ABSTRACT

Title of Dissertation:	THE ASSOCIATION BETWEEN PARENTAL EXECUTIVE FUNCTION AND CHILDREN'S LANGUAGE SKILLS AT 18 MONTHS
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Executive function (EF) is thought to be particularly important for parenting (Crandall et al., 2015). Studies have shown that maternal EF is related to parenting quality and children's social and cognitive outcomes (Bridgett et al., 2015). These studies are few and are mostly conducted with mothers raising the question of whether paternal EF also affects children in the same way as maternal EF. In an effort to address these gaps I examined whether maternal and paternal EF influenced child language at 18-months, in part through parental engagement in home learning activities, in a sample of low-income, first time parents and their infants. My results did not show a significant, direct influence of maternal or paternal EF when children were 9 months old on children language skills at 18 months. Similarly, neither of the overall indirect effects of parental EF to child language through home parental learning activities were significant. However, paternal EF did positively predict paternal home learning activities, though this was not the case for mothers. Results of this study highlight the unique influences on maternal and paternal parenting and suggest further study is needed to fully elucidate the relation between parental EF and child language skills.

THE ASSOCIATION BETWEEN PARENTAL EXECUTIVE FUNCTION AND CHILDREN'S LANGUAGE SKILLS AT 18 MONTHS

by

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Dedication

This effort is dedicated to the many families who participated in, inform, and inspire my work.

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Chapter 1: Introduction

Statement of the Problem

In the world of parenting research, substantial efforts have been made to explore how parents' personal characteristics influence their parenting and thus their children's development. Theoretical models of parenting (e.g., Belsky, 1994; Bornstein et al., 2018; Taraban & Shaw, 2018) highlight parents' personal characteristics, such as parents' education and cognitions as determinants of parenting behaviors which, in turn, influence child outcomes beginning in early childhood. This literature shows that parents' levels of education and cognitions such as beliefs about child rearing are consistently related to children's social and cognitive development through their impact on parenting behaviors and practices (Bornstein, 2015; Cabrera et al., 2014).

Recently, there has been an increased theoretical and empirical focus on how parents' regulatory skills, particularly parental executive function (EF) shape parenting behaviors and children's outcomes. Parental EF, a skill that represents a set of cognitive processes that support a person's ability to reason, problem solve, and plan (Bornstein, 2015; Diamond, 2013), is important for children's early development, primarily through its influence on parenting (Diamond, 2013). Parents with strong EF skills are better able to organize their environment in predictable ways and are more attuned to children's needs, which, in turn, helps promote children's development (Azar et al., 2008; Bridgett et al., 2015; Crandall et al., 2015; Deater-Deckard, 2014).

Theoretical models posit that parental EF influences children's development through parenting (Bridgett et al., 2015; Crandall et al., 2015; Deater-Deckard, 2014). There are to date only a handful of studies that have tested whether parenting behaviors mediate the association between parents' EF and children's development. For example, using a sample of 158 mothers and their infants, Bridgett and colleagues (2011) found that mothers with better EF when children were 4 months old spent more time in caregiving activities (e.g., feeding, reading to, or playing with their children) when children were 6 months old, which partially mediated the influence of maternal EF on toddler EF at 18 months. Other studies have used tested mediational paths using concurrent data. These studies found that the influence of parental EF on early child outcomes, such as children's EF and conduct problems, is partially mediated by parenting (e.g., Cuevas et al., 2014; Deater-Deckard et al., 2012b; Distefano et al., 2018; Korucu et al., 2019; Suor et al., 2017; Zeytinoglu et al., 2017).

Despite the growing empirical evidence of the importance of parental EF for children's development and the mechanisms by which it matters for children, many notable gaps in the literature remain. First, similar to developmental research broadly, fathers are vastly underrepresented in this literature. In Crandall and colleagues' review of empirical work examining cognitive control and parenting, only three of the 35 studies reviewed focused on fathers, two of which were focused exclusively on parents with ADHD (2015). Little progress has been made since the publication of their review; only five of the studies reviewed for this paper included fathers as at least 20% of their parent sample, and only two were studies that focused exclusively on fathers. This is a notable omission because theoretical and empirical work has demonstrated that fathers influence their children's development above and beyond the influence of mothers (Cabrera et al., 2014). Moreover, results of studies that did include fathers were inconsistent. Many studies observed the influence of parental EF is similar for mothers and fathers (e.g., Distefano et al., 2018; Korucu et al., 2019; Meldrum et al., 2018). Yet, others found null effects or differential effects by parent gender (Meldrum et al., 2018). For example, in one study of Dutch boys, maternal parenting mediated the effect of maternal self-control on boys' aggression, but the same mediational path was not significant for fathers (Meldrum et al., 2018). Thus, the influence of both mothers' *and* fathers' EF on children warrants further exploration.

Second, the large majority of studies on this topic have been conducted with primarily European American families, many of which were also well educated and/or have middle to high household incomes. The absence of more diverse samples may be of particular importance in the study of the influence of parental EF as there is evidence to suggest that EF may be especially salient to parenting in the context of poverty (Deater-Deckard et al., 2012a; Sturge-Apple et al., 2017). The environmental stressors associated with living in poverty have been shown to carry a substantial cognitive burden and impede cognitive functioning (Mani et al., 2013). Stress related to economic hardship has been found to negatively impact adults' performance on reasoning tasks (Mani et al., 2013) and inhibition tasks (Mittal et al., 2015). Thus, mothers and fathers living in poverty may face an additional challenge during parenting since their cognitive capacities may be depleted by environmental stressors. As such, it is important to explore whether the evidence of the influence of parental EF on parenting and child outcomes is consistent within samples of low-income families. Exploring this process in low-income samples, while also controlling for education, isolates the unique influence of parental EF within the context of economic hardship. This process may account for some of the unexplained variance in parenting and child outcomes in low-income families as well as highlight an important opportunity for intervention.

Third, the prevalence of concurrent designs and the few longitudinal tests of mediation prevent a clear conclusion regarding the mechanisms through which both parental EF and other contextual variables influence children. Concurrent mediational designs do not provide clear insight as to which variables are acting as mediators because they lack temporal precedence (Jose, 2016), something that is sorely needed here. Despite clear theoretical support for the mediational role of parenting, only a handful of studies have tested mediation with longitudinal data. This type of study can give us insight into the mechanisms that may explain why parental EF is important for children's development. Additional theoretical and empirical exploration is needed to determine the mechanisms of influence of parental EF on parenting and child outcomes in diverse contexts.

Fourth, theoretical models suggest that parental EF influences early child development across multiple domains of development. Yet, the empirical evidence thus far has largely focused on social and some cognitive outcomes with substantial support for the influence of parental EF on children's EF, conduct problems, and emotion regulation (Bridgett et al., 2015; Crandall et al., 2015). One domain of child development that has received little attention in this literature is language. A strong body of work demonstrates that children learn language at least in part through parenting processes such as the quality of parent-child interactions including scaffolding (Mazursky-Horowitz et al., 2018; Meuwissen & Carlson, 2015; St. John et al., 2018) and engagement in positive caregiving behaviors (Bridgett et al., 2011). These parenting behaviors are influenced by parents' EF. Insight into the association between parental EF and child language largely comes from studies where it is included as a control variable, in which most studies report significant positive associations between parental EF and child language skills (e.g., Distefano et al., 2018; Suor et al., 2017). This is a notable gap as language is a critically important domain in early childhood. Children's early language skills are foundational for the development of subsequent language as well as other cognitive and school readiness skills (Friend & Bates, 2014; Gooch et al., 2016; Matte-Gagné & Bernier, 2011; Merz et al., 2020).

Proposed Study

I aim to address these gaps by examining whether parenting behaviors at 15 months mediate the association between parental EF at 9 months and child language at 18 months using longitudinal data from a sample of diverse, low-income families and their young children who are participating in an ongoing NIH-funded intervention (Cabrera & Reich, 2017). The sample includes 210 two-parent families and their infants who are being followed from the time the children are 9 months to 48 months of age. I use data from direct assessments of both mothers' and fathers' EF and parents' reports of their engagement in home learning activities at 15-months to predict children's language skills at 18-months.

Research Questions and Hypotheses

Research Question 1: Are maternal and paternal executive function at 9 months directly related to children's language skills at 18 months?

Hypothesis 1a: Mothers with better executive function when their infants are 9 months will have toddlers with higher language scores at 18 months.

Hypothesis 1b: Fathers with better executive function when their infants are 9 months will have toddlers with higher language scores at 18 months.

Research Question 2: Are the associations between maternal and paternal executive function at 9 months and children's language skills at 18 months mediated by maternal and paternal engagement in home learning activities at 15 months?

Hypothesis 2a: Mothers with better executive function when their infants are 9 months will have toddlers with higher language scores at 18 months because they engage in more home learning activities at 15 months.

Hypothesis 2b: Fathers with better executive function when their infants are 9 months will have toddlers with higher language scores at 18 months because they engage in more home learning activities at 15 months.

Contribution to the Field

Results of this study provide insight into the theory that parental EF influences child outcomes, including child language. I hypothesize that mothers' and fathers' EF will influence children's early language skills through parenting as a mechanism. Null findings would suggest that parental EF is not an important predictor of children's early language skills within this sample and would represent evidence that does not support theories of how parental EF influences child outcomes. Should my hypothesis be supported, the results would have substantial implications for programs that aim to improve parenting and child outcomes in low-income families. Interventions generally focus on increasing parent resources or teaching specific skills, yet these results would expand the focus by adding information on how parents' regulatory skills influence parenting. Programs could use such information in many ways, such as: assessing parental EF to determine the goodness of fit of particular parenting interventions, or by targeting parental EF directly as a mechanism for improving parenting.

Additionally, if my results support my hypotheses, they will highlight an important new avenue for further research. If EF influences parenting, it may also influence other important aspects of parents' behavior such as engagement in parenting interventions or participation in their children's schooling. Future work in this area may yield valuable insights into issues at both the program and policy level.

Chapter 2: Review of the Literature

Theoretical Framework

Parents are the most proximal influence on children's development (Belsky, 1994; Bronfenbrenner & Morris, 2007). Parents have a direct influence on their child through the genetic makeup they bequeath onto their children (Belsky, 1994; Bronfenbrenner, 1995; Bronfenbrenner & Morris, 2007). Yet parents' influence on their children goes beyond genetics. Belsky (1984) outlined a process model of parenting which describes parents' non-genetic influence child outcomes. Parents' own developmental history shapes their personal characteristics (e.g., work, personality, marital relations) and social network, both of which then influence their parenting which in turn influences child outcomes (Belsky, 1984). Parents' non-genetic characteristics influence their children at least in part through the influence those characteristics have on parenting behaviors (Belsky, 1994; Cabrera et al., 2014; Taraban & Shaw, 2018). Belsky (1984) originally identified parents' developmental history, psychopathology, and personality as the most important parental characteristics that influence parenting and subsequent child outcomes. Updated models of parenting have expanded that list to include other characteristics such as gender, age, cognitions, affect, beliefs, education, role identity, and self-regulation ability (Cabrera et al., 2014; Taraban & Shaw, 2018). For example, Taraban and Shaw (2018) illustrate that parents' personality (e.g., an overly cautious personality) influences their child's personality in part through their parenting (e.g., an overly cautious parent may be overprotective of their child which may then lead the child to be anxious in novel situations).

The Importance of Parents' Executive Function

Executive function refers to a set of cognitive processes that support a person's ability to reason, problem solve, and plan. A full discussion of the models and definitions of EF, though a worthwhile academic endeavor, is beyond the scope of this paper. Here, I use Diamond's (2006) model and terms for the sub-components of EF: inhibition, working memory ("updating" in Miyake et al., 2000), and cognitive flexibility ("shifting" in Miyake et al., 2000), which are described in detail in the next section. In spite of the diverse conceptualizations of the construct itself, the general domain of EF is widely acknowledged as important to an array of developmental outcomes (Baggetta & Alexander, 2016).

Broadly speaking, EF (and the subcomponents thereof) has a protracted developmental trajectory that begins in the first few years of life and is consistently related to social and cognitive outcomes across the lifespan, above and beyond the influence of IQ (Baggetta & Alexander, 2016; Diamond, 2013). In children, EF is related to a wide variety of outcomes (e.g., school readiness and success: Diamond & Lee, 2011, math skills: Cragg & Gilmore, 2014, reading: Cartwright, 2012, and social skills: Riggs et al., 2006) and is considered essential to healthy development throughout the lifespan (Diamond, 2013). In adults, improved EF is associated with marital harmony (Eakin et al. 2004), professional success (Bailey, 2007), and better quality of life (Brown & Landgraf, 2010; Davis et al. 2010); while poor EF is associated with negative outcomes such as obesity (Miller et al., 2011), substance abuse (Baler & Volkow, 2006), crime (Denson et al., 2011), mental health disorders (Baler & Volkow, 2006; Diamond, 2005, Barch, 2005), and social problems (Denson et al., 2011). Environmental factors (e.g., parenting, socioeconomic status, bilingualism) have been found to influence the development of EF in children (Arredondo et al., 2015; Hackman et al., 2015; Kok et al., 2014) and appear to be relevant to EF in adults, though the nature of this association is less clear in adulthood (Bridgett et al., 2013; Carreras et al., 2019; Deater-Deckard et al, 2012a; Sturge-Apple et al., 2014; Sturge-Apple et al., 2017).

Although some studies have found EF to be stable in older children and adults (Ettenhofer et al., 2006; Harms et al., 2014), there is preliminary evidence that EF can be improved (and potentially then improve outcomes associated with EF) through intervention (Buschkuehl et al., 2012; Diamond & Lee, 2011; Hindin & Zelinski, 2012; Morrison & Chein, 2011). For example, Karbach and Kray (2009) found that EF training was effective at improving performance on EF tasks and that benefits transferred to other executive tasks and fluid intelligence in three age groups (i.e., 8-10; 18-26; and 62-76 years of age). There is also initial evidence to suggest that training in EF and other outcomes, such as health and exercise, has reciprocal benefits (Allan et al., 2016; Hindin & Zelinski, 2012) and that effects can be maintained over time (Rebok et al., 2014). This evidence suggests that understanding and targeting EF through interventions may provide a unique opportunity to improve numerous developmental outcomes for both children and parents.

Intergenerational Model of Maternal Emotion Control and Cognitive Control Capacities and Parenting

Given that EF has been demonstrated to underlie numerous cognitive and behavioral processes, researchers have identified parental EF, a primary component of self-regulation, as one particularly relevant parental characteristic and as a potential source of unexplained variance in parenting and child outcomes (e.g., Braungart-Rieker et al., 2010; Dix, 1991; Hoover- Bridgett et al., 2015; Crandall et al., 2015; Deater-Deckard, 2014; Dempsey, & Sandler, 1997; Sturge-Apple et al., 2014). The Intergenerational Model of Maternal Emotion Control and Cognitive

Control Capacities and Parenting developed by Crandall and colleagues (2015) is a theoretical framework that focuses specifically on the influence of parental self-regulation, including parental EF. The model posits that parental various aspects of self-regulation, including parental EF, influences child outcomes, and that this influence is mediated at least in part through parenting (2015). As a complement to the broader heuristic models of parenting, the model provides strong theoretical support for the influence of parental EF on parenting, which in turn influences children's developmental outcomes.

Crandall and colleagues (2015) define self-regulation as a combination of emotional control (i.e., emotion regulation) and cognitive control (i.e., EF). They posit that maternal self-regulation directly influences parenting, which in turn contributes to child health and development throughout the lifespan (Crandall et al., 2015). The authors also suggest influences on maternal self-regulation. They submit that the "maternal, family, and neighborhood context" has a bi-directional influence on maternal self-regulation, as well as direct influences on both parenting and child development.

Crandall and colleagues (2015) describe the specific components of parenting that are influenced by self-regulation, suggesting that mothers with better self-regulation engage in more positive parenting and less negative parenting. Here, I focus on the cognitive aspect of self-regulation described in the model (2015), that is EF which encompasses inhibition, working memory, and cognitive flexibility. These components of EF capture three different cognitive process that are relevant to parenting.

Inhibition, also referred to as inhibitory control, is the ability to inhibit a dominant response in favor of a subdominant but more appropriate response (Diamond, 2013). Applied to parenting, inhibition is a parent's ability to repress their reflective response and instead choose a more appropriate parenting behavior, such as when a parent refrains from yelling in response to their child's misbehavior and instead uses a reasoned discipline practice. In addition, theory suggests that inhibition skills encompass attentional control, which refers to one's ability to attend to relevant stimuli while ignoring interfering stimuli (Crandall et al., 2015; Diamond, 2013; Deater-Deckard, 2014). In parenting, this aspect of inhibition would be critical for the quality of parent-child interactions; a parent must selectively attend to their child's cues during play interactions and inhibit their attention to the myriad of other cognitive demands on a parent.

Working memory is the ability to retain, understand, and manipulate information (Diamond, 2013). For parents, this represents their ability to remember and process information in the context of a dynamic and ever-changing parent-child relationship. Parents must constantly incorporate new information and update their thinking, plans, and behaviors accordingly. For example, during a play interaction, a parent must be simultaneously mindful of the ongoing play narrative, their child's daily routine and practical needs, and the demands of other family members and responsibilities. Similarly, in the context of the parent-child relationship, a parent must remember the multiple influences on their child's behavior in order to sensitively and appropriately respond to their cues, such as remembering that fussiness may be due to a missed nap rather than boredom and responding accordingly.

Building on the foundational skills of inhibition and working memory, cognitive flexibility involves the ability to change perspectives or behaviors in response to new demands or information (Diamond, 2013). For parents, this skill is the ability to understand things from their child or co-parent's perspective and adapt their parenting approach based on new information. For example, a parent may stop spanking their child and instead use time-out in response to learning new information about the consequences of corporal punishment. Additionally, a parent must be able to adapt to a child's needs in order to have high-quality interactions. In the example of the fussy child during play time, the parent must be flexible and adjust to a calmer activity or shorter play time.

This conceptualization of the role of parental EF provided by Crandall and colleagues (2015) makes several notable contributions to the field by including specific paths of influence for contextual factors, detailing relevant parenting behaviors, and explicitly defining their parent population as mothers. The authors do not preclude that the process could operate similarly for fathers, but rather state that their theory can only be prudently applied to mothers given lack of theoretical or empirical guidance on whether or not these processes operate similarly for mothers and fathers.

Evidence of the Mediational Model

The extant literature provides preliminary evidence of the theorized indirect effect of parental EF on child outcomes which is at least partially mediated by parenting. Only four studies were identified that provided a direct, full test of the mediational model from parent to child (i.e., utilized a longitudinal design with mediational analyses), however the results of all of those studies supported the mediational of the influence of parental EF on parenting and subsequent child development outcomes.

The first of the studies was done by Bridgett and colleagues (2011) using a sample of 158 predominately white mothers and their 4-month-old infants. They explored how maternal effortful control (which is often conceptualized as an aspect of EF; Diamond, 2013), measured using the effortful control subscale of the Adult Temperament Questionnaire at 4-months, influenced the time mothers spent in caregiving at 6-months (i.e., self-report of time spent playing, reading, feeding, and holding their infants), and children's effortful control at 18-

months, controlling for infant's orientation to and regulation of negative emotions over time (Bridgett et al., 2011). Results of their latent growth curve model found that first, maternal effortful control had a direct effect on children's negative emotions (concurrently, $\beta = -.13$), time spent in caregiving behaviors at 6-months ($\beta = .19$), and children's effortful control at 18-months ($\beta = .20$). Maternal effortful control also predicted both the slope and intercept for children's orienting and regulation of negative emotions which was measured at 4, 6, 8, 10, and 12 months. Results of the full model showed that maternal effortful control influenced child effortful control both directly, and indirectly through the time mothers spent in caregiving. The authors did not control for the influence of fathers in their model and thus their estimate of the influence of mothers may be overestimated.

Next, Suor and colleagues (2017) explored the influence of maternal working memory, harsh discipline, and maternal responsiveness on children's working memory and how that process interacts with SES in a sample of predominately white mothers and their toddlers from diverse income and education backgrounds. When the children were 3.5 years old, the data collection protocol included an SES risk index (i.e., a composite of family income-to-needs ratio, maternal education, and maternal reports of neighborhood chaos), a direct assessment of maternal working memory, and use of harsh discipline and responsiveness were coded from mother-child interactions. Children's working memory was then measured when they were 5 years old (Suor et al., 2017). Results showed that SES positively predicted children's working memory ($\beta = .45$) and negatively predicted harsh discipline ($\beta = -.56$), and that harsh discipline mediated the influence of SES on child working memory ($\beta = -.37$) above and beyond the mediational role of maternal responsiveness. The mediational influence of harsh discipline was then moderated by maternal working memory such that SES was predictive of harsh discipline, but only for mothers with low working memory (β = -.22), even after controlling for child negative affect, maternal responsiveness, and child verbal ability.

The third test of a mediational effect comes from Zeytinoglu and colleagues (2017) who explored how parental effortful control, a component of EF, influences parental emotional support and children's behavioral outcomes in a sample of 278 4-year-olds and their primary caregivers (96% mothers). When children were 4 years old, mothers' effortful control was assessed using the Adult Temperament Questionnaire and their emotional support was assessed by coding a parent-child interaction for emotional responsiveness, intrusiveness (reverse scored), and negativity (reverse scored), then when children were 5 years old their EF was assessed using a battery of lab-based tasks and their behavioral regulation was reported on by teachers (Zeytinoglu et al., 2017). Results of their full SEM model showed that maternal effortful control had a direct positive influence on children's behavioral regulation (β = .16), as well as an indirect influence through maternal emotional support which had a positive influence on behavioral regulation (β = .30). For children's EF, only a small indirect effect was observed for maternal effortful control, again through emotional support, all of which remained significant when controlling for minority status, maternal education, and child gender (Zeytinoglu et al., 2017).

Finally, Meldrum and colleagues (2018) provide another test of the mediational model in their study of parental self-control (conceptualized as a lack of impulsivity and the ability to make long term plans similar to conceptualizations of EF), ineffective parenting, and child self-control in a sample of 117 Dutch boys and their mothers and fathers. When the boys were 17 months old, both mothers and fathers reported on their self-control, then when the boys were 23 months old both parents completed the Harsh Discipline subscale of the Parental Behavior Checklist, the Alabama Parenting Questionnaire items on lack of structure and inconsistent discipline, and items on the Parenting Scale related to parental laxness and overreactivity (Meldrum et al., 2018). Finally, the boys' self-control was assessed using the Inhibitory Control scale from the Toddler Behavior Assessment Questionnaire when they were 35 months old. Results from their SEM model of the unique effects of both mothers and fathers showed that parental self-control was negatively predictive of ineffective parenting for both mothers (β = -.613) and fathers (β = -.226) respectively, but that only maternal ineffective parenting mediated the effect of maternal self-control on of child self-control (β = -.515; Meldrum et al., 2018).

Together these studies provide a promising start for the emerging body of literature demonstrating the influence of maternal EF on child outcomes, mediated by parenting. Moreover, these studies bolster the evidence from partial tests of the model (i.e., concurrent associations, tests of the influence of parental EF on either parenting or child outcomes, see Bridgett et al., 2015 for a review). This evidence is consistent with the theoretical model from Crandall and colleagues (2015). Overall, the evidence shows that mothers with better EF engage in more positive parenting behaviors, have more positive mother-child interactions, and engage in less harsh and negative parenting, which all contributes to improved cognitive and behavioral regulation in toddlers and preschool aged children. Notably, the one study that meaningfully included fathers and demonstrated that the unique associations between maternal and paternal EF and parenting appear to be similar for both mothers and fathers, but the subsequent influence of maternal and paternal parenting on child outcomes may differ (Meldrum et al., 2018).

Yet, many gaps still remain. Only one of the studies meaningfully included both mothers and fathers in their model, something that is necessary to accurately assess the influence of each parent. Additionally, the samples used in these studies were largely homogenous. All or the majority of each sample identified as white, and all but one study (Suor et al., 2017) included participants with high levels of education and middle-class incomes (e.g., average income-to-needs ratio of 3.03 and 2.11 in Bridgett et al., 2011 and Zeytinoglu et al., 2017, respectively). Lastly, it remains unknown how other factors, such as household chaos or financial strain, play a role in this process as the controls used in each study were largely minimal and varied from no controls (Bridgett et al., 2011) to including basic family and contextual factors (Zeytinoglu et al., 2017).

The Influence of Parental Executive Function on Language and Related Child Outcomes

There has been almost no empirical focus on the influence of parental EF on child language. To my knowledge to date, I have not identified any studies that focus primarily on the influence of parental EF on child language. This is an important omission for several reasons. Language skills are foundational for both academic and social outcomes. Early language skills promote academic achievement as they facilitate later literacy critical thinking skills (Gilkerson et al., 2018). Furthermore, language skills underlie higher-order cognitive processes and social skills (Bernier et al., 2012; Kovacs & Mehler, 2009; Vallotton & Ayoub, 2011; Whedon et al., 2018). For example, language skills enable early EF development as they facilitate children's ability to label their own perspective, orient their goal-directed behavior, and form and use higher-order cognitive rules (Hendry et al., 2016; Vallotton & Ayoub, 2011; Zelazo, 2015).

Yet an influence of parental EF on children's language is suggested by both theoretical models that describe broad impacts of parental EF on children's cognitive outcomes (e.g., Bridgett et al., 2015; Crandall et al., 2015) and by the extant evidence from studies that include child language as a control variable and studies of related neurocognitive outcomes, such as child executive function.

Insight into how parental EF influences child language can be gleaned from studies that included child language as a covariate and reported results for a test of an association between parental EF and child language (Boutwell & Beaver 2010; Chen et al., 2020; Distefano et al., 2018; Kao et al., 2018; St. John et al., 2018; & Suor et al., 2017). All of the studies I identified that reported results related to language drew from samples of all or mostly mothers and children between the ages of three and five. Of these, three studies demonstrated small to moderate correlations between parental EF and child language (Boutwell & Beaver 2010; Distefano et al., 2018; & Suor et al., 2017). Meanwhile, three did not find a significant association between parental EF and child language in (Chen et al., 2020; Kao et al., 2018; St. John et al., 2018). Notably, Chen and colleagues (2020) explored whether concurrent parental EF and child EF mediated the influence of child trauma on a latent factor representing children's cognitive functioning indicated by child IQ and receptive language in a sample of 109 parents (89% mothers) and their children between 2 – 5 years of age. Neither the bivariate correlation between parental EF and receptive language nor the direct path from parental EF to the cognitive functioning factor in their model were significant (Chen et al., 2020). These results warrant additional exploration in order to clarify the inconsistent findings, which could be due to differences in samples and/or the measurement of parental executive function, as well as to control for the influence of other factors.

Second, there is substantial support for an influence of parental EF on other aspects children's neurocognitive development. The evidence is most robust for children's EF, which has a similar and interrelated developmental trajectory to children's language skills (Friend & Bates, 2014; Gooch et al., 2016; Merz et al., 2020). I identified ten studies that tested a direct association between parental EF and children's EF in early childhood, only two of which found entirely null effects (Meuwissen & Carlson, 2015; von Suchodoletz et al., 2017). The majority yielded evidence of a positive association between parental EF and child EF (Chen et al., 2020; Cuevas et al., 2014; Distefano et al., 2018; Korucu et al., 2019; Lee et al., 2019; Suor et al., 2017).

This finding was largely consistent regardless of contextual variables such as socioeconomic status (Distefano et al., 2018) and though most studies included primarily Caucasian participants, the association was also observed in a sample of South Korean mothers (Lee et al., 2019). Even in the more methodologically robust studies (e.g., Cuevas et al., 2014; Distefano et al., 2018), there was evidence of a direct and independent effect of parental EF, regardless of SES or maternal education. For example, in their longitudinal study of 62 mothers and their toddlers, Cuevas and colleagues (2014) found that maternal EF in infancy had a moderate positive influence ($\beta = .38$) on child EF in toddlerhood above and beyond the effect of maternal caregiving, maternal education, and child verbal ability. Notably, the association between parental and child EF appears to be stronger for the neurocognitive aspects of EF. For example, Kim and colleagues (2017) found that, in their sample of mothers and preschoolers, maternal working memory was positively associated with child performance on the cognitive version of the Go/ No Go task, but not the emotional version of the Go/No Go task.

In sum, there is strong evidence for the influence of maternal EF on some cognitive child outcomes, while at the same time the few and inconsistent insights into a possible association between parental EF and child language warrant further exploration. Generally, maternal executive function was shown to be associated with children's executive function, such that mothers with better EF have children with better regulatory skills themselves. The few inconsistencies in results may partially be due to the degree to which the larger context or other influences were considered. For example, several studies that yielded mixed or null results for a direct effect of parental EF found evidence of an indirect effect when the mediating role of parenting was included (e.g., Deater-Deckard et al., 2010; Deater-Deckard et al., 2012b; Meuwissen & Carlson, 2015).

The evidence for the influence of paternal EF on child outcomes is less robust. Of the fifteen studies that explored parental EF reviewed for this paper, three studies included at least some fathers (Distefano et al., 2018; Kao et al., 2018; Korucu et al., 2019) and only one study included fathers as more than 20% of their sample (Meuwissen & Carlson, 2015). Those that did include fathers explored gender as a moderator and did not find any differences in the association between parent and child EF for mothers and fathers (Distefano et al., 2018; Korucu et al., 2019).

Parental Executive Function and Parenting

Parents promote their children's early language development through their own language inputs, cognitively stimulating activities, and high-quality interactions (Cabrera et al., 2020; Gilkerson et al., 2018; Malin et al., 2014; McFadden & Tamis-Lemonda, 2013; Tomopoulos et al., 2006). These parental inputs may be particularly important for children's early expressive language skills, such as vocabulary (Karrass & Baraungart-Reiker, 2005; Schmitt et al., 2011). Furthermore, many socioeconomic differences in language skills are explained by differences in parental input (Daneri et al., 2018; Kuhn et al., 2014; Rosen et al., 2020), which further suggests that parental characteristics influence children's early language skills (Davis-Kean et al., 2005; Westerlund & Lagerberg, 2008).

As such, parental EF is also implicated as important for child language skills because several of the above parenting processes that promote child language skills have been shown to be influenced by parental EF. Again, this is a burgeoning area of research. This body of work largely supports the theorized association between parental EF and the parenting processes that are important for child language skills, though the strength of the evidence varies somewhat depending on the specific parenting process.

Quality of Parent-Child Interactions

First, there is a robust literature on the influence of parental EF on the quality of parent-child interactions. This is critical as the quality of parental interactions with their children (e.g., sensitivity, intrusiveness) directly influence children's early language development (Baumwell et al., 1997; Justice et al., 2019; Malin et al., 2014). The quality of parent-child interactions is one of the most common aspects of parenting studied in association with parental EF. There is strong evidence for the influence of parental EF on both positive qualities (e.g., sensitivity) and negative qualities (e.g., intrusiveness) of parent-child interactions.

All of the studies I reviewed that explored negative interaction qualities as an outcome found a significant negative association with parental EF (Bridgett et al., 2017; Chary et al., 2018; Cuevas et al., 2014; Kao et al., 2018). Bridgett and colleagues (2017) and Cuevas and colleagues (2014) both coded parent-child interactions for things such as intrusiveness, insensitivity and negative affect. Bridgett and colleagues (2017) found that poor maternal EF when infants were 4 months old predicted increased negative parenting when infants were 8 months old ($\beta = .22$), even when controlling for cumulative risk, infant negative emotionality, and infant gender. Notably, they also found that mothers' reports of their own childhood experiences with negative parenting predicted maternal EF, such that mothers who experienced more negative parenting had poorer EF skills ($\beta = .48$; Bridgett et al., 2017). Meanwhile, Chary and colleagues (2018) used survey measures of negative parenting with similar results. Maternal EF was negatively associated with a composite score on the Parenting Scale (i.e., a composite of the laxness, overreactivity, and verbosity subscales) in their sample of 241 mothers and their 30-month-old infants, an association that was moderated by sleep (2018).

However, a conflicting result was obtained by Deater-Deckard and colleagues (2016) who tested an association between maternal EF and observed negative affect in a sample of 151 mothers and their 3 – 7-year-old children. Unlike the studies that found an association with the composite measure of harsh parenting, the researchers did not find an association between maternal EF and negative affect alone (Deater-Deckard et al., 2016).

Investigations of parental EFs and positive aspects of parent-child interactions yielded slightly more variable results, though taken together the results suggest an influence of parental EF on positive interaction quality. Though not found in all studies (e.g., Kao et al., 2018; Korucu et al., 2019) several have shown a positive association between parental EF and positive interaction quality: parents with strong EF skills had more positive interactions and vice versa (Deater-Deckard et al., 2016; Distefano et al., 2018; Chico et al., 2014; Gonzalez et al., 2012). For example, Distefano and colleagues (2018) found that parents with better EF used more autonomy-supportive parenting during an observed dyadic puzzle task, controlling for SES, child verbal ability, and child age, in their sample of 85 parents (72 mothers) and their preschool children. Similarly, Chico and colleagues (2014) found that lower EF skills in teen mothers were associated with less sensitivity and fewer vocalizations during interactions with their infants.

Parental Scaffolding

Another construct of relevance is parental scaffolding, which has consistently been shown to promote early language development (e.g., Dieterich et al., 2006; McFadden & Tamis-LeMonda, 2013; Mermelshtine, 2017; Smith et al., 2000). Parental scaffolding has consistently been found to be associated with parental EF when measured globally (Mazursky-Horowitz et al., 2018; Meuwissen & Carlson, 2015; St. John et al., 2018), though results are less consistent in studies of specific EF components. The evidence of an association between scaffolding and global EF is quite robust. First, St. John and colleagues (2018) found that parents (58 mothers, 6 fathers) with better EF used more appropriate scaffolding during an observed puzzle task with their preschool children ($\beta = .269$), controlling for parental verbal ability. Then Mazursky-Horowitz and colleagues (2018) found a similar result in their study of 84 mothers and their elementary aged children, with the additional result that the association remained regardless of whether or not the child had parent-reported ADHD. Finally, Meuwissen and Carlson (2015) demonstrated the same process in their study of fathers and their toddlers. Fathers with better EF skills used more autonomy support ($r = .279$) and less control ($r = -.234$) during an observed dyadic scaffolding task (Meuwissen & Carlson, 2015).

At the same time, studies of specific EF components and scaffolding are conflicted. Obradović and colleagues (2017) observed that higher maternal working memory predicted more appropriate scaffolding ($\beta = .07$) during mother-child interactions in a sample of 1,291 mothers and their 4-year-old children in rural Pakistan, even after controlling for maternal short-term memory, verbal IQ, child and mother age, and family wealth. Notably, the authors also found that maternal working memory mediated the influence of maternal age and family wealth on scaffolding (Obradović et al., 2017). On the other hand, Lee and colleagues (2018) failed to find an association between maternal working memory and contingency or intrusiveness during scaffolding in their sample of South Korean mothers and their 4-5-year-old children, though they did find that cognitive flexibility was negatively associated with intrusiveness during scaffolding ($r = -.21$; Lee et al., 2018).

Parental Engagement in Stimulating Activities

There is also emerging evidence that parental executive functions influence their engagement in cognitive stimulating activities with their children, which is an important way that parents promote their children's language development (Cabrera et al., 2020; Lee et al., 2014). First, one study of mothers and their infants found that mothers' self-report of their effortful control, an aspect of EF, had a moderate influence on the amount of time mothers reported spending in caregiving activities, including play, reading, feeding, bathing, dressing, and holding their infants (Bridget et al., 2011). Though this study is limited by the reliance on self-report measures and a homogenous sample (e.g., participants were almost exclusively white and the majority were middle class), these results suggest that executive functions may operate on the quantity as well of the quality of positive parenting (Bridget et al., 2011).

In another recent study by Korucu and colleagues, researchers found that parental EF was not associated with the quality of parent-child interactions, but that it did predict parents' reports of how often they engaged in EF-specific, cognitively stimulating parenting practices (e.g., "I play games that require my child to stop, think, then act"; $\beta = .22$), even when controlling for age, income, gender, and parental education (Korucu et al., 2019). These results suggest that parental EF may also be operating through its influence on how much parents are engaging in the activities that are promotive of their children's early language development.

Gaps in the Literature

Overall, there is considerable evidence of the mediational model for the influence of parental EF on child outcomes through parenting. While this evidence is strongest for other cognitive outcomes, theory and the extant evidence suggests parental EF may influence children's early language skills. There is clear support for the role that parental EF plays in quality of parent-child interactions and scaffolding, both of which are important mechanisms for promoting child language. Meanwhile, the evidence for an influence of parental EF on parental engagement in cognitive stimulating activities highlights an exciting opportunity for future work. This is especially important to explore in early childhood during the sensitive periods in which parents are influencing their children's language development (e.g., 15- 20 months, Gilkerson et al., 2018), as well as when socioeconomic disparities begin to emerge (Daneri et al., 2018; Fernald et al., 2012; Kuhn et al., 2014). In addition to the omission of child language as an outcome and the limited work linking parental EF and engagement in cognitive stimulating activities, there are several gaps in the extant literature, including the role of contextual factors, lack of mediational evidence, and the absence of fathers.

First, it remains unclear exactly how the process through which parental EF impacts parenting and child outcomes is influenced by or interacts with other contextual variables. For example, Fontaine and Nolin (2012) explored whether there were differences in EF in parents who had been accused of child abuse or neglect and those without an abuse history. The researchers did not observe any group differences in their sample of 23 mothers and 26 fathers (Fontaine & Nolin, 2012). On the other hand, Deater-Deckard and colleagues (2012a) investigated the relationship between maternal EF and household chaos in a sample of 153 mothers and their 3 – 7-year-old children. They found that mothers with better EF skills reported less chaotic environments, an association that was moderated by socioeconomic risk so that the association between maternal EF and household chaos was strongest for mothers experiencing the highest socioeconomic risk (Deater-Deckard et al., 2012a). Similarly, Sturge-Apple and colleagues (2017) found that maternal inhibition positively predicted maternal sensitivity one year later and mediated the influence of socioeconomic status on maternal sensitivity in their sample of 185 mothers and their toddlers. This issue is further complicated by the lack of true tests of mediation. The vast majority of studies in this area are correlational or partial tests of mediation. Without a robust longitudinal design, that is predictor variables measured prior to outcomes and mediational analyses, it is difficult to establish the direction of influence and the temporal precedence of predicting variables.

Lastly, the evidence is largely drawn from samples of mothers. Of the studies reviewed here, four included a small proportion of fathers (Distefano et al., 2018; Kao et al., 2018; Korucu et al., 2019; St. John et al., 2018), one included roughly equal numbers of mothers and fathers (Fontaine & Nolan, 2012), and one was exclusively fathers (Meuwissen & Carlson, 2015). This is a notable omission for two reasons. First, it remains unclear whether parental EF relates to parenting and child outcomes in the same way that maternal EF does. Second, studies that estimate the influence of only one parent, mothers or fathers, may yield inaccurate estimates of the overall effect of parents' EF. Including both mothers and fathers is essential in truly understanding the ways in which parental EF influences parenting and child outcomes.

Chapter 3: Methods

Data Source

The Baby Books 2 (BB2) project is an ongoing randomized control trial of a parenting intervention in the United States to improve child development knowledge among first-time, low-income, cohabitating heterosexual parents (Cabrera & Reich, 2017). The goal of the BB2 intervention is to test whether increases in child development knowledge would increase parenting practices that promote optimal child development and improve the quality of parent-child relationships, which in turn would improve child outcomes. The intervention consists of bilingual (Spanish-English) read-aloud "baby books" for each developmental stage (i.e., 9-, 12-, 18-, and 24-months) embedded with anticipatory guidance (AG) messages. AG messages are based on the American Pediatric Association' Bright Futures Guidelines for Health Supervision (Hagan et al., 2008), providing advice (i.e., anticipatory guidance) to parents about how to promote children's socioemotional, cognitive, language, math, and physical development; improve parenting practices, including using appropriate discipline and safety practices; and, improve co-parenting support. The BB2 books include books for mothers and books for fathers. The books for each parent are equivalent in storyline and content, except that both the titles and main characters of the books for mothers are mothers (e.g., "Mommy's Growing Baby") and the title and main characters of books for fathers are fathers.

Participants

Parents participating in BB2 had to be co-residing; be first-time biological parents; have an annual household income up to $75,000, or 300% of the federal poverty line for a family of four, at the initial home visit and, pass a literacy screener administered during recruitment, which required at least a 1st grade reading level in either English or Spanish. A wide range of household incomes up to $75,000 were included to capture families that fall within the “low income” category as defined by the Department of Housing and Urban Development (HUD) Income Limits in the areas from which the families were recruited (HUD, 2017).

The sample for the larger study (N = 210 families) consists of first time, heterosexual parents. The sample is ethnically, economically, and linguistically diverse. Ethnic minority parents and parents reported English as a second language make up a majority of the sample, with at least a third of the families identifying Spanish as their primary language.

Analytic Sample

The analytic sample (n = 148 families; Table 1) for my study includes families for which outcome data (i.e., child language at the 18-month wave) were available (Table 3). Bias analyses comparing families who were missing data (n = 62) with families included in the analytic sample (n = 148) revealed that the two groups did not differ significantly on ethnicity, child language exposure, nativity status, parental age, marital status, childcare enrollment, household income, intervention condition, or study site. The only significant difference between the two groups was for maternal employment status ($F(1, 209) = 5.64$, $p = .02$), with more stay-at-home mothers in the analytic sample and more employed mothers not in the analytic sample.

Procedure

Mothers and fathers were recruited by English and English/Spanish bilingual researchers at community centers, physician offices, emergency room waiting rooms, farmers’ markets, parks, and WIC clinics in two major metropolitan areas--one in the mid-Atlantic and one in the Southwest. Recruitment took place over the course of 2 years. Families were recruited when their baby was less than 9-months of age and followed until their child was 48-months of age. Families were told that the project was aimed at understanding how reading to babies helps them learn and were offered children's books as well as financial compensation for their time.

Data collection for BB2 took place on a rolling basis over multiple home visits, phone calls, and online surveys when the children were 9, 12, 15, 18, 21, 24, and 30 months old. Participating families were consented at the baseline home visit when the child was 9 months old and were randomly assigned to one of the four conditions prior to completing their initial visit. The four conditions determined the type and number of books the parents received. The parents were given either: a "mommy" book *and* a "daddy" book, a "mommy" book only, a "daddy" book only, or a commercially produced book with no target parent. All of the books provided to families were bilingual and had text in both English and Spanish. All home visits (9-month, 18-month, 24-month, and 30-months) were scheduled at a time convenient for the family within five days (plus or minus) of their child's birthday for the target age at each wave (e.g., plus or minus five days from their 18-month birthday). Mothers and fathers were present for all baseline home visits and participated in data collection equally.

Data collection was conducted in either English or Spanish as requested by the participants. To ensure measurement equivalence, all measures were translated and back translated by native speakers from several regional dialects of Spanish (e.g., Mexico, Peru, Cuba, El Salvador, Spain, Chile). Both study sites were jointly trained on all data collection procedures through the use of video conferencing and all study staff met regularly to discuss best practices in order to maintain consistency across sites.

The home visits consisted of mother and father interviews, a child language assessment, a direct assessment of parents' EFs, and video-taped mother-child and father-child semi-structured interactions. The parent-child interactions included four sections: shared reading, free-play without toys, free-play with toys, and a clean-up task. Following the completion of data collection, fathers and mothers were shown a brief video that described the benefits of reading to infants and demonstrated strategies for positive parent-child reading interactions. At the conclusion of the video, the parents were given either intervention books or commercial books, based on condition. Parents were instructed to read the book to their child every day or as often as possible using the tips they saw in the video.

Phone interviews were conducted when children were 12, 15, and 21 months of age. Phone calls were scheduled separately for mothers and fathers, at times that were convenient for each parent. During the phone calls, parents were interviewed about changes to their employment and living arrangements, their child's health and social development, and their participation in the intervention. To minimize the burden of phone call surveys on participants, additional questions were administered using an online, web-based survey (i.e., Qualtrics). Those parents without reliable computer or internet access completed the survey via phone call. The Institutional Review Boards of two universities approved all project materials and procedures.

The data for this study (Table 2) were drawn from the first four waves of data collection: (1) the 9-month home visit, (2) the 12-month phone call survey, (3) the 15-month Qualtrics survey, and (4) the 18-month home visit.

More specifically, parental EF and most control variables (see measures section for a list of considered control variables) were measured at the 9-month home visit, child temperament (an omitted control variable) was measured during the 12-month phone call, parental home learning activities were measured during the 15-month Qualtrics survey, and child language skills were assessed at the 18-month home visit.

The parent-child interactions relevant to this study were observed during the 9-month home visit and focus on the 10-minute free-play with toys portion of the interaction. Parents were provided with developmentally appropriate toys and asked to play with their children as they usually would. This portion of the interaction was broken into two parts, each five minutes long, during which two different bags of toys were provided. Bag A of toys included a toy doll, a car, a helicopter, a ball, and a shape sorter, while Bag B contained a grocery store set (i.e., a cash register, basket, and assorted produce and dry goods) and a pizza kit (i.e., a toy pizza, pan, spatula, and shakers of cheese and pepper). Both the order in which the bags were presented and the order of mother-child and father-child interactions were randomized to reduce order effects.

Measures

Dependent Variable

The dependent variable in this study is child language. This variable represents an overall score for both receptive and expressive language skills, which were assessed during the 18-month home visit using the Preschool Language Scales- 4th Edition (PLS; Zimmerman et al., 2002). The PLS is widely used to assess language in young children because it is a measure that has been widely validated and provides age-appropriate standardized scores based on a nationally representative sample that was stratified based on parent education, geographic region, and race described by the 2000 Census (Zimmerman et al., 2002). Children were assessed in either English or Spanish as determined by their parent prior to the home visit. Parents of bilingual children who reported speaking a language other than English at home were instructed to identify the language in which the child was most proficient for assessment. Bilingual children were only assessed in the identified language and responses provided in another language were not included (i.e., assessments were not conceptually scored). Research assistants from both sites administered the assessment and were trained together by a Clinical Psychologist with substantial experience administering the PLS. In order to establish reliability within the study, research assistants were first required to administer the assessment to a trained graduate student and then correctly score a videotaped assessment done by a trained graduate student.

The PLS assessment yields an overall standard score in addition to two subscales, expressive communication and auditory comprehension (i.e., receptive language). English and Spanish versions of the assessment were designed to be functionally equivalent and as such, standard scores for both versions may be considered on the same scale. The PLS has strong psychometric properties including test-retest stability coefficients that ranged from .90 - .97 for the total score, and internal consistency reliability coefficients from .66 - .96 in the standardization sample, with the coefficients for most age-brackets over .81 (Zimmerman et al., 2002). For this study, I used the standardized total language score in order to represent global language skills including both expressive and receptive language. The standardized scores for all three scores (i.e., total language, auditory comprehension, and expressive communication) are calculated such that a score of 100 represents the average score within the population for the associated age range out of a possible range of 50 - 150, with a scores between 85 – 115 (which represents plus or minus one standard deviation in the population) considered normative (Zimmerman et al., 2002). The age-appropriate standardized total language score was entered as a continuous dependent variable in my analyses.

Independent Variables

Parental Executive Function. Mothers' and fathers' EF was directly assessed using the Hearts and Flowers task (HF: Davidson et al., 2006; Diamond et al., 2007). The HF task has been found to tap the attention shifting and inhibitory control aspects of EF (Blankson & Blair, 2016), and has been found to be valid with ethnically and economically diverse samples of children and adults (Camerota et al., 2019; Roy et al., 2014; Ursache & Raver, 2014; Ursache & Raver, 2015; von Suchodoletz et al., 2017). The assessment was administered electronically using an Android tablet and lasted approximately two minutes. Participants were shown three conditions. In the first condition, they were asked to press the same side of the screen when they saw a heart, then, in the second condition, the opposite side of the screen when they saw a flower. In the final condition, participants were shown a mix of hearts and flowers and must respond using the rules from the first two conditions. In each condition, participants are first allowed to practice the rule in an untimed pre-trial session before completing the timed test trial. In the timed test trials, participants had 750 milliseconds in which to respond. In a small number of cases (*n* = 10 parents in the analytic sample), participants completed a different version of the assessment, in which the allotted response time was greater than 750 milliseconds, due to administrator error. For these cases, responses entered after 750 milliseconds were scored as incorrect. Non-responses (i.e., the participant failed to respond during the allotted response time) and anticipatory responses (i.e., responses that were considered invalid due to insufficient response time to be a response to the stimulus, under 200 milliseconds) were coded as incorrect, consistent with established scoring procedures (Davidson et al., 2006; Diamond et al., 2007). The EF scores were calculated using the proportion of correct responses across all test trials (i.e., all of the timed trials in the first condition, second condition, and mixed condition) as that is thought to be the most accurate measure of global EF (Diamond & Kirkham, 2005; Diamond et al., 2007). EF scores were calculated separately for both mothers and fathers and were used as a continuous, independent variable in analyses.

Parental Home Learning Activities. Parental home learning activities were measured in two ways: the frequency of parents' engagement in cognitive stimulation activities and parental involvement in home literacy activities. Both measures were administered during the online Qualtrics survey portion of the 15-month parent interview.

Cognitive Stimulation Activities. Engagement in cognitive stimulation activities was measured using the five-item cognitive stimulation subscale of the Parent Engagement survey (Cabrera et al., 2016). Both mothers and fathers were asked how frequently they engaged in activities using a six-point scale that ranged from "*not at all*" to "*more than once a day*." Examples of items include "*sing songs with your child*" and "*tell stories to (him/her)*." The subscale score was created by taking the average score of the five items. The reliability of this scale in my sample was acceptable (α = .70).

Parental Involvement in Home Literacy Activities. Both mothers and fathers were asked to report on their engagement in literacy activities with their children using the Parental Involvement in Home Literacy Activities subscale of the Home Literacy Environment Scale (Farver et al., 2006). For this measure, parents were asked to identify how often they engage in literacy-related activities, such as "*how often do you read to your child at home?*" and "*how often do you try to teach your child the letters of the alphabet?*", using a 7-point Likert scale ranging from 1, for never, to 7, for daily (Farver et al., 2006). The Parental Involvement in Literacy Activities subscale is an average of five items that are specific to the parent's behavior.

In my sample, the reliability of the overall scale was good (α = .80), and reliability of the subscale was moderate (α = .66).

In order to model the underlying construct of how often a parent is engaging in different home learning activities with their children, I created two latent factors representing maternal and paternal home learning activities using the summary scores from the two measures described above. Latent variables are better suited than measured composite variables here as they represent the underlying construct of the related observed measures while accounting for measurement error (Pett et al., 2003; Streiner 2006).

Control Variables

The goal of my study was to explore the relationship between parental EF, parental home learning activities, and child language. To do this, I aimed to isolate the influence of parental EF separate from other confounding factors. At the same time, overcontrolling for confounding factors, particularly those with which the relationship with parental EF is unclear, may have limited my ability to detect the true influence of parental EF (Grewal et al., 2004). I used two methods to balance the need to account for other factors with the need for a parsimonious model. First, I explored the correlations between all factors that could theoretically be relevant to this process to identify which are relevant to my sample (Tables 5 and 6). Second, I fit my model both with and without control variables to conduct the most sensitive test of my hypothesized paths and account for multicollinearity.

My preliminary analysis of potential control variables included 17 variables in association with all identified primary variables (i.e., parent EF, average scores for both indicator subscales for parental home learning, and child language total scores) as well as with the specific language domain scores (i.e., expressive and receptive language). The control variables I considered were parent age, parental education, household income, whether the parent was working or in school, the hours per week the parent spent at work or in school, whether the child was enrolled in childcare, the hours per week the child spend in childcare, the number of adults living in the home, parental nativity status, parental child development knowledge, the total number of words parents used during observed parent-child interactions, the quality of observed parent-child interactions, parents' home language, child gender, difficult child temperament, study site, and intervention condition.

Four variables emerged as relevant for my sample (Table 2) and were included as control variables in my analytic model: parent education, parents' word count, parents' home language, and study site. Although intervention condition was not associated with my primary variables at the bivariate level, I also included it as a control for both parental home learning factors as well as child language skills, as those are intended targets of the intervention being evaluated in the larger study (Cabrera & Reich, 2017). I describe these variables in detail below. Additional information on the measurement of omitted variables can be found in the appendix.

Parental home language was measured as a dichotomous variable indicating whether the parent reported they spoke English or Spanish (or another language) with their child at the 9-month home visit. Parental education was measured as the highest level of education received by each parent and is a five-level categorical variable that includes "less than high school," "completed high school," "some college," "completed a two or four-year degree," and "more than a four-year degree." Parental word count for both mothers and fathers during parent-child interactions was calculated from the transcripts of mother-child and father-child interactions at the 9-month wave. This continuous variable represents the total number of words spoken by the parent during the free-play portion of their parent-child interaction. Parental home language, word count, and education were measured separately for mothers and fathers and were controlled for on the primary variables for the respective parent (e.g., maternal home language, maternal word count, and maternal education were controlled for on maternal EF, maternal home learning activities, and child language skills).

Study site is a dichotomous variable that represents where the family participated in the study (i.e., at the University of Maryland site or the University of California, Irvine site). Study site was included for two reasons. First, there were some demographic differences between the samples at the two universities at the bivariate level (Tables 5 and 6). Second, though substantial efforts were made to ensure consistent procedures and measurement across site, it is possible that differences in in administration had an influence on the variables of interest. Finally, intervention condition is a dichotomous variable that indicates whether or not the family was assigned to one of the three experimental conditions (i.e., the "both" condition in which families received two intervention books-one for mothers and one for fathers, the "dad" condition in which families received one "dad" book, the "mom" condition in which families received one "mom" book) or the control condition in which families received one commercially available book for both parents. Because parents received their first book(s) (i.e., "treatment") at the conclusion of the 9-month home visit, the intervention condition could not have impacted parental EF at 9-months. As such, intervention condition was only controlled for on maternal home learning activities, paternal home learning activities, and child language skills.

It is important to note that the demographic control variables covaried to some degree, which may have introduced some multicollinearity into the overall model even though all observed bivariate correlations were well below the standard threshold for multicollinearity (i.e., ρ = .75 to .95; Grewal et al., 2004). Structural equation modeling allows for the covariance between variables which ameliorates some of the consequences associated with multicollinearity (Tarka, 2018). The primary consequence of multicollinearity in SEM is unstable parameter estimates, that is the overall estimation of variance accounted for by the model should be robust to effects of multicollinearity, but the parameter estimates for specific paths in the model may be unstable (Grewal et al., 2004; Yuan & Chan, 2008). In the context of my study, multicollinearity should not have influenced my ability to test whether the overall model accounts for significant variance in my sample. Instead, the consequence of multicollinearity would be that I may not be able to distinguish the degree to which influences on endogenous variables were due to specific control variables (e.g., whether it was parental education or parental home language that has a true influence on parental EF, though the overall estimate of an influence on parental EF should be accurate). Since the focus of my study is on the influence of parental EF and not the unique influence of the control variables, I addressed this by comparing the full analytic model to a model without control variables.

Analytic Plan

First, I conducted descriptive analyses for all study variables, including psychometric properties of each measure within my analytic sample, summary statistics for child language, parent EF, all indicator variables for the maternal and paternal home learning activities factors, and control variables. I also calculated bivariate correlations between all study variables.

To test my hypotheses, I used structural equation modeling (SEM; Figure 2). I used Mplus8 (Muthén & Muthén, 2017) to fit my conceptual model simultaneously to conduct a latent variable path analysis to test direct paths between parental EF and child language, and indirect paths through parental home learning activities. Latent variable path analysis allows for the assessment of theoretically identified direct and indirect influences on measured and latent variables (Hancock & Muller, 2006). This approach was more appropriate for my analyses than multivariate regression because it allowed me to test hypothesized causal links, conduct a simultaneous test of all of the direct and indirect paths, and differentiated between error and unexplained variance (Hancock & Muller, 2006). Moreover, the use of latent variables to represent maternal and paternal home learning activities allowed for the assessment of the underlying construct and at the same time accounted for measurement error (Pett et al., 2003; Streiner, 2006).

First, I conducted confirmatory factor analyses (CFA) to create two latent variables for maternal and paternal home learning activities. As described above, the parental home learning activity factors were originally indicated by 10 items, five items from the cognitive stimulation subscale of the Parent Engagement scale and five items from the Parental Involvement in Literacy Activities subscale of the Home Literacy Environment Scale. Guided by the standard practice in latent modeling, any indicator variables with loadings less than |.4| were removed from the model as low loadings represent poor data-model fit (Pett et al., 2006).

My structural equation model is presented in Figure 2. My model includes maternal and paternal EF which were hypothesized to be related to maternal and paternal home learning activities factors, respectively, which were then related to child language skills, a measured variable. I also hypothesized that both paternal and maternal EF would be directly associated with child language skills. Maternal and paternal EF, as well as both the maternal and paternal home learning activity factors, were allowed to co-vary. In terms of control variables, the influence of study site was controlled for on all primary variables (i.e., maternal and paternal EF, maternal and paternal home learning activities factors, and child language), and the influence of intervention condition was controlled for on maternal home learning activities, paternal home learning activities, and child language. The influence of demographic control variables parental education, word count, and home language were controlled for on all primary variables, with maternal control variables controlled on the maternal primary variables (i.e., maternal EF and maternal home learning activities) and child language, and paternal control variables controlled on the paternal primary variables (i.e., paternal EF and paternal home learning activities) and child language. I fit my model using full information maximum likelihood (FIML) estimation to account for missing data within my analytic sample.

In FIML missing data are addressed within the analyses such that all available information is used to estimate the model parameters. To do so, FIML estimates parameters based on what population parameters from which the observed sample data would most likely be produced. Essentially, the goal of FIML is to estimate the most probable parameters within the population given the observed covariance matrix (Enders, 2013).

To evaluate model fit, that is the degree to which the observed data aligned with my model, I used three measures of model fit as recommended by Hancock and Muller (2006): (1) the Comparative Fit Index (CFI), (2) the Root Mean Square Error of Approximation (RMSEA), and (3) the Standardized Root Mean Residual (SRMS). I used the most rigorous standards for defining an adequate model fit using these statistics. The CFI represents the degree to which the observed model aligns with the hypothesized model, adjusting for sample size. Higher CFI values represent a better data-model fit within the possible range of 0 - 1 (Bentler, 1990). RMSEA describes the residual variance in the model also represented by a value between 0 – 1, where smaller values indicate less residual variance and thus a better data-model fit (Hu & Bentler, 1999). Finally, SRMS provides an absolute measure of data-model fit and represents the standardized difference between the hypothesized and observed models, with smaller values indicating a better fit (Hancock & Muller, 2006; Hu & Bentler, 1999). I conducted a theoretically grounded model modification by adjusting parameters (e.g., fixing or freeing parameters in the model, adjusting the structure of indicators for latent variables) as necessary and theoretically appropriate to achieve adequate data-model fit.

Once I achieved an adequate data-model fit, I conducted latent variable path analyses to test the paths specific to each question.

RQ 1 Hypotheses: (1a) Mothers with better executive function when their infants are 9 months will have toddlers with higher language scores at 18 months. (1b) Fathers with better executive function when their infants are 9 months will have toddlers with higher language scores at 18 months.

RQ 1 Analyses: I tested whether maternal EF and paternal EF had a significant, positive direct effect on child language skills (Figure 1 paths A and B, respectively).

RQ 2 Hypotheses: (2a) Mothers with better executive function when their infants are 9 months will have toddlers with higher language scores at 18 months because they engage in more home learning activities at 15 months. (2b) Fathers with better executive function when their infants are 9 months will have toddlers with higher language scores at 18 months because they engage in more home learning activities at 15 months.

RQ 2 Analyses: For this question, I tested whether maternal EF and paternal EF had a significant, positive indirect effect on child language skills through maternal and paternal home learning activities (Figure 1 paths C and D, respectively). I used bootstrapping to test for the significance of indirect effects using 1,000 bootstrapped samples to determine a 95% confidence interval for significance.

Power Analysis

There are two primary considerations in terms of statistical power in SEM: the ability to detect adequate data model fit for the full model (i.e., to reject the null hypothesis that there is not adequate data model fit using the standards described above) and the ability to test specific parameters within the model (i.e., to reject the null hypothesis that a specific structural path within the model is not significant). Power analysis for the full model depends on the level of the data model fit (i.e., the degree to which the model accurately represents the process within the population), the desired power level (e.g., .80 for RSMEA which corresponds to a test using an alpha of .05), the degrees of freedom in the model, and the sample size (Hancock & Muller, 2006). Hancock & Muller provide examples of what sample sizes are required to achieve adequate power depending on each of those factors. My sample size was 148 families and there were 516 degrees of freedom in my model, which well exceeded the threshold necessary to test the data model fit of the full model using $\alpha = .05$ with adequate data model fit as indicated by RSMEA. My analytic model and sample size had power of .98 using the recommended standard of $\varepsilon_1 = .02$ for data-model fit (Hancock & Muller, 2006), and power of .86 using the even more conservative standard of $\varepsilon_1 = .03$ (Preacher & Coffman, 2006).

For the second issue of whether or not my model had sufficient power to detect specific significant paths within the model, the recommended power analysis depends on whether it is an *a priori* or post hoc power analysis. As my study is a secondary data analyses, all power analyses are considered to be post hoc power analyses. Post hoc power analysis is recommended to be estimated after the proposed analyses have been conducted (Hancock & Muller, 2006). In this case, the recommended approach is to first estimate the parameters within the model and, if they are not significant, simulate what the required sample size would be if the estimate represented an accurate and significant effect within the population. If the sample size is comparable to that of my study, then the parameter is likely not significant within the population and represents a true null finding. However, if the sample size required greatly exceeds that in my study, then the null finding could reflect either that the parameter is not significant in the population or that the parameter is significant in the population but was not detected due to lack of power.

With this approach, non-significant parameter estimates that are theoretically hypothesized to be significant are evaluated to determine whether the lack of significance may be due to a lack of power (Hancock & Muller, 2006). I conducted post hoc power analyses for all non-significant parameters that I hypothesized to be significant in the population using the established standards described by Hancock & Muller (2006).

Chapter 4: Results

Descriptive Statistics

Descriptive statistics for the primary variables and indicator items are shown in Table 4. Overall, the data for the independent, mediating, and dependent variables were normally distributed and had adequate variability. For the independent variable of EF, mothers in my sample responded to 41% of the test trials correctly in the EF assessment and fathers responded to 47% of test trials correctly. Parental EF scores were normally distributed though the average accuracy was lower than what has been observed in other studies (e.g., von Suchodoletz et al., 2017). For the home learning activities indicator items, both mothers and fathers responded that they engaged in relatively high levels of home learning activities with the exception of one item, "*how often do you go to the library with your child?*" which had an average of 2.2 for mothers and 2.1 for fathers, corresponding to the response scale item "*almost never*." The remaining indicator items had adequate variability and met the assumptions required for latent factors (e.g., normally distributed). For child language, $M = 90.9$, $SD = 9.1$, which is below the population mean, though this difference is within one standard deviation of the mean ($\mu = 100$; $\sigma = 15$, Zimmerman et al., 2002).

Preliminary Analysis

Prior to testing the structural paths in the proposed model, I first conducted a confirmatory factor analysis (CFA) to evaluate the measurement components of the latent factors for maternal and paternal home learning activities. CFA is used to confirm that the observed data are consistent with the hypothesized latent factors (Hancock & Muller, 2006). The parental home learning activity factors were originally proposed to be indicated by ten items, five items from the cognitive stimulation subscale of the Parent Engagement scale and five items from the Parental Involvement in Literacy Activities subscale of the Home Literacy Environment Scale. The fit of the original proposed factor structure met or fell below accepted standards for data-model fit. RMSEA= .05 (90% CI [.03 – 0.07]) met the accepted standard of RMSEA ≤ .06 though to upper bound of the confidence interval fell outside that range. When accounting for rounding, SRMR = .08 exceeded the standard of SRMR ≤ .08. Lastly, CFI = .90 fell below the recommended standard of ≥ .95. In the original CFA, one item (*"how often do you take your child to the library*") emerged as a particularly poor indicator for both mothers and fathers. It did not adequately load onto the maternal factor ($\beta = .27$, $p > .05$) and paternal factor ($\beta = .32$, $p > .05$). Standard practice in the field is to remove any indicator variables with loadings less than |.4| as low loadings represent poor data-model fit (Pett et al., 2006).

A CFA model fit with the remaining nine items (Table 7) indicating the home learning factors for each parent had adequate fit. The three fit indicators exceeded standard thresholds for acceptable fit: RMSEA = .00 (90% CI [.00 - .04]), CFI = 1.0, SRMR = .06. Additionally, a model comparison of the two CFA models showed that the modified model with 9 indicators for each parent was the superior fit ($\Delta\chi^2 = 90.35$, $df = 35$, $p < .001$). All of the 9 indicators loaded adequately for at least one parent (Table 7) and were thus retained in the final model.

Path Analysis

My structural equation is presented in Figure 2. The model includes hypothesized paths that paternal and maternal EF were directly associated with child language skills as well as indirectly through that maternal and paternal home learning activities. Maternal and paternal EF, as well as both the maternal and paternal home learning activity factors, were allowed to co-vary, as were indicator variables within and between parents.

The model also includes key family and demographic control variables. Study site was controlled for on all primary variables (i.e., maternal and paternal EF, maternal and paternal home learning activities factors, and child language), and the influence of intervention condition was controlled for on maternal home learning activities, paternal home learning activities, and child language. Parental education, parental word count, and home language were controlled for on all primary variables, with maternal control variables controlled on the maternal variables (i.e., maternal EF and maternal home learning activities) and child language, and paternal control variables controlled on the paternal variables (i.e., paternal EF and paternal home learning activities) and child language.

Model fit statistics and significance values could not be computed for the proposed model (Figure 2). This was likely due at least in part to the large amount of residual variance for one of the indicator items for the maternal and paternal home learning activities factors, "*how often do you read to your child at home*." Residual variance is the amount of variance not accounted for by error or the latent factor (Hancock & Muller, 2006). Model modification indices indicated that the residual variance of that item was being driven in part by parental education and home language for both parents, which is consistent with the literature on determinants of parental reading behaviors (Storch & Whitehurst, 2001; Suizzo & Stapleton, 2007). Thus, structural paths were added to the model such that maternal education and maternal home language predicted the indicator item "*how often do you read to your child at home*" for mothers, and paternal education and paternal home language predicted the same indicator item for fathers. The modified final model is illustrated in Figure 3.

The fit of the final model was adequate, with all of the three fit statistics meeting or exceeding acceptable standards. RMSEA = .03 (90% CI [.00 - .04]) fell below the standard of

RMSEA ≤ .06. SRMR = .06 fell below the standard of SRMR ≤ .08. The third assessment, CFI = .95, met the recommended standard of ≥ .95. The overall model (Figure 4) explained a significant amount of variance in child language scores (R^2 = .15, p < .01).

Direct Effects

The coefficients for the direct influence of study variables on total child language are presented in Table 8. Neither the direct path from maternal EF to child language (β = .09, p = .45) nor the direct path from paternal EF to total child language (β = -.09, p = .51) were statistically significant.

Indirect Effects

The indirect effect from maternal EF total child language through maternal home learning activities (β = -.002, 95% CI [-.044, .020], p > .05) was not statistically significant. Similarly, the indirect effect from paternal EF to child language through paternal home learning activities was not statistically significant (β = .001, 95% CI [-.063, .057], p > .05).

Other Findings

The model yielded several other significant findings. First, maternal and paternal word count, as hypothesized, during the 9-month interactions were the only statistically significant predictors of children's total language scores (: β = .23, p < .01 and β = .15, p < .05, respectively). Second, maternal and paternal education were negatively and significantly associated with maternal and paternal EF (β = -.27, p < .01; β = -.24, p < .01). Third, fathers with higher EF scores when their child was 9 months engaged in significantly more home learning activities when their child was 15 months than? (β = .21, p = .03) whereas mothers with higher levels of education engaged in more learning activities than mothers with less ($\beta = .26$, $p < .05$).

Models without Control Variables

In order to disentangle the influence of parental EF on child language from the influence of the control variables, I fit the same model described in Figure 3 without control variables (i.e., education, home language, and word count for both mothers and fathers, study site and intervention condition) for each of the language scores (i.e., total, expressive, and receptive the latter of which are discussed below). The full results of these models are not reported here but are available upon request. Each of the three models scores achieved adequate fit: all three criteria for model fit exceeded conventional standards. However, none of the models explained a significant amount of variance in language scores. The parameter estimates from these models were consistent with those observed in the models with control variables; neither the hypotheses for direct nor indirect effects were supported.

Post Hoc Power Simulation

I conducted post hoc power simulations in order to determine whether my study had the statistical power to detect specific parameters within the model. I simulated 1000 datasets using the parameter estimates generated from my final model (Figure 3) using pwrSEM (Wang & Rhemtulla, 2021) in RStudio (Version 1.0.143; RStudio Team, 2016). This procedure allowed me to estimate the power to detect an effect if the estimated parameters are significant and accurate in the population, even though they were not significant in my model (Hancock & Muller, 2006; Wang & Rhemtulla, 2021). The targeted non-significant parameters were: the direct influence of maternal EF on child language, the direct influence of maternal EF on maternal home learning activities, the direct influence of maternal home learning activities on child language, the indirect influence of maternal EF on child language through home learning activities, the direct influence of paternal EF on child language, the direct influence of paternal home learning activities on child language, and the indirect influence of paternal EF on child language through paternal home learning activities. First, I estimated the power using my actual sample size, results of which for each parameter fell well below acceptable standards (Table 9). Second, I incrementally increased the simulated sample size until adequate power (i.e., greater than .80) was achieved for each parameter which showed that sample sizes much larger than those in my study would be required to identify the parameters as significant (Table 9). These results indicate that null results could be due either to the absence of a meaningful effect or to lack of power to detect a significant effect (Hancock & Muller, 2006).

Supplementary Analyses

The literature on the association between family characteristics and children's language skills suggest that receptive and expressive vocabulary develop at different rates and are predicted by different outcomes (Clark, 1995; Ryan et al., 2016). Therefore, I tested whether parental EF was related to receptive or expressive language skills. I conducted supplementary analyses by fitting my original model using both expressive and receptive language skills as outcome variables.

Expressive Language

First, I fit the same model described above (Figure 5) using the expressive communication subscale standard score of the PLS as the outcome. The model achieved similarly adequate fit to the prior model, (RMSEA = .04 (90% CI [.02 - .05]), CFI = .91, SRMR

= .07) and explained a significant amount of variance in expressive language scores (R^2 = .18, p < .01). Results of this model (Figure 5) were similar to the prior model. Neither maternal nor paternal EF had a statistically significant direct influence on children's expressive language (Table 8). Similarly, the indirect influences of maternal and paternal EF on child language through maternal and paternal home learning activities were also not statistically significant (mothers: β = -.002, 95% CI [-.052, .068], p > .05; fathers: β = -.004, 95% CI [-.023, .047], p > .05).

Receptive Language

I then fit the model described in Figure 6 using the auditory comprehension subscale standard score of the PLS, which measures receptive language skills, as the outcome variable. Again, the model achieved similarly adequate fit to the primary model, (RMSEA = .03 (90% CI [.01 - .05]), CFI = .92, SRMR = .07) and explained a significant amount of variance in receptive language scores (R^2 = .11, p < .05), though this was less than both the primary model and expressive language model. Results of the receptive language model (Figure 6) were similar to the primary model. Neither of the direct effects from parental EF to child language (Table 8) were statistically significant, nor were the indirect effects from parental EF to child language through home learning activities (mothers: β = -.002, 95% CI [-.016, .033], p > .05; fathers: β =.006, 95% CI [-.042, .064], p > .05).

Chapter 5: Discussion

The goal of this study was to expand the literature on how parental EF influences child development by examining a model that tested whether parental EF influences child language skills, in part through its influence on parenting behaviors. I drew upon a sample of ethnically and racially diverse, low-income families- including both mothers and fathers, and used a longitudinal design, both of which are uncommon in the extant literature in this area. This work represents an empirical test of the theoretical models that posit parental EF influences children both directly and indirectly through parenting (Bridgett et al., 2015; Crandall et al., 2015).

The Direct Influence of Parental Executive Function on Child Language

First, I hypothesized that there would be a positive, direct effect from both parents, such that mothers and fathers with better EF would have children with better language skills. Contrary to my hypothesis, there was no significant direct effect from either maternal EF or paternal EF on children's total language scores, expressive language, or receptive language.

Theoretical models suggest that parental EF has a direct impact on children's cognitive outcomes (e.g., Bridgett et al., 2015; Crandall et al., 2015), and there is strong evidence of this link for child EF and conduct problems (see Bridgett et al., 2015 and Crandall et al., 2015 for reviews). However, initial evidence of a direct association between parental EF and child language has been mixed, and this evidence has been drawn from samples of older children (i.e., preschool) than were included in this study (Boutwell & Beaver, 2010; Chen et al., 2020; Distefano et al., 2019; Kao et al., 2018; St John et al., 2018; & Suor et al., 2017). The results of my study do not support the theory that parental EF has a direct influence on child language. It is possible that the non-significant associations between parental EF and child language represent a true null finding, as many have suggested that EF is a biologically heritable trait (Bridgett et al., 2015; Deater-Deckard, 2014; Diamond, 2013), and the genetic influence of parental EF might not extend to language skills.

Another possible explanation for the null findings is that parental EF has a direct influence on child language but is a lagged effect (i.e., a dependent variable has a delayed response to an independent variable; Kuiper & Ryan, 2020; Mayer & Carroll, 1987). If this is the case, the influence of parental EF when children are 9 months old was not yet observable at 18 months of age but will emerge later in life. This interpretation aligns with the developmental trajectory of language abilities. There is a period of rapid language development between the ages of 15 – 24 months (MacWhinney, 2011). It could be that the direct influence of parental EF is only observable later during or after the completion of that sensitive period. Further study with children before, during, and after the sensitive period for language development in toddlers in order to fully investigate whether there is a direct influence of parental EF on child language.

Indirect Influences of Parental Executive Function through Home Learning Activities

For my second research question I hypothesized that, for both mothers and fathers, parents with better EF would have children with better language skills because they engage in more home learning activities. I found no evidence parental EF influences child language indirectly through home learning activities- neither the indirect effect of maternal EF nor the indirect effect of paternal EF was significant. There are two direct paths of influence contained within my RQ2 hypothesis: (1) that parental EF will positively influence home learning activities, and (2) that home learning activities will positively influence child language. For mothers, neither of the paths from maternal EF to maternal home learning activities nor from maternal home learning activities to child language were significant. However, for fathers, there was a significant effect from paternal EF to paternal home learning activities but not from paternal home learning activities to child language.

Parental Home Learning Activities and Child Language Skills

In order for a variable to act as a mediator, it must be directly related to the outcome variable (Muthén, 2011). In this study, neither maternal home learning activities nor paternal home learning activities had a significant direct influence on child language, which precluded the presence of an indirect effect through home learning activities. However, because I used SEM, I tested both the direct paths and the overall indirect paths simultaneously, rather than sequentially as is done in regression models (Hancock & Muller, 2006).

There are several possible reasons for this null finding. First, the measure of parental home learning activities used in this study is a measure of the frequency of those activities, not the quality of those activities. The quality of parent-child interactions, particularly around learning activities, has been consistently demonstrated to predict child language (Baumwell et al., 1997; Justice et al., 2019; Malin et al., 2014). Even in this study, parental word count, one measure of the linguistic quality of interactions, significantly predicted child language. It may be that the quality of parental home learning activities is more salient than the frequency for language development at this stage. Another possible explanation for this finding is once again that it may be a lagged effect. The influence of more frequent parental home learning activities when children are 15 months old may not be observable until later in life. In either case, further research is needed to clarify the relationship between parental home learning activities and child language skills.

Parental Executive Function and Home Learning Activities

The substantial literature that demonstrates an influence of parental EF on parenting behaviors (see Crandall et al., 2015 for a review) informed my hypothesis that parental EF would influence child language indirectly through home learning activities. However, for mothers, the portion of the hypothesis referring to a positive influence of maternal EF on maternal home learning activities was not supported. This was not the case for fathers. While the overall hypothesis of an indirect effect of paternal EF on child language was not supported, there was a significant, positive influence of paternal EF on paternal home learning activities. In this study, fathers with better EF engaged in more frequent home learning activities.

To my knowledge, this is the first study that has yielded differential results for the influence of parental EF on parenting behaviors by parent gender. This finding suggests that the omission of fathers from much of this theoretical and empirical literature is even more problematic than previously described. Theoretical models of the influence of parental EF are drawn largely from mothers (Crandall et al., 2015) but some have suggested that these models can be similarly applied to fathers (Bridgett et al., 2015; Deater-Deckard, 2014). That assumption directly influenced my decision to draw upon a theoretical framework that was conceptualized for mothers, however, the finding that EF has a different influence on parenting behaviors for fathers than it does for mothers calls that assumption into question.

There could be many reasons for the differential influence of parental EF on maternal and paternal parenting in this study. First, there may be additional influential or moderating factors that were not included in this study. It could be that paternal EF was acting as a proxy for another paternal characteristic that has a positive influence on paternal behaviors in this sample. It could also be that there are moderating influences, particularly related to socioeconomic status and education. For mothers, education was the only variable that predicted maternal home learning activities, while education was not a significant predictor of home learning activities for fathers. The unusual association between education and EF in this sample may also be relevant to the differential influence of EF on parenting behaviors for mothers and fathers. Additional research is needed to elucidate the relationship between EF and parenting behaviors for all parents.

Other Findings

This study also yielded two notable findings that were outside the scope of my primary research questions. First, parental EF was negatively related to education, such that more educated parents had lower EF skills, for both mothers and fathers. This result is inconsistent with the extant literature suggesting that EF and education are positively associated. However, this could be a situation in which context matters. The literature linking EF and education comes from more well-resourced samples that were largely conducted in the US (Hackman et al., 2015; Sektnan et al., 2010;), many of which do not report the nativity status of their sample. It could be that the cognitive benefits of increased education (i.e., improvements in EF) depend on the educational setting, which may have been different for the low-income, majority immigrant sample in this study. Another reason may be that the cognitive benefits previously attributed to education are actually reflecting another aspect of socioeconomic prestige or social capital associated with higher education in the US, rather than the educational experience itself. For immigrants to the US, education obtained outside the US provides less social capital than education obtained in the US (Friedman & Krackhardt, 1997; Zahn 2015). In this case, immigrant parents would lack the social capital that is usually associated with education, which results in the negative association between education and EF. This argument is supported by the post hoc analyses (see appendix) that showed the negative bivariate association between education and EF was only significant for the immigrant parents in this sample. A third possibility is that the negative association between education and EF represents another aspect of the immigrant paradox (Coll & Marks, 2012; Millet, 2016; Vaughn et al., 2014), such that those who immigrate to the U.S. with very low levels of education have unusually strong cognitive skills (see appendix). This may be particularly relevant to my sample, as these parents were voluntarily seeking out a program designed to promote reading and learning in their children. Thus, the immigrant parents with low education in my sample are likely a highly motivated, highly regulated group. Future research should explore the relationship between education and EF in diverse contexts.

The second notable finding was the differential strength of influence of maternal and paternal word count on child language. The positive influence of both maternal and paternal word count during the 9-month interactions on child language at 18 months is consistent with the extant literature (Romeo et al., 2018; Zimmerman et al., 2009). What is notable about this finding is that, in this sample, mothers had a larger influence on child language than fathers. This was particularly true for expressive language, for which paternal word count was not a significant predictor. One reason for this finding could be that mothers and fathers spend different amounts of time with their children in this sample. Though a direct measure of time spent with their child was not available, post hoc analyses (see appendix) showed that fathers reported more hours working per week than mothers in this sample.

Limitations

No empirical effort is without limitations, and my study is no exception. First, though this study uses a longitudinal, mediational design, each of the primary variables (i.e., parental

EF, home learning activities, and child language) were only measured at one point in time. Best practice in longitudinal modeling is to measure each variable at each timepoint (Hancock & Muller, 2006), which was not possible with the dataset I used. Furthermore, given the rapid growth in language skills during this developmental period, investigation of the relations between parental EF and child language should be explored before, during, and after this sensitive period.

Another limitation of this work is my measure of language. Thought the PLS is a widely used and well validated measure, it may not have been the best measure for this study. First, the PLS only provides information about children's language skills in a single language, either English or Spanish. Given the large number of bilingual and multilingual families in my sample, it is likely that the language skills of those children were underestimated. This is particularly true for children whose primary language was not English or Spanish, several of which were missing PLS scores due to a total lack of comprehension during administration. Another challenge with the PLS is that it is measuring language within a specific context which may not be the most salient aspect of language related to the parenting variables included in my study (i.e., home learning activities). It could be that another measure of language, such as frequency and diversity of language coded from videotaped interactions would have been related to home learning activities in my sample. Finally, a measure of language at 18-months is incredibly early. Children are just beginning to form complete words and often still largely communicate with less specified vocalizations. This limitation again calls for assessment of language throughout this sensitive period.

The measure of home learning activities is an additional limitation of my study for several reasons. First, home learning activities were self-reported. Multi-method measures of parenting have been established as the gold-standard, as self-report measures may be more susceptible to bias or social desirability and parents may be unaware of their own behaviors (Power et al., 2013), while other aspects of parenting may be unlikely to be observed in the research setting (Deater-Deckard & Bell, 2017). Second, it may not be the most salient parenting process to language development at this age or in the specific context of this sample. It may be that other formal or informal learning activities, conversational exposure and diversity, or other aspects of language such as gestures are more important for the children in my sample.

Finally, my study did not explore any moderators or moderated mediation. First, this is an important next step as prior work has shown that parental EF and contextual variables may interact to influence parenting (Deater-Deckard et al., 2012a; Sturge-Apple et al., 2017), which is consistent with the unusual association between education and EF depending on immigration status in my sample. Furthermore, other aspects of my study design may have interacted with my primary variables and influenced by results. For example, it is possible that the influence of the intervention attenuated the influence of EF on home learning activities for mothers. Another example is that of bilingualism, it could be that EF supports specific aspects of bilingual language development or bilingual parenting. Finally, there may be important differences in the variability of language development at 18 months depending on socioeconomic status, nativity status, number of adults in the home, or home or other language environments.

Implications

This study has both academic and practical implications. The primary academic implication is the clear need for more diverse participants in empirical research and the consideration of context in theory development. The omission of both fathers and immigrants in this area of research has direct consequences for the developmental theories and conceptual frameworks that are based upon empirical evidence. The results of this study highlight the consequences of homogenous samples and the importance of considering context. For fathers, the supposition that cognitive abilities and self-regulation influence parenting similarly for both parents must be empirically tested rather than assumed. For context, the lack of contextual awareness- even in simply reporting demographics such as nativity status, is problematic as the processes observed in one population are assumed to be normative.

The practical implication of this study relates to parental EF as a target of intervention. Several have argued that parental EF may be an untapped opportunity to improve parenting behaviors and subsequently child development. The results of this study suggest that this step may be premature. More research is needed to understand the role of EF in parenting and child development for both mothers and fathers, as well as in other domains of child development such as language.

Conclusion

This study did not find evidence of the theoretical models that posit parental EF influences children's language both directly and indirectly through parenting. As this work represents one of the first efforts in this area, more work is needed to fully understand whether parental EF influences child language. It must be noted that this effort is limited to a single, specific measure of language and not child outcomes broadly. Additionally, I did not find evidence that maternal EF influences maternal parenting behaviors, though I did find evidence of this influence for fathers. This study demonstrates the unique role of mothers and fathers in shaping child development, the variability of parental characteristics as determinates of parenting, and particularly the importance of context in understanding developmental processes.

Tables and Figures

Tables

Table 1: Analytic Sample Demographics

Table 1

Analytic Sample Demographics

	All Parents (*N* = 396)	Fathers (*n* = 148)	Mothers (*n* = 148)
	M(SD)/ %	M(SD)/ %	M(SD)/ %
Child is a boy	48%	--	--
Parent Age	28.2 (6.1)	29.3 (6.5)	27.1 (5.5)
Parent born in U.S.	45%	44%	48%
Primary Language			
English	8%	8%	9%
Spanish	7%	7%	7%
Bilingual: English/ Spanish	63%	63%	63%
Bilingual: English/ Other	7%	7%	7%
Multilingual	15%	15%	14%
*Race/Ethnicity**			
Hispanic/ Latino	72%	68%	68%
Black	13%	12%	13%
Asian	6%	6%	4%
Multiracial	2%	5%	7%
White	7%	8%	7%
Other	< 1%	1%	1%
Education			
Less than high school	16%	22%	10%
Completed high school	21%	24%	19%
Some college	31%	29%	32%
4-year degree or higher	32%	25%	39%
Household Income			
$10,000 or less	11%	7%	14%
$10,001 to $20,000	17%	15%	19%
$20,001 to $30,000	9%	8%	17%
$30,001 to $40,000	12%	10%	15%
$40,001 to $50,000	21%	25%	11%
More than $50,000	30%	34%	25%

Note. Both mothers and fathers were asked to report on either their household income or both partner's income and their own (which were combined to create household income). Consistent with previous findings in income reporting, there is a large amount of variability and inaccuracy in self-reported income data which may account for differences between maternal and paternal reports (Moore et al., 2000).
*All racial/ethnic categories except Hispanic/ Latino are non-Hispanic (e.g., White, non-Hispanic).

Table 2: Variables Included in Analysis

Table 2.

Variables Included in Analyses

Variable	Measure(s)	Administration Type	Wave
Primary Variables			
Executive Function	Hearts & Flowers	Direct Assessment	9 months
Home learning Activities	Cognitive Stimulation Activities Farver Home Literacy Scale	Parent Interview-Qualtrics Survey	15 months
Child Language	Preschool Language Scales- 4th Edition	Direct Assessment	18 months
Control Variables			
Maternal Education	Highest level of education attained by mother	Parent Interview	9 months
Paternal Education	Highest level of education attained by father	Parent Interview	9 months
Maternal Home Language	Dichotomous variable denoting whether Spanish was the maternal home language	Parent Interview	9 months
Paternal Home Language	Dichotomous variable denoting whether Spanish was the paternal home language	Parent Interview	9 months
Maternal Word Count	Continuous variable indicating the number of words spoken by mother during the free-play interaction	Transcript of Mother-Child Play Interaction	9 months
Paternal Word Count	Continuous variable indicating the number of words spoken by the father during the free-play interaction	Transcript of Father-Child Play Interaction	9 months
Study Site	University of Maryland or University of California, Irvine	Based upon enrollment location	9 months
Intervention Condition	Dichotomous variable indicating whether or not the family was in the control group	Assigned upon enrollment	9 months

Note. Control variables were controlled for at all levels, with the maternal controls on maternal EF and home learning activities, and paternal controls on paternal EF and home learning activities. Intervention condition was only controlled on maternal home learning activities, paternal home learning activities, and child language.

Table 3: Missingness By Wave

Table 3.

Missingness By Wave

Wave	All Parents	Moms	Dads	Full Families
Wave 1	420	210	210	210
Wave 3 Online Survey	315 (75%)	166 (79%)	149 (71%)	142 (68%)
Wave 4 Home Visit	312 (74%)			156 (74%)
Valid Wave 4 Outcome Data*	296 (70%)	148 (70%)	148 (70%)	148 (70%)

Note. *Wave 4 outcome data is measured using the Preschool Language Scales- 4th Ed. A total of 8 families had a child who was unable to complete the assessment due to child non-compliance, other child factors, or premature termination of the home visit.

Table 4: Descriptive Statistics

Table 4.
Descriptive Statistics for Primary Variables

	Mothers			Fathers		
Variable	*M* (SD)	Range	*n*	*M* (SD)	Range	*n*
Executive Function[a]	.41 (.11)	.19 - .96	148	.47 (.16)	.11 – 1	147
Home Learning Activities						
Parent Involvement in Home Literacy Scale Items[b]						
1. Read to your child at home?	6.2 (1.0)	2 – 7	129	5.6 (1.4)	1 – 7	121
2. Go to the library with your child?	2.2 (1.4)	1 – 5	129	2.1 (1.3)	1 – 6	121
3. Try to teach your child the letters of the alphabet?	5.4 (1.8)	1 – 7	129	5.4 (1.7)	1 -7	121
4. Play rhyming games with your child?	5.0 (2.1)	1 – 7	129	4.6 (2.1)	1 – 7	120
5. Point out words to your child and tell them what they say?	6.0 (1.6)	1 – 7	129	6.1 (1.6)	1 – 7	121
Participation in Cognitive Stimulation Activities Scale Items[c]						
1. Play peek-a-boo with your child?	5.1 (1.1)	1 – 6	128	4.9 (1.0)	3 – 6	120
2. Sing songs with them?	5.7 (0.7)	2 – 6	128	5.1 (1.1)	2 – 6	120
3. Tell stories to them?	4.8 (1.2)	1 – 6	128	4.4 (1.4)	1 – 6	120
4. Play together with toys for building things (e.g., blocks)?	4.7 (1.3)	1 – 6	128	4.4 (1.4)	1 – 6	120
5. Roll a ball, toss a ball, or play games with a ball?	5.0 (1.0)	2 – 6	128	4.9 (1.1)	1 – 6	120
Child Language Skills[d]	90.9 (9.1)	61-119	148	90.9 (9.1)	61-119	148

Note. [a] Executive function was measured by calculating the proportion correct of all test trials in the Hearts & Flowers assessment.

[b] Question stem for these items is "*About how often do you...*" and the response scale is 1 = Never, 2 = Almost never, 3 = Monthly, 4 = Two times per month, 5 = Weekly, 6 = Every other day, 7 = Daily.

[c] Question stem for these items is "*How many times in the past month have you done the following things with your child...*" and the response scale is 1 = Not at all, 2 = Rarely, 3 = A few times a month, 4 = A few times a week, 5 = About once per day, 6 = More than once per day.

[d] Child language skills reflect the standard score from the Preschool Language Scales – 4th Ed.

Table 5: Correlations for Mothers

Table 5.

Correlations between primary variables and potential control variables for mothers (N = 148)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Parent EF	--																					
2. Parent age	.30***	--																				
3. Parent education	-.24**	.40***	--																			
4. Household income	-.01	.21*	.20*	--																		
5. Parent is working/ in school	.07	-.02	.05	.43***	--																	
6. Hours worked per week	.01	.07	.13	.41***	.78***	--																
7. Child is enrolled in childcare	-.13	.08	.22**	.25**	.53***	.60***	--															
8. Hours in childcare per week	-.09	.05	.03	.01	-.36**	-.09	.09	--														
9. Number of adults in the home	-.13	-.17†	-.05	-.01	.07	.07	.16	-.24	--													
10. Parent nativity status	-.06	.24**	-.09	-.34***	-.21*	-.19*	-.18*	.04	.06	--												
11. Child development knowledge	-.01	.13	.35***	.34***	.29***	.28***	.19*	-.30*	-.07	-.37***	--											
12. Parent word count	.00	.27**	-.04	.02	-.08	-.04	-.10	-.08	-.16	.00	.12	--										
13. Parent-child interaction quality	.03	.07	-.01	.01	.12	.08	.09	.17	-.04	.00	.20*	.51***	--									
14. Parents' home language	-.05	.17*	-.05	-.11	-.05	.01	.00	.09	.03	.45***	-.30***	-.02	-.10	--								
15. Child is a boy	-.02	.02	-.06	-.07	-.10	-.08	-.21*	-.02	.14	.05	.04	.10	.03	-.01	--							
16. Difficult child temperament	-.01	-.10	.06	-.03	-.02	.01	-.08	-.15	-.08	-.02	-.04	.02	-.01	-.01	-.12	--						
17. Study condition	-.24**	.00	-.09	.01	.00	-.08	-.05	-.15	.06	.02	.08	-.01	-.02	-.16†	.07	-.03	--					
18. Study site	-.05	.00	.17*	.19*	.09	.10	.03	-.27*	-.08	-.27**	.28**	-.15	-.14†	-.14†	-.03	.02	.00	--				
19. Cognitive stimulation activities	.03	.03	-.11	.02	.05	.06	.03	-.05	-.16	-.06	-.02	-.01	.06	-.06	-.02	-.10	.04	.10	--			
20. Involvement in literacy activities	-.03	.06	-.11	.03	.12	.09	.00	-.09	-.14	-.13	.13	.23*	.05	-.15†	.14	-.02	.12	.05	.56***	--		
21. Receptive language skills	.06	.04	-.03	.06	-.04	-.11	.01	.02	.00	-.02	.28**	.09	.13	-.06	.05	-.19*	.10	.08	.12	.14	--	
22. Expressive language skills	-.05	.04	.00	.08	-.07	-.14†	.05	-.08	.02	.07	.18*	.20*	.19*	-.09	.05	-.20*	.12	.09	.08	.14†	.44***	--
23. Total language skills	.01	.05	-.02	.08	-.06	-.15†	.03	-.04	.01	.03	.27**	.16†	.19*	-.09	.06	-.23**	.13	.10	.12	.17†	.86***	.83***

Note. Missing data at the item level was addressed using pairwise deletion.

† $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Table 6: Correlations for Fathers

Table 6.

Correlations between primary variables and potential control variables for fathers (N = 148)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Parent EF	--																					
2. Parent age	-.11	--																				
3. Parent education	-.23**	.14†	--																			
4. Household income	-.08	.25**	.19*	--																		
5. Parent is working/ in school	.03	-.02	-.03	.18*	--																	
6. Hours worked per week	.04	-.05	-.02	.31***	.64***	--																
7. Child is enrolled in childcare	-.06	-.03	.01	.25**	.08	.19*	--															
8. Hours in childcare per week	-.06	.13	.07	-.03	.11	.07	.03	--														
9. Number of adults in the home	-.18†	-.05	-.07	.08	-.06	-.02	.21*	.11	--													
10. Parent nativity status	.00	.24**	-.17*	-.11	.14†	-.05	-.03	.01	.01	--												
11. Child development knowledge	.01	-.03	.27**	.24**	.01	.15†	.04	-.03	-.07	-.24**	--											
12. Parent word count	.11	.07	-.04	.11	.20†	.25*	.10	.22	-.07	-.04	.16	--										
13. Parent-child interaction quality	-.07	.01	.09	-.03	.04	.01	.12	.03	.08	-.01	-.03	.48***	--									
14. Parents' home language	.02	.14†	-.05	-.06	-.03	-.01	.08	-.09	.10	.51***	-.18*	-.15	-.15†	--								
15. Child is a boy	.06	-.02	-.05	-.09	.07	.05	-.08	-.04	.00	.01	.13	.01	-.24**	.03	--							
16. Difficult child temperament	.08	.03	.02	-.03	-.09	-.11	.09	-.04	.12	-.12	.04	-.04	.00	-.12	.07	--						
17. Study condition	-.09	.06	-.04	-.05	.03	.01	-.10	.02	-.02	.05	-.07	.02	-.01	-.16†	.06	.05	--					
18. Study site	.05	-.07	.03	.14†	-.04	.11	.12	-.13	-.12	-.22**	.36***	.10	.05	-.14†	-.07	.02	.00	--				
19. Cognitive stimulation activities	.16†	-.07	.04	-.06	-.08	-.22*	-.02	.12	-.14	-04	-.01	.00	.12	-.22*	-.16†	-.06	.02	.16†	--			
20. Involvement in literacy activities	.19*	.05	.04	-.03	-.01	-.10	-.02	.16	-.19	-.05	.04	.09	.00	-.33***	-.01	-.03	.23*	.13	.57***	--		
21. Receptive language skills	.00	.08	.09	.10	.17*	.14†	.08	-.04	-.09	.13†	.25**	.15	.10	-.06	.06	-.09	.10	.08	.06	.20*	--	
22. Expressive language skills	-.10	.02	-.03	.07	.08	.08	.04	-.03	-.02	-.05	.10	.29**	.14†	-.09	.07	-.15†	.12	.09	.01	.16†	.44***	--
23. Total language skills	-.05	.06	.04	.10	.15†	.13†	.07	-.04	-.06	.11	.21*	.25*	.14†	-.09	.07	-.14†	.13	.10	.04	.21*	.86***	.83***

Note. Missing data at the item level was addressed using pairwise deletion.

† $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Table 7: Standardized Loadings for Home Learning Factors

Table 7.

Standardized Loadings for Final Maternal and Paternal Home Learning Factor Indicators

Indicator Item	Maternal Factor (β)	Paternal Factor (β)
Home Literacy Environment, Parental Involvement Subscale		
1. Read to your child at home?	.41	.53
2. Go to the library with your child? [a]	--	--
3. Try to teach your child the letters of the alphabet?	.56	.65
4. Play rhyming games with your child?	.57	.66
5. Point out words to your child and tell them what they say?	.54	.75
Parental Engagement, Cognitive Stimulation Subscale		
1. Play peek-a-boo with your child?	.63	.47
2. Sing songs with them?	.63	.44
3. Tell stories to them?	.66	.77
4. Play together with toys for building things?	.44	.34
5. Roll a ball, toss a ball, or play games with a ball?	.40	.35

Note. Indicator items with loadings larger than |.40| for at least one parent were retained in the final model.

[a] Indicator did not adequately load onto the factors for mothers ($\beta = 0.26$) and fathers ($\beta = .32$) and was thus dropped from the final model.

Table 8: Direct Effects on Child Language Scores

Table 8.
Direct Effects on Children's Language Scores at 18 Months

	Total Language			Expressive Communication			Auditory Comprehension		
	B	SE B	β	B	SE B	β	B	SE B	β
Maternal EF	5.60	6.31	0.06	-1.30	7.44	-0.02	11.02	7.45	0.11
Paternal EF	-3.76	5.13	-0.05	-6.93†	5.26	-0.12†	0.94	5.92	0.01
Maternal Home Learning Activities	-0.56	1.20	-0.06	-0.43	1.28	-0.04	-0.62	1.42	-0.06
Paternal Home Learning Activities	0.04	1.11	0.01	0.25	1.08	0.03	-0.22	1.28	-0.02
Maternal Education	-0.02	0.64	0.00	0.18	0.63	0.02	-0.16	0.80	-0.02
Paternal Education	0.17	0.70	0.02	-0.38	0.68	-0.05	0.67	0.83	0.08
Maternal Word Count	0.01***	0.00	0.23***	0.01**	0.00	0.25**	0.01*	0.00	0.15*
Paternal Word Count	0.01**	0.00	0.15**	0.00	0.00	0.10	0.01*	0.00	0.15*
Maternal Home Language	3.76	6.06	0.09	1.73	5.26	0.04	5.11	6.61	0.11
Paternal Home Language	-3.76	6.53	-0.10	-5.14	5.38	-0.13	-2.11	7.04	-0.05
Study Site	1.45	1.56	0.07	0.47	1.60	0.02	1.83	1.85	0.08
Intervention Condition	4.40**	1.83	0.19*	4.92**	1.80	0.22**	2.76	2.31	0.11

Note. † $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Table 9: Post Hoc Power Simulation for Non-Significant Parameters

Table 9.
Post Hoc Power Simulation for Non-Significant Parameters

Parameter	Parameter Estimate	Power with N = 148	Sufficient N
Maternal EF→ Child Language	.06	.31	1400
Maternal EF→ MHLA	.04	.19	3000
MHLA→ Child Language	-.06	.43	750
Maternal EF→ MHLA→ Child Language	-.002	.10	> 5000
Paternal EF→ Child Language	-.05	.32	1000
PHLA→ Child Language	.01	.38	750
Paternal EF→ PHLA→ Child Language	.001	.14	> 5000

Note. MHLA = Maternal Home Learning Activities; PHLA = Paternal Home Learning Activities. Sample size was increased in increments of 50 until 1000, after which it was increased in increments of 500. Simulation was terminated at N = 5000.

Figures

Figure 1. Conceptual Model

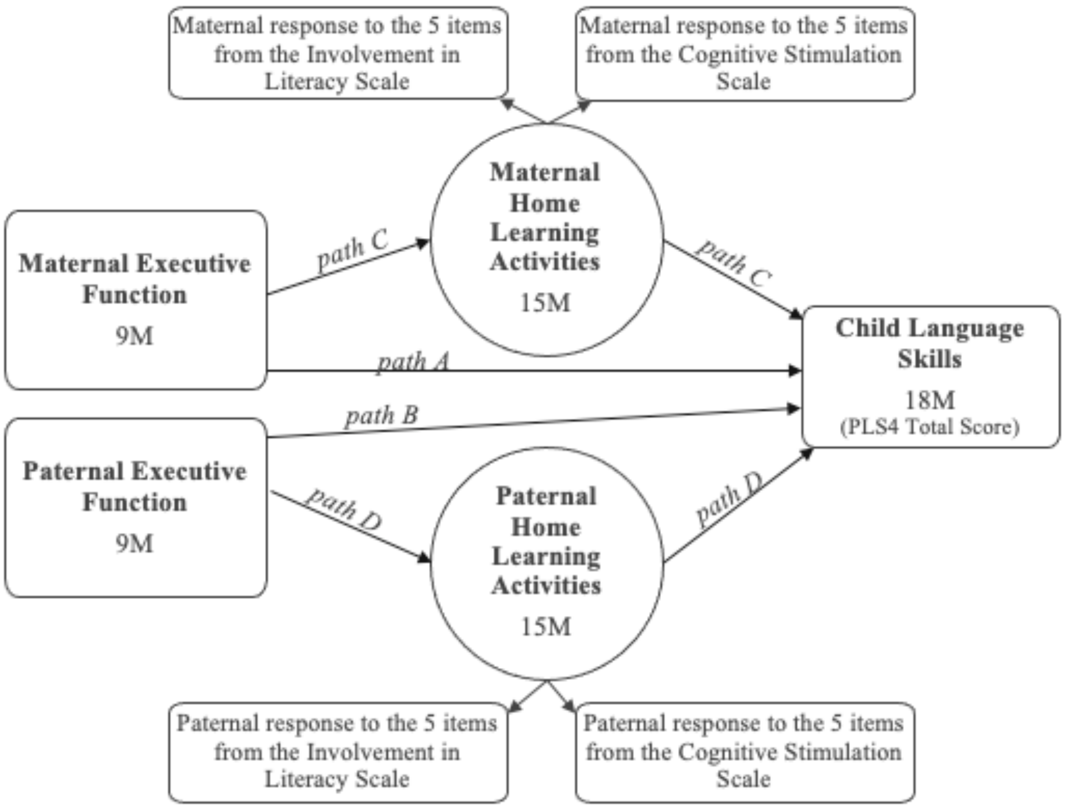


Figure 1. Conceptual model illustrating the hypothesized paths that were be tested.

Note. Control variables and individual indicator variables (i.e., the 10 individual items from the two scales for mothers and for fathers) are not shown here.

Figure 2. Full Proposed Analytic Model

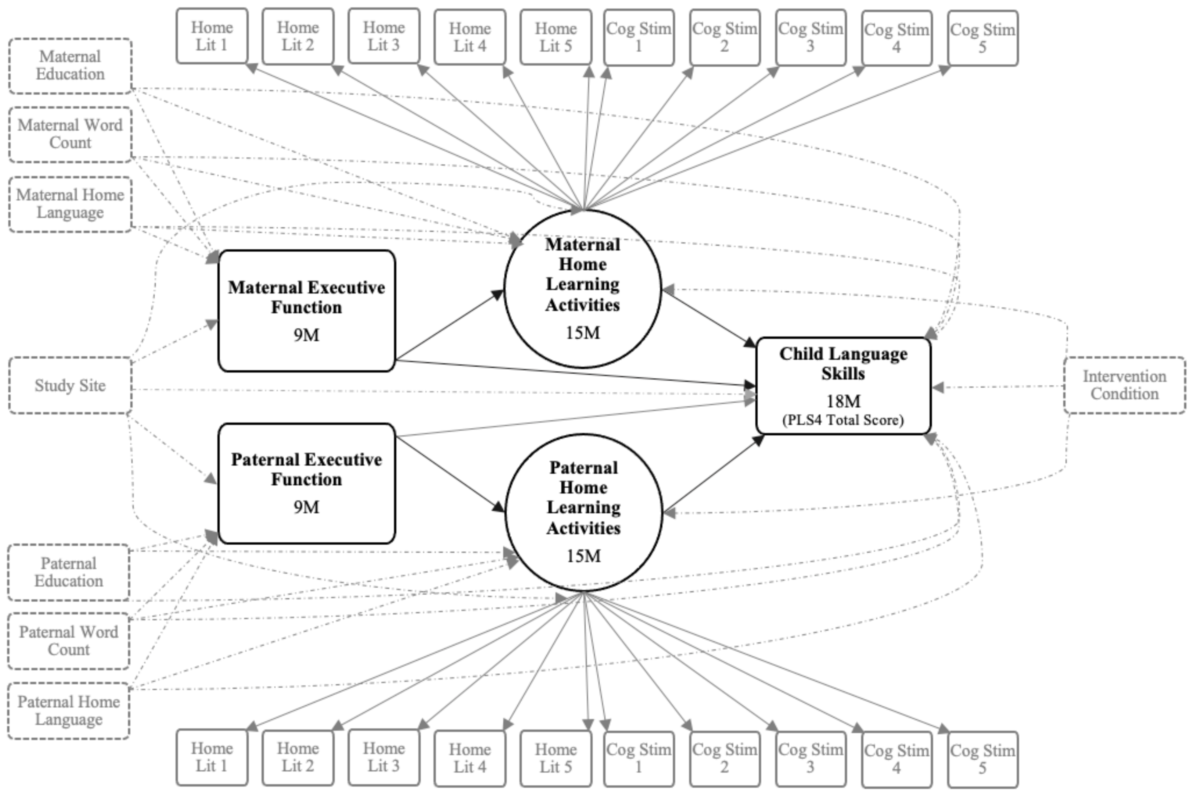


Figure 2. Proposed analytic model illustrating the paths between all primary variables, indicator variables, and control variables. Primary variables and the associated paths are shown in black. Indicator variables and their associated paths are shown in solid grey. Control variables and their associated paths are shown in dotted grey. Covariances between primary, control, and indicator variables both within and between parents are not shown for simplicity. Home Lit = Involvement in Home Literacy Scale items. Cog Stim = Cognitive Stimulation Scale items.

Figure 3. Final Analytic Model

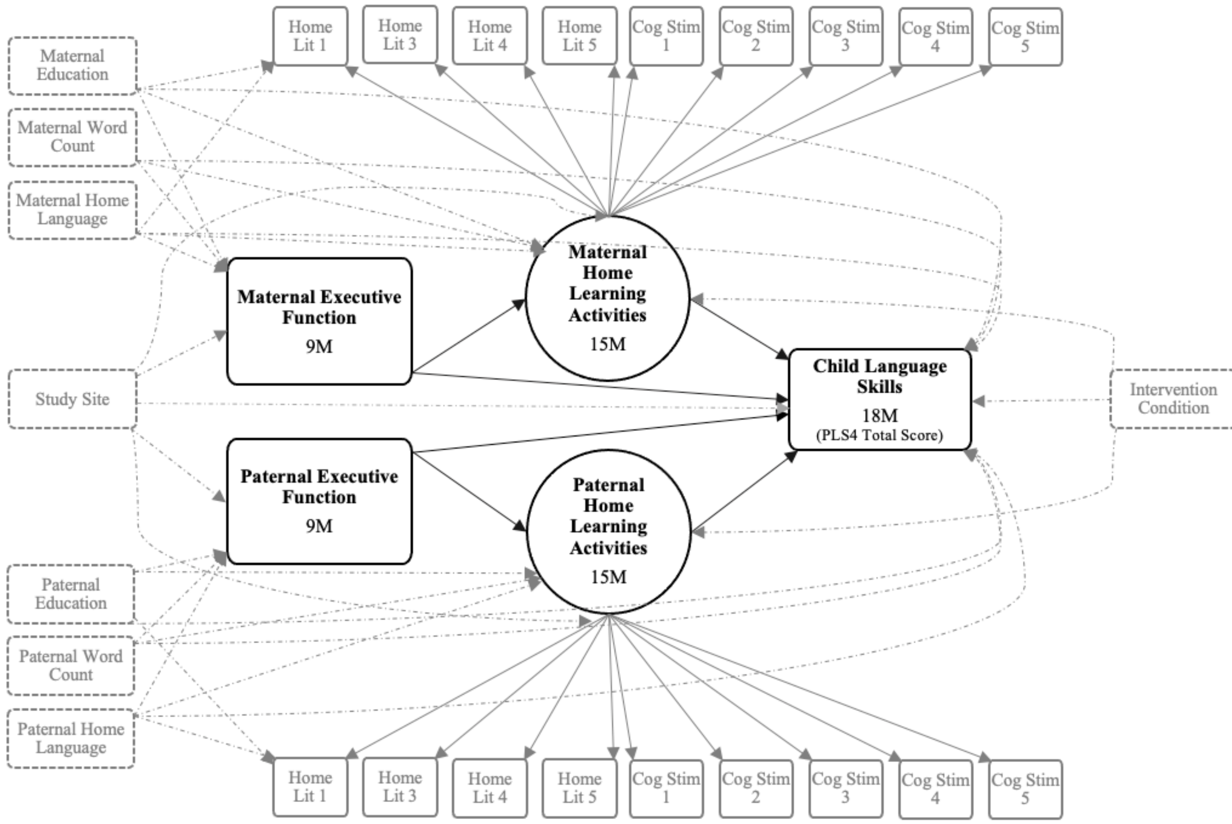


Figure 3. Final analytic model illustrating the paths between all primary variables, indicator variables, and control variables. Primary variables and the associated paths are shown in black. Indicator variables and their associated paths are shown in solid grey. Control variables and their associated paths are shown in dotted grey. Covariances between primary, control, and indicator variables both within and between parents are not shown for simplicity. Home Lit = Involvement in Home Literacy Scale items. Cog Stim = Cognitive Stimulation Scale items.

Figure 4. Total Language Model Results

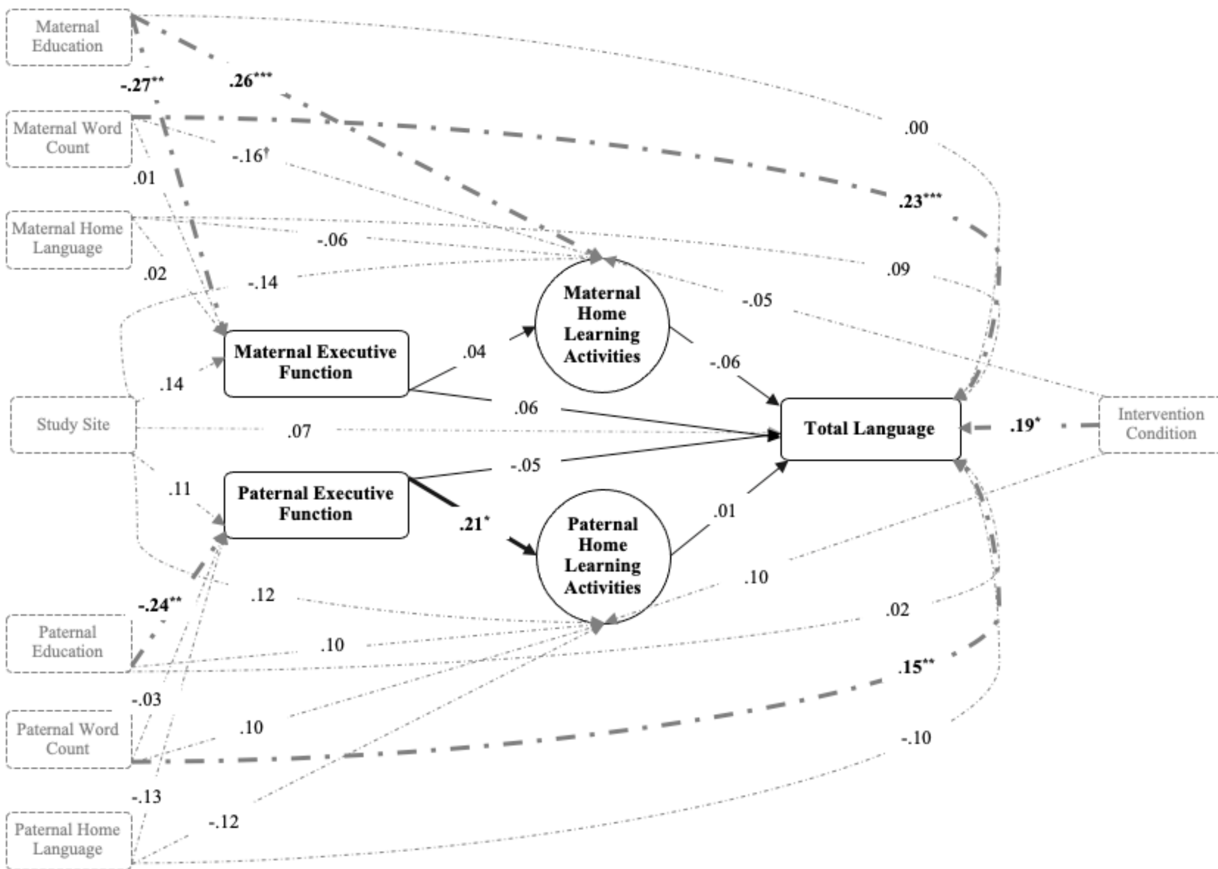


Figure 4. Path diagram with standardized coefficients for total language scores. The primary variables and parameters relevant to the hypotheses are shown in solid black. Control variables and their associated parameters are shown in dotted grey. Covariances and indicator items are omitted for simplicity.

† $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Figure 5. Expressive Language Model Results

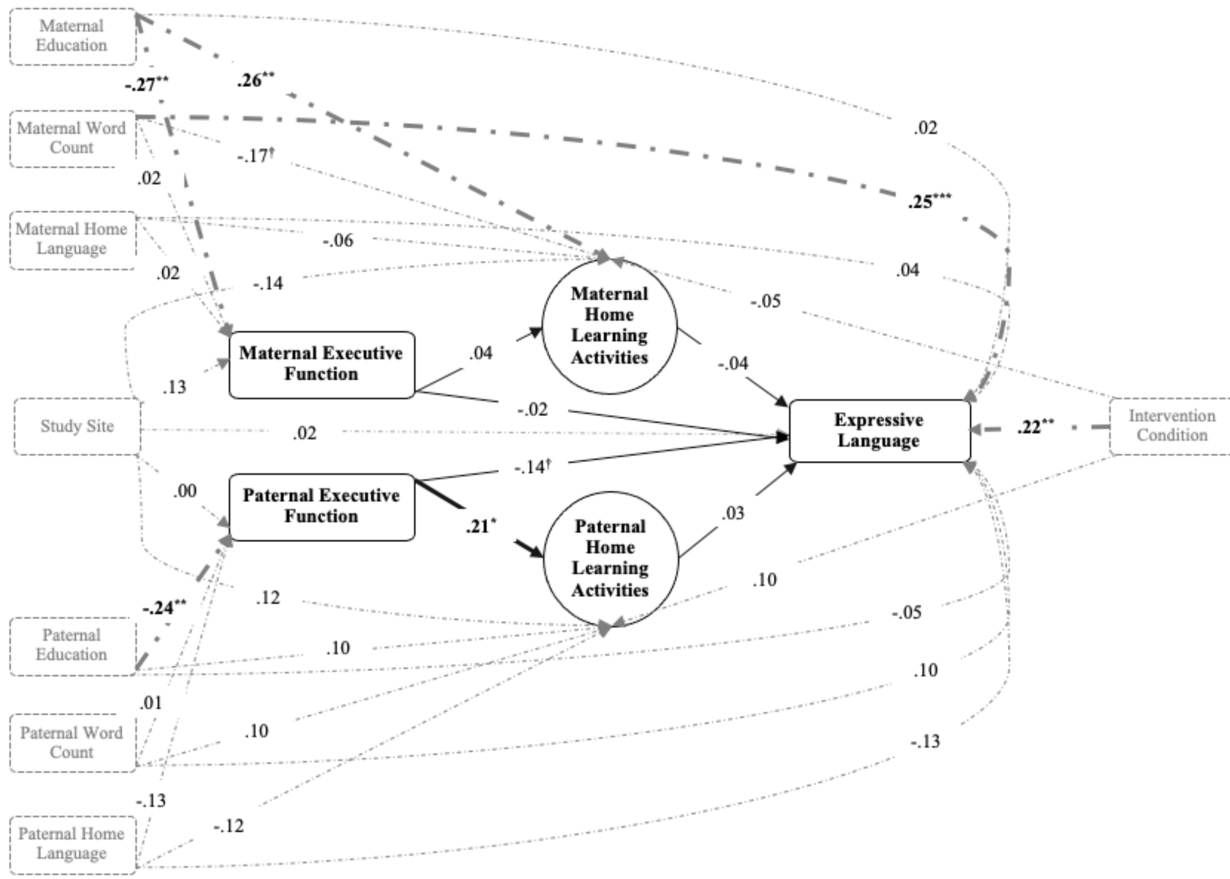


Figure 5. Path diagram with standardized coefficients for expressive language scores. The primary variables and parameters relevant to the hypotheses are shown in solid black. Control variables and their associated parameters are shown in dotted grey. Covariances and indicator items are omitted for simplicity.

† $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Figure 6. Receptive Language Model Results

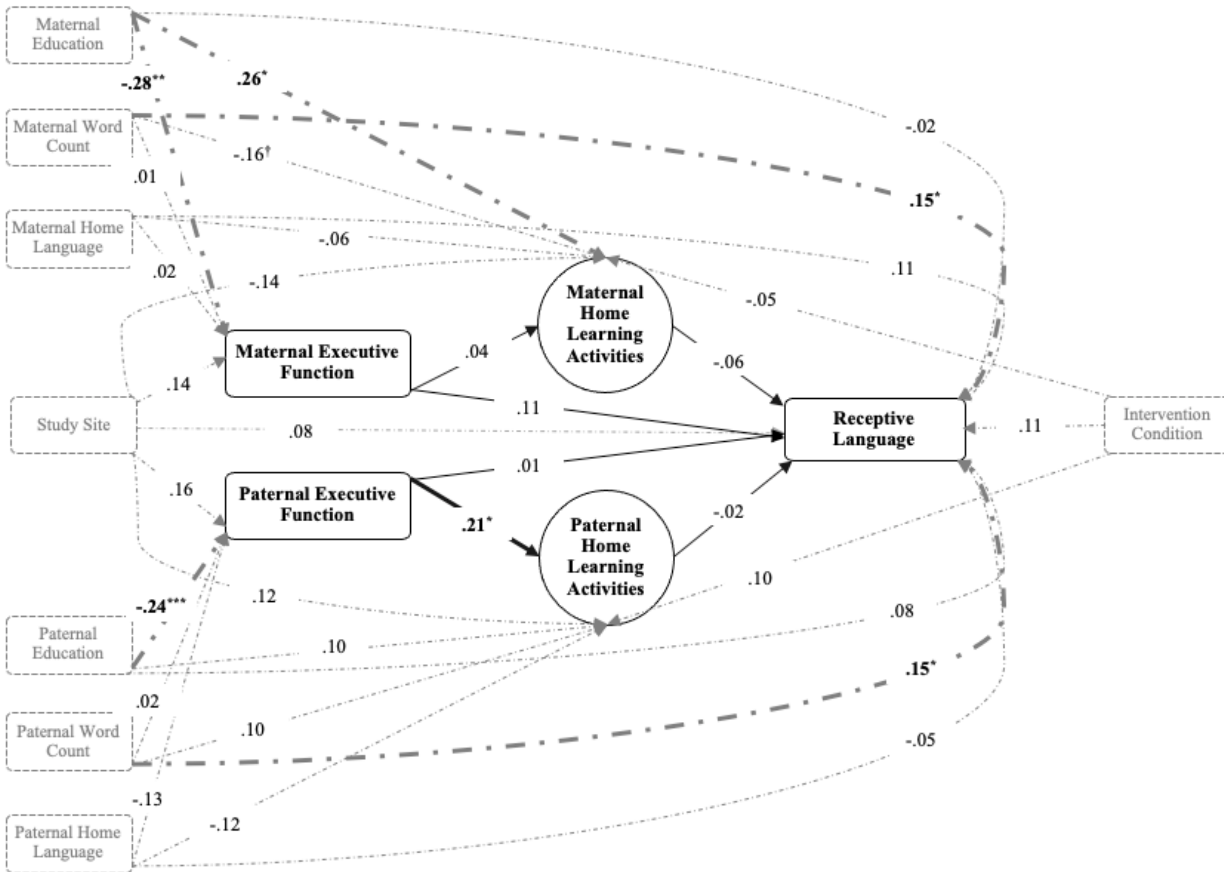


Figure 6. Path diagram with standardized coefficients for receptive language scores. The primary variables and parameters relevant to the hypotheses are shown in solid black. Control variables and their associated parameters are shown in dotted grey. Covariances and indicator items are omitted for simplicity.

† $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Figure 7. Education Levels by Nativity Status

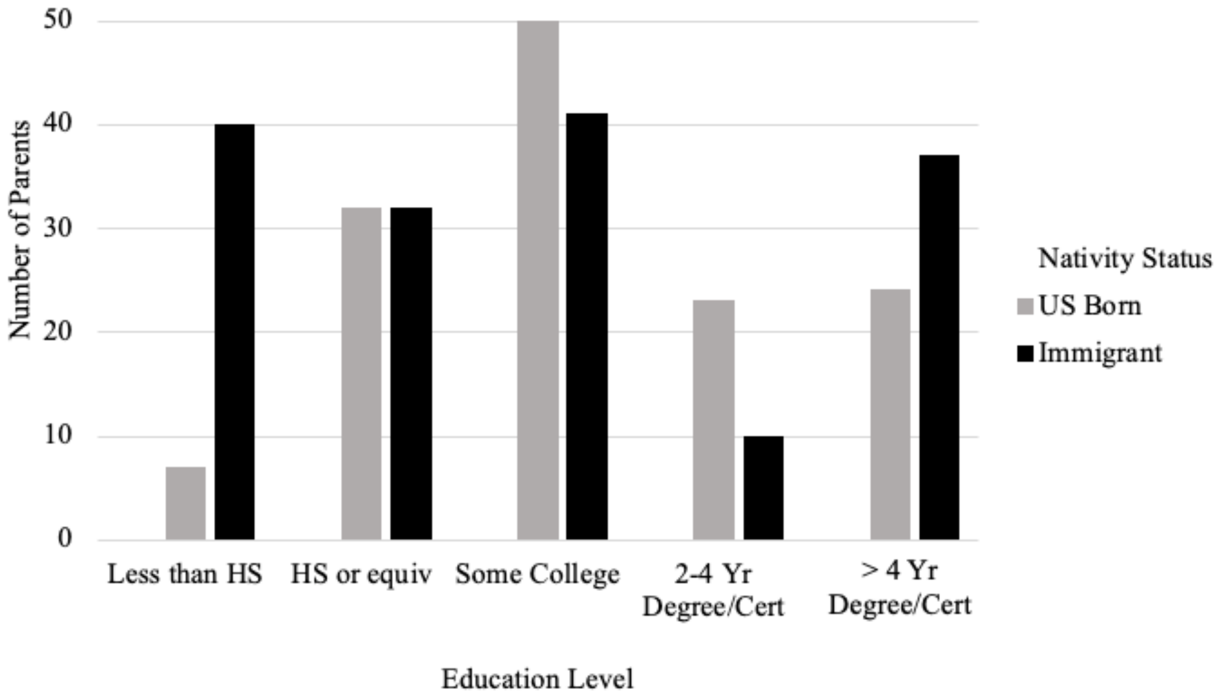
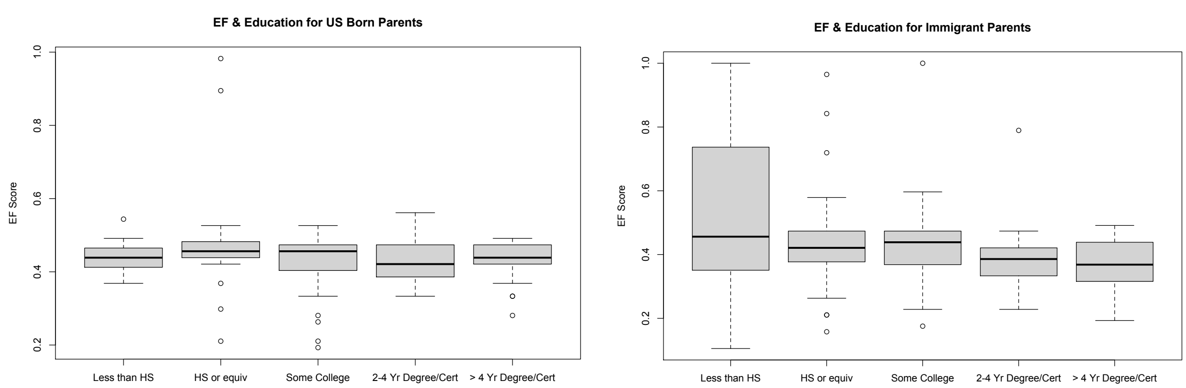


Figure 8. Executive Function by Levels of Education and Nativity Status



Appendices

Considered Control Variables Omitted from the Analytic Model

All of the variables below were measured during the 9-month home visit parent interviews or coded from the 9-month parent-child interactions, with the exception of difficult child temperament which was measured during the 12-month phone call interview.

Parent Age

Parent age reflects the parents' age in years at the time of the baseline (i.e., 9-month) home visit and was entered as a continuous variable.

Household Income

Household income represents maternal and paternal reports of the annual household income. Parents provided either a numerical value or if unable to report an exact income, they selected an income category. Numerical responses were then recoded using the associated income category. The resulting household income measure is a six-level categorical variable that includes "$10,000 or less," "$10,0001 – $20,000," "$20,0001 – $30,000," "$30,0001 – $40,000," "$40,0001 – $50,000," and "more than $50,000."

Parental Employment Status and Hours Worked

Parents were asked whether they were currently working or in school and if so, the number of hours worked in the past week for each job and/or school. Parents' responses for all jobs and school were summed to create a total number of hours worked. Because there was substantial variability in the number of hours parents worked or were in school, both parents' work status (a dichotomous variable for working or not working) and the number of hours worked (a continuous variable) were included in the preliminary analyses.

Childcare Enrollment and Hours in Childcare

Parents were asked whether anyone provided childcare for their baby including center-based care, home-based care, relative care, or another type of childcare. The childcare enrollment variable is a dichotomous variable that represents whether or not parents reported that their child was enrolled in any type of childcare. If parents reported their child was enrolled in childcare, they were asked to report the hours per day and days per week that the child spent in each type of care. The hours in childcare per week variable was calculated by multiplying the hours per day and days per week and then adding together the hours per week in each childcare setting.

Number of Adults in the Home

Parents were asked to report the total number of adults that were living in their home during the parent interview. This variable was included in preliminary analyses in order to capture informal help with caretaking that may take place in intergenerational or multifamily living arrangements.

Parental Nativity Status

Parental nativity status is a dichotomous variable that represents whether or not the parent was born in the United States. While this variable was correlated with several of the primary variables in my study, it also overlaps both conceptually and analytically with the other demographic variables included in my model (i.e., parental education, home language, and study site). As such, parental nativity status was omitted from the final model.

Child Development Knowledge

Mothers' and fathers' knowledge of child development is represented by the "child development knowledge" variable and was assessed using the *Opinions about Young Children Questionnaire*. The *Opinions about Young Children* is a criterion-referenced 41-item measure adapted from the *Opinions about Babies Questionnaire* (Reich, 2005) that assesses parents' knowledge of children's health and development and appropriate parenting practices (Cabrera & Reich, 2017; Reich, 2005). Both mothers and fathers were presented with several statements; possible responses were "agree," disagree," or "no opinion." For the purposes of the current study, only the nine items related to cognitive, emotional, and language development were included in the analyses. Each item was scored as correct or incorrect. Items in which the parent indicated having no opinion were scored as incorrect. The proportion correct was calculated by dividing the number of correct responses by the total number of items answered for each parent. The resulting continuous variable represents the average proportion of correct responses for each parent.

Parental Language Use

In order to account for the influence of parents' language use on their children's language skills, I included explored paternal and maternal language use as control variables. Parental language use for both mothers and fathers during parent-child interactions was calculated from the transcripts of mother-child and father-child interactions at the 9-month wave. This continuous variable represents the total number of words spoken by the parent during the free-play portion of their parent-child interaction.

Parent-Child Interaction Quality

Parent-child interaction quality plays an important role in how parents promote their children's language development (Baumwell et al., 1997; Justice et al., 2019; Malin et al., 2014). The larger BB2 study does not include a measure of parent-child interaction quality between the 9-month and 18-month visits. As such, I control for the influence of parent-child interaction quality measured concurrently with parent EF (i.e., at 9 months). This variable represents an average of mother-child and father-child interaction quality observed during the videotaped free-play with toys portion of interactions. A composite score for the quality of parent-child interactions of both parents together was created by averaging the codes for responsiveness, warmth, achievement orientation, and animation from the mother-child and father-child interactions (Cox & Crnic, 2003). Each quality score was coded using a 5-point scale from "Qualitative Ratings for Parent-Child Interactions," (Cox & Crnic, 2003). Interactions were coded by three research assistants, one of whom was a master coder. Reliability was determined by requiring that all coders be within one point of the master coder at least 90% of the time.

Difficult Child Temperament

Child temperament was measured during the 12-month phone call parent interview and represents the degree to which the child is perceived to have a difficult parent. Both mothers and fathers reported on their child's temperament using the Emotionality, Activity, and Sociability Temperament Survey (EAS; Buss & Plomin, 1984; Mathiesen & Tambs, 1999). Maternal and paternal ratings on a five-point scale of how characteristic three items were of their child (i.e., "child cries easily," "child often fusses and cries", and "child reacts intensely when upset") were used to calculate an overall continuous variable representing the degree to which both parents describe the child has a difficult temperament (Carlson & McLanahan, 2006).

Post-Hoc Exploratory Analyses

Though they that were outside the scope of my research questions, the negative associations between parental education and parental EF, and the differential strength of influence of maternal and paternal word count on child language warranted additional exploration.

Parental Education and Executive Function

Given that the majority of parents in this sample are immigrants and the prior evidence of a positive association between parental education and EF has been drawn from primarily US samples (see Bridgett et al., 2015 and Crandall et al., 2015 for reviews), I further probed how education and EF varied by nativity status in my sample. First, I explored the distribution of education for each group. An ANOVA comparing education by nativity status showed that, on average, US born parents had higher education levels ($F(1, 294) = 5.36$, $p < .05$). However, the distributions for the two groups differed such that there were both more immigrant parents than US born parents with less than a high school diploma *and* more immigrant parents with more than a four-year degree than US born parents (Figure 7). On the other hand, there was not a significant difference in EF scores by nativity status ($F(1, 294) = .04$, $p > .05$). Finally, the correlation between education and EF differed for the two groups. For US born parents there was not a significant correlation between education and EF ($r = -.14$, $p > .05$), but there was a significant correlation for immigrant parents ($r = -.31$, $p > .001$).

Differential Influence of Maternal and Paternal Word Count

There are many reasons found in the extant literature for why mothers and fathers can have different impacts, one of which is that they may spend different amounts of time with their children (Craig, 2006). While a direct measurement of time spent with children was not available, I used the proxy of hours worked or spent in school to gain further insight into why maternal word count had a stronger influence on child language than maternal word count. An ANOVA comparing mothers' and fathers' work and school hours showed that, on average, fathers worked or were in school for more hours (M = 39, SD = 18.1) than mothers (M = 16, SD = 18.3; $F(1, 294) = 123.08$, $p < .001$).

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