$.

** $p < .01$. $N = 182$.

Note: EC = Early Childhood, MC = Middle Childhood, EF = Executive Function. Child Sex 1 = Male, 2 = Female. Attachment 0 = Insecure at least one timepoint, 1 = Always secure.

Table 6

Bivariate Correlations Split by Attachment Status

	1	2	3	4	5	6	7	8
1. Lab EF	--	.34**	.49**	.44**	.41**	.12	.29*	-.11
2. School Behavioral Control	.25*	--	.36**	.23	.18	.18	.25*	.28*
3. Mother Parenting	-.05	.19	--	.28*	.21	.43**	.48**	-.03
4. EC Father Support	.05	.004	.04	--	.60**	-.03	.22	-.10
5. MC Father Support	-.07	.25*	.41**	.41**	--	.05	.14	-.21
6. Mother Age	.18	-.07	.17	-.08	-.06	--	.51**	.06
7. Mother Education	.16	.14	.10	-.002	.13	.5**	--	-.05
8. Child Sex	.12	.34**	-.08	.01	.01	-.08	-.05	--

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

Note: The bottom left half shows children who were insecure at one or more time points (N = 100); the top right shows children who were always secure (N = 69). EC = Early Childhood. MC = Middle Childhood. EF = Executive Function. Child Sex 1 = Male, 2 = Female

Table 7

Goodness of Fit Statistics for the Models

Model	χ^2	df	χ^2/df	$\chi^2(df)$	CFI	RMSEA
1	21.84 ^{**}	5	4.37	--	.87	.14
2 (vs. 1) Final Model	.61	2	.30	12.29(2) ^{**}	.97	.08
2 Fully constrained	41.52 ^a	30	1.38	--	.91	.07
2 with 1 free path (vs. 2 fully constrained)	36.23	29	1.25	5.31(1) [*]	.95	.05

^a = $p < .10$,

^{*} $p < .05$,

^{**} $p < .01$

Model 1: mother parenting → child EF, Model 2: mother parenting and father parenting → child EF.