ABSTRACT

Title of dissertation: THE INFLUENCE OF MATERNAL SENSITIVITY AND MATERNAL STIMULATION ON LATER DEVELOPMENT OF EXECUTIVE FUNCTIONING VIA STRUCTURAL EQUATION MODELING

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This study investigated the relations between early maternal behaviors, maternal sensitivity and maternal stimulation, and the later development of executive function. It was hypothesized that maternal behaviors could influence the development of executive function either directly or indirectly by influencing a child's language or attentional abilities. This study attempted to model these relationships using archival data from phase I and phase II from the Study of Early Child Care and Youth Development (SECCYD). Structural equation modeling was used with data from 470 participants on measures of SES, maternal sensitivity, maternal stimulation, language, attention, and executive function. From existing literature three nested models were proposed to examine how maternal behaviors influenced the later development of executive function. While there were significant differences between the three proposed models it is important to recognize the overall poor fit of the models. The differences between the models suggest that maternal sensitivity and maternal stimulation do not directly influence executive functioning in the 1st grade but instead influence the development of executive functioning through assisting the child in development of attention and language skills. Interestingly, the model also indicated verbal ability played an important role in the development of

executive function. Secondly the study attempted to examine multi-group differences in the proposed models (Caucasian and African American). While small sample size precluded this analysis, examining the effect size differences between the two groups indicated that within the current sample ethnicity, language ability, and SES are deeply entangled. The results of the current study highlight the potential role of language ability in the development of executive function and the need for cleaner measures of executive function that are developmentally appropriate.

THE INFLUENCE OF MATERNAL SENSITIVITY AND MATERNAL STIMULATION ON LATER DEVELOPMENT OF EXECUTIVE FUNCTIONING VIA STRUCTURAL EQUATION MODELING

by

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Caleb, age 5, as his aunt was leaving to go the coffee shop to work on her dissertation, “If you want to work with children, why do you go always go the coffee shop and work? Are there children at the coffee shop?”

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CHAPTER I

Introduction

Research has frequently noted a relationship among cognitive, academic, and social skills and parental factors (Stevens, Blake, Viatle, & Macdonald, 1998; Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004). More specifically a foundation has been laid that supports the impact of maternal influence on the future development of problem solving skills (Freund, 1990; Hess & Shipman, 1965; Hubbs-Tait, Culp, Culp, & Miller, 2002). Dodici, Draper, and Peterson (2003) note a range of factors were related to future cognitive and social development; specifically they report relationships between emotional tone, parental talk, engagement, parental guidance style, parental responsivitity, and parental sensitivity. Although at times the strength of that relationship has been challenged, Burchinal, Campbell, Bryant, Wasik, and Ramey (1997) write that, "the extent to which characteristics of the child and family influence cognitive performance is still subject to debate because different analytic methods yield varying results" (p. 935). Nevertheless, the debate of the influence of socialization on cognitive outcomes has moved from questioning its existence to examining the mechanisms and mediators of change (NICHD Early Child Care Research Network, 2000).

[1]The original NICHD SECCYD study was conducted by the NICHD Early Child Care Research Network supported in part by NICHD and was made available to qualified researchers for scientific collaboration. The author gratefully acknowledges this collaboration.

Prior research has examined maternal influence during a collaborative task, typically a joint play, and reported that maternal sensitivity and maternal stimulation during a child's infant and preschool years influences later cognitive abilities (NICHD Early Child Care Research Network, 2005a). One such study, Landry, Smith, Swank, and Miller-Loncar (2000), examined rural, low SES families (n=228) to see if children's later functioning was facilitated by certain maternal behaviors, namely maintaining children's focus, responsiveness, and directiveness, during both collaborative play and daily activities. The authors reported that maternal interaction style, as observed when the children were 24 months old during two interactions (one play interaction and one daily activity interaction), indirectly influenced the cognitive skills of children at 4 ½ years by directly influencing cognitive and social skills at 2½ and 3 ½ years. The authors report, "when parents identify critical elements of the task on which the child should focus, children are better able to sustain attention and organize strategies to attempt to solve the problem" (2000, p. 17). This suggests that certain maternal behaviors may be more influential during earlier years (2 and 3 years) than later years (4 and 5 years).

Although this relationship between specific maternal behaviors and future cognitive development is fairly well established, there have been few studies to examine the influence of maternal behaviors, specifically sensitivity and stimulation, on the development of executive functioning (Assel, Landry, Swank, Smith, & Steelman, 2003; Landry, Miller-Loncar, Smith, & Swank, 2002). Of the studies that have examined the influence of maternal behaviors on the broad concept of cognitive skills, the majority have examined cognitive skills immediately following a play task, and thus, the relationship appears to be most established following an immediate time frame and not examining how maternal behaviors influences long-term cognitive development.

As Landry and associates (2000) note, "an important developmental goal for children during the preschool years is the ability to interact independently with their world without a high degree of structure and support from others" (p. 358). This requires the development of a range of cognitive processes (e.g., inhibition) and the coordination of those processes (e.g., executive functioning). As cognitive development proceeds, it is expected that these cognitive regulatory processes provided by the parent should become more internalized until the child can complete the task autonomously. For the purposes of the current study executive functioning will be defined as a, "set of cognitive processes that are necessary for goal-directed behavior and that are mediated by the prefrontal cortex of the brain" (Welsh, Friedman, & Spieker, 2006, p. 5) and measured via memory, inhibition, and planning (Welsh & Huizinga, 2001).

The underlying theoretical framework for the current question comes from developmental and neuropsychological research. It is important to note that this is secondary analysis of data from the Study of Early Child Care and Youth Development (SECCYD) (NICHD, 2000). The original NICHD SECCYD research study was developed from an ecological model and considered two ecological mechanisms that were thought to influence cognitive and intellectual development (NICHD, 2000). The first mechanism suggests that children's cognitive and intellectual development may be the result of an enriched and varied environment. As children develop they would begin to actively organize their own experiences through exploration of their environment. This mechanism would result in parents with greater resources being better equipped to provide cognitively rich stimulation which results in greater intellectual development. The second mechanism suggests that it is through adult-child interactions and tutored/scaffolded experiences that children develop intellectually (Vygotsky, 1978). More specifically, children gain the most intellectually when they are taught using appropriate, structured experiences.

As previously noted there is limited empirical research relating maternal behaviors during joint play tasks and future development of executive functioning. Although the available research appears to clearly note the importance of parental involvement, the research is less clear about the differential impact of two specific components, maternal sensitivity and maternal stimulation, of maternal involvement. These different component skills may be of variable importance for the future development of executive functioning, depending on the child's age. This research will examine the relationship between maternal sensitivity and maternal stimulation and the later development of executive functions. Within the context of this study, mother-child interaction is recognized as "mother and child actively engaged in the same friendly play or work together" (Gardner, Ward, Burton & Wilson, 2003, p. 368). The current study defines maternal stimulation as, "the degree to which the parent tries to foster his/her child's cognitive and mental development" (NICHD, 2000) and maternal sensitivity as, "the degree to which parents adapt to children's needs and abilities" (Beckwith & Rodning, 1996 as cited in Dodici et al., 2003, p. 125).

Although executive functioning is central to everyday experiences and theorists have postulated that contextual factors influence the development of executive functions, as of yet there is little empirical research available to support (or reject) these theories

(Henderson & Moore, 1980; Welsh & Pennington, 1988). To establish the motivation and justification for the present study, the literature review that follows will first examine the literature on mother-child interactions, specifically stimulation and sensitivity, and secondly review relevant literature related to executive function, specifically the constructs theorized to underlie the executive functioning (Simon, 1975; Welsh, 1991; Welsh & Huizinga, 2005).

Statement of Purpose

The purpose of this study is to add to the small body of empirical research about the influence of maternal behaviors on the development of executive function. Because executive function influences nearly every aspect of behavior, the results of this study could have both theoretical and practical importance. Dodici, Draper, and Peterson (2003) write that it, "seems imperative that parents should be made aware of the influence of their everyday interactions may have on their children's success in school.....Parents need to seize teachable moments as they occur all day long, and many parents may need education and/or support to do this effectively"' (p. 134). This may have implications for supporting parental involvement in various early intervention programs.

This study will examine via structural equation modeling the relationship between early maternal sensitivity and maternal stimulation and later development of executive functions. Specifically, this study will be examining different factors that have been either empirically or theoretically linked to maternal behaviors and executive functioning: early vs. late maternal stimulation and maternal sensitivity, ethnicity (Caucasian and African American), and maternal verbal ability. A socio-cultural perspective of child development would suggest that children learn through adult interactions but few researchers have empirically examined how early vs. later maternal stimulation and sensitivity may influence later executive functioning development and if ethnicity moderates and maternal verbal ability mediates socioeconomic factors related to the development of executive functioning.

First, and the major goal of the study, is to examine the relationship between maternal behaviors on later development of executive functioning. Specifically, this study will examine whether the influence of maternal stimulation and maternal sensitivity on executive functioning was direct or indirect through the effect on children's early language and attentional skills. Prior research has suggested that certain types of maternal support is most beneficial during early development by supporting earlier acquisition of language and cognitive abilities which in turn are prerequisites for the development of executive functions (Landry et al., 2000).

Secondly this study will examine ethnicity as a moderator variable that influences the development of executive functions. Ethnicity (i.e., Caucasian and African American) was selected as a potential moderator because of the strong cross-cultural theory and research that suggests maternal interactions can be culturally bound. Specifically, research suggests that African American mothers are more directive in their assistance during collaborative tasks and ask fewer scaffolding questions, this may result in less cognitive stimulation and a different mechanism for the development of executive functioning for different ethnic groups (Connell & Prinz, 2002). This study will examine whether estimates of model parameters remained invariant across two ethnic groups

(Caucasian and African American) or whether group membership moderated the relationships specified in the model (Frazier, Tix, & Barron, 2004).

Finally, this study will examine the role of maternal verbal ability, as measured by maternal performance on the PPVT-R, as a possible mediator between SES and executive functions using structural equation modeling. The meditational hypothesis being tested suggests that maternal verbal ability mediates the relationship between SES and executive function. It is expected that increases in SES will result in increased maternal verbal ability which in turn better predict the development of executive function above and beyond SES alone.

Research Questions

1. What is the relationship between maternal sensitivity and maternal stimulation and the later development of executive functioning?
2. Does ethnicity moderate the strength of the relationship between maternal behaviors and executive functioning?
3. Does maternal verbal ability mediate the relationship between SES and executive functioning?

Three competing nested models will be developed to examine research question 1. Nested multiple group models will also be used to examine if ethnic group membership moderates the relationship between maternal behaviors and executive functioning (research question 2). Non-nested model comparison will be used to analyze maternal verbal ability as a mediator between SES and executive functioning (research question 3). The goal of this study is to identify a parsimonious, substantively meaningful model that fits the observed data adequately well.

CHAPTER II

Literature Review

Overview of Mother-Child Interactions

Development of Mother-Child Interactions

Joint attention, which is process that underlies mother-child interactions, begins to emerge between 9 to 12 months. Neurocognitive researchers have implicated the ventromedial prefrontal cortex, which specializes in processing social information, in the development of joint attention (Nichols, Fox, & Mundy, 2005). Infants begin interacting dyadically with objects and other people at about six months of age. But as early as 9 months of age, infants are capable of engaging tridyadically between themselves, a parent, and a third object of interest. Joint attention during infancy is typically assessed by measuring children's initiation of joint attention (e.g., gestures and eye contact) and children's response to parental attempts to engage (e.g. time on task). Vaughn and colleagues (2003) report significant individual differences in infant's joint attention regulatory and initiation abilities. Developmental knowledge about a child's ability to attend and interact has also stemmed from autism research. Individuals with autism frequently have a decreased ability to initiate or respond to joint interaction, in fact failure to initiate joint attention is frequently related to the differential diagnosis of autism (Baird et al., 2000).

Around age two children are first able to understand the basic content of communication but still require explicit directives related to their focus of interest (Wertsch, 1979). By age three, children still need assistance to focus on an area of interest but are able to better express their goals. As cognitive development proceeds it is expected that these cognitive regulatory processes provided by the parent should become more internalized until the child can autonomously complete the task. For example, researchers reported that during a collaborative interaction task that required planning mothers assumed greater responsibility when planning with 4 and 5-year-olds then when planning with 6 and 7-year-olds (de la Ossa & Gauvain, 2001).

Conceptually, developmental psychologists suggest that self-regulation is learned as part of the reciprocal process in which social interactions shape current and future behavior. Vygotsky's (1978) much cited theory of "proximal development" emphasizes the importance of the context in which development occurs. The theory suggests that as children begin to develop cognitively support can be critical to assist the child in working above their current autonomous level. During mother-child interactions the zone of proximal development is typically conceptualized as "regulating the child's behavioral responses, such as directing the child's attention, maintaining goal direction, reminding the child where he or she is in the task, and/or evaluating the success or failure of the child's task behaviors" that are required for autonomous performance (Freund, 1990, p. 113).

Wood and Middleton (1975) describe how effective instruction supports a child such that, "As he enacts and perfects such isolated task constituents, uncertainty about what to do and what to anticipate as a consequence of his actions diminishes, at least with regard to subset of the task. This further frees the child to consider the wider or related task constraints and operations. At best, this process continues until he becomes acquainted with and skilled in all aspects of task activity to the point where he can initiate and control his own behavior in the absence of an instructor" (p. 190). Current theory suggests that maternal support (e.g., cognitive stimulation) may be more influential during certain time periods. During these developmental transitions, certain contexts can play lesser or greater roles in future development. Specifically, researchers suggest that certain types of maternal behaviors would be more effective for younger children than for older children (Landry et al., 2002).

In particular some researchers has found that sensitive and stimulating mother-child interactions are found to be most beneficial during early development by supporting earlier acquisition of language and cognitive abilities which in turn are prerequisites for future cognitive and social development (Landry, Smith, Miller-Loncar, & Swank, 1997). Other researchers using the NICHD SECCYD dataset (NICHD Early Child Care Research Network, 2005) have reported dissimilar findings using hierarchical regression and suggest that a child’s experiences and environment throughout their early and late childhood make important and roughly equivalent contributions to their cognitive outcomes. The current study will attempt to further examine these findings using structural equation modeling.

Mother-Child Interaction and Culture

When considering the development of mother-child interactions, it is also necessary to consider cultural influences. Valenzuela (1997) writes that, “cultural differences may be responsible for the lack of an association between maternal sensitivity in the home and mother and child behavior during play interactions” (p. 851). Cross-cultural research suggests significant parental variability in attitudes and behaviors related to the maternal role (Bornstein, Haynes, Pascual, Painter, & Galperin, 1999; Roopnarine, Johnson, & Hooper, 1994). Researchers go further than noting the cultural variation and suggest that mother-child interactions are a mechanism for transmitting culture. Mother-child interactions have been viewed as a microgenic mechanism, which transmits culture through the use of culturally relevant everyday family tasks and play (Vandermaas-Peeler, Way, & Umplevy, 2003).

As Connell & Prinz (2002) note, “Research has generally supported the findings that parent-child interactions characterized as warm, structured, and emotionally responsive are related to positive cognitive and behavioral gains in children, regardless of racial/ethnic group or social class” (p. 189). But other researchers, namely Baldwin, Baldwin, and Cole (1990), suggest that for African American children more directive maternal interactions results in more positive development. Thus the current study will examine the role of ethnicity (Caucasian and African American) in moderating the influence of mother-child interactions on later development of executive functions.

In one recent study, the authors reported that sensitive mother-child interactions were, “found to be a potentially buffering factor for children from families at risk for school difficulties, such as ethnic minority families” (Morrison, Rimm-Kauffman, & Pianta, 2003, p. 197). The study examined how mother-child interactions during 2 four-minute problem solving tasks in kindergarten were related to a number of positive and negative outcome measures in middle school. Specifically the authors reported that non-White children, predominantly African American children, who engaged in less sensitive mother-child interactions, showed more problem behavior in middle school compared with non-While children who engaged in more sensitive mother-child interactions. Also non-While children who engaged in more sensitive mother-child interactions showed similar levels of negative behaviors as their peers. This suggests that maternal sensitivity may have a buffering effect for at-risk children thus sensitive and stimulating parenting may be more important (i.e., have greater cognitive, social, and behavior benefits) for certain ethnic groups.

These findings were similar to the work of Buchinal and associates (1997) which suggested that between-family differences can have a greater impact for certain ethnic groups, specifically African American children from low income families, as compared with Caucasian children from middle class families. Also importantly, Nabors, Evans, & Strickland (2000) note for certain cultures, specifically African American cultures, it is difficult to disentangle the influence of culture from social class and parental education as they are highly related with a large percentage of African Americans having lower socioeconomic status and less education as compared to Caucasians. Morrison, Rimm-Kauffma, & Pianta (2003) write that, "These demographic variables (referring to ethnicity, gender, ses) may be indices of larger cultural variations in social processes, which together create risk status for the child. Thus, attempts to evaluate the predictive power of process variables such as mother-child relationships must account for these demographic predictors" (p. 188). The current model examined if ethnicity (Caucasian vs. African American) moderated the strength of the relationship between maternal behaviors and executive functioning.

Maternal-Child Interactions during Joint Play

Parent-child play has been the focus of a considerable amount of research thus a overview of parent-child interactions will be reviewed here. An important note to the current study is the exclusion of fathers/male caregivers in the study. This is due to pragmatic limitations in the NICHD dataset that does not contain samples adequate for the proposed SEM analyses. This is an acknowledged limitation in the current study as other researchers (e.g., Tamis-LeMonda et al., 2004) have shown that fathers make unique contributions to children's cognitive and social outcomes and would be a valuable avenue for future research.

In one recent study, Gardner, Ward, Burton, and Wilson (2003) examined the relationship between mother-child interactions during joint play tasks and the development of conduct disorders. They reported that positive parenting practices as measured during joint play tasks, makes a unique contribution to the early development of conduct disorder. Specifically they note that when children engaged in pretend play with their mothers, the play included more integration and higher-order activities. Fein and Fryer (1995) report that the effectiveness of maternal play styles represents an inverted-U-shaped function such that, "Mothers who are distant or indirect have little influence on their children; mothers who are intrusive and tutorial have a negative influence. Mothers who offer direct suggestions, solicit pretend behaviors from their children, and participate in pretend exchanges have a positive influence on their children" (p. 378). From this the general conclusion is that mothers are most effective when they provide moderate support. This U-shaped function is similar to the relationship suggested by researchers of the effectiveness of teachers. The available literature appears to suggest that the relationship between maternal support during play activities is complex and that optimal support requires a knowledge of the child's abilities, typical development, and appropriate support strategies.

Conceptualizations of Sensitivity and Stimulation

The greatest commonality across mother-child interaction definitions is the basic idea that adult-child interactions result in a shared task and a common engagement. What is less clear or defined are the features of adult-child interaction that explicitly influence children's learning. Rogoff (1990) notes five theoretically supported features of this scaffolding like process across conceptualizations that are thought to underlie positive parent-child interactions. First, each of the conceptualizations includes an expert tutor, typically a parent, who can bridge the knowledge gap for the novice learner, a child. Secondly, the expert tutor provides structuring support so that the overall goal of the project can be met. The third principle states that expert tutor ensures active participation and contribution from the novice. In conjunction with this concept, the next principle suggests that effective guidance must involve a transferring or increase of responsibility from the expert tutor to the novice learner. Finally, and germane to the current study, these scaffolding encounters frequently occur in a more naturalistic context for children through everyday play behavior. Following a developmental perspective it could then be expected that a child would learn specific skills and then generalize those skills (Rogoff, 1990).

Although Rogoff's research has recognized the core supported tenets of positive scaffolding support, there is still significant variance between those principles and the ways they are operationalized and labeled across studies. Because there is frequently overlap between the proposed mechanisms and factors and the terms used to describe them, there is confusion within the field as to what exactly is the nature of the help or support being provided. For example, Vandermaas-Peeler, Way, and Umpleby (2003) report that guidance, engagement, and frequency of interaction varied as independent factors in their study of parental scaffolding. In another study examining factors that support childhood outcomes, the researchers report that responsivity/sensitivity, emotional tone, engagement, parental talk, and parental guidance are theoretically or empirically recognized as individual but interrelated factors (Dodici et al., 2003). Others, namely Rogoff (2003), describe parental interactions in terms of ‘guided participation’ or ‘cognitive apprenticeship’ while Brown & Campione (1990) use the term ‘reciprocal teaching’ to describe this concept. The current study examined two forms of parenting support, maternal sensitivity and maternal stimulation. These concepts were chosen, in part, because each broadly encompassed a range of parenting behaviors and in part based on the previous research which empirically linked them to positive childhood outcomes (Landry et al., 2002; NICHD, 2005).

The Development of Sensitivity and Stimulation

Developmental psychologists have long recognized the importance of sensitive and stimulating maternal interactions during early childhood (Dodici et al., 2003; Landry et al., 2002) but only more recently has there been closer examination of the developmental unfolding of those sensitive and stimulating interactions (Dallaire & Weinraub, 2005). It is important to separate parenting practices, which are subject to change and grow in developmentally appropriate ways over time, from parenting styles, which have shown relative stability over time. Darling and Steinberg (1993 as cited in Dallaire & Weinraub, 2005) suggest that the practices or behaviors that parents use to display their parenting styles (e.g., sensitivity) should change over time. For example during infancy, sensitive and stimulating parenting is practiced by attuning to the infants non-verbal cues and assisting the infant in maintaining joint attention with the goal of developing a secure attachment. Keller, Lohaus, Volker, Elben, and Ball (2003) report that sensitivity (i.e. prompt response to child's need) is critical during infancy as infants have limited working memory. For toddlers, sensitive and stimulating parenting behaviors are focused on self-regulation and guidance with the goal of developing autonomy and compliance. For preschoolers, sensitive and stimulating parenting is focused on the development of academic and social competency through both warmth and setting of limits/control. It is important to note that although the relative stability of stimulation and sensitive parenting has been supported, the actual behaviors and goals of these constructs changes based on age appropriate competencies (Dallaire & Weinraub, 2005).

Sensitivity

As noted above, there are a number of positive, neutral, and negative techniques that parents use to provide structure and support during these interactions. Sensitivity has been defined many ways such as, "the degree to which parents adapt to children's needs and abilities" (Beckwith & Rodning, 1996, as cited in Dodici et al., 2003, p. 125). Other researchers conceptualize sensitive parenting more broadly along two dimensions: warmth and contingency (Keller et al., 2003). Because the current study is longitudinal in nature and because how a parent displays sensitivity over time should change to meet the developmental needs of the child, sensitivity is conceptualized more broadly than many studies which are looking for specific behaviors at a single point in time, The current study will use two scales to measure sensitivity: supportive presence and respect for autonomy. These scales will be discussed more fully later in the paper.

In Wood and Middleton's study (1975), they examined effective levels of sensitivity by mothers. They hypothesized that effective instruction would require a child to complete an extra operation or decision above and beyond what could be completed independently. This 'region of sensitivity to instruction' was thought to be the most effective level of intervention and the researchers suggested the most effective mothers provide this level of intervention. The researchers examined ways that mother's intervened with children and suggested 5 levels of maternal intervention (general verbal instruction, specific verbal instruction, direct intervention by indicating materials, direct intervention by assembling material, and demonstrates on operation). The author's suggested that, "the sensitive instructor continually modifies his or her approach to the teaching task on the basis of the tutees responses. Each instruction can be likened to a hypothesis; a hypothesis about the most effective level or intervention" (p. 190). More recently, the NICHD Early Child Care Research Network (1999) reported that maternal sensitivity was influenced by the amount of time that the child was in child care such that an increase the amount of hours in childcare resulted in a decrease in sensitivity in children under 36 months. They also reported that having a martial partner resulted in higher levels of maternal sensitivity.

Stimulation

As Hubbs-Tait and associates note, "Although the relation of children's cognitive functioning to specific levels of such parental cognitive stimulation varies across samples, in general, the greater parental use of statements that challenge children to use representational thought the better children's cognitive performance" (2002, p. 110). Sigel, Stinson, & Flaugher's (1991) operationalization of this concept of cognitive stimulation, which they call cognitive distancing, resulted in the level of cognitive stimulation being directly related to the type of challenging nature of the questions being asked by the mother.

This concept was similar to Bernstein's (1961 as cited in Hess and Shipman (1965) description of communication styles during parent-child interactions as either restricted or elaborated. Restricted communication style are stereotyped, scripted, and lack specificity or differentiation by task or individual. This style of communication is explicit, directive, and short. On the other hand an elaborated communication style is more individualized to task and individual. It emphasizes a more complex range of thoughts and diverse communication styles. For example, if a parent asked a child to pick up their toys using an elaborated style of communication they would say, "Johnny, please pick up these toys and put them in the toy box so we can go to the park" or if they were using a restricted style a mother would say "Pick up the toys". In the first statement, the child is being asked to integrate several pieces of information: a time dimension, more complex vocabulary, and to consider the impact of his behavior on future behavior and others. The second statement the child is expected to comply with only one, simple request. Other researchers (Landry et al., 2002) use the terms maternal scaffolding and maternal stimulation interchangeably and operationlaize them more broadly by examining a number of verbal and non-verbal behaviors that occurred during a 60 minute interaction.

The current study will measure stimulation using scales at 24 (cognitive stimulation) and 36 months (mothers as mediators of cognitive development and cognitive stimulation) and at 54 months (cognitive stimulation, goal directed partnership, and quality of assistance). As noted the operationalization of these measures is important to understanding the exact nature of what is being measured, thus the next section will focus broadly on issues related to measuring mother-child interactions and then provide more specific details about how the current study operationalized maternal sensitivity and maternal stimulation.

Measuring Mother-Child Interactions

There are several methodological issues to consider when measuring mother-child interactions. Specifically researchers must consider the reliability, validity, and the utility of the chosen methodology in relation to the question of interest. Based on the current research and the available literature, there are many compelling reasons why it is most appropriate to measure mother-child interactions using direct observations. Namely, direct observation allow for a fuller understanding of complex behaviors as compared to parent reports which are subject to systematic bias based on expectations, mood, and social economic status. (Eddy, Dishon, & Stoolmiller, 1998). Aspland and Gardner (2003) note the many ways that direct observations can be coded. "Parent-child interactions can be interpreted on many different levels including content (e.g., the semantic content of verbalizations), interactional quality (e.g., affect, sensitivity, reciprocity), frequency of specified behaviors (e.g. suggestions), and behavioral contingencies (e.g. praise contingent on compliance)" (Aspland & Gardner, 2003, p. 137). This suggests that direct observations can result in a range of relevant information.

While direct observation techniques are not without their limitations (i.e., time consuming and expensive), overall they appear to be the most reliable and valid method for examining mother-child interactions. As a result of the intensiveness and expense it is more uncommon for studies with larger samples sizes to use direct observations. Thus, the sample sizes for studies which use direct observations are traditionally smaller than the sample size of studies using self-rating scales. Additionally, because direct observations are more time consuming and expensive, researchers tend to carry out fewer observations, which can lead to low/reduced stability of data (Aspland & Gardner, 2003). Fortunately, the sample size the current study is quite large with multiple time points which allows for greater generalizability and more stability.

Another concern related to reliability is that, "high levels of day-to-day variability in behavior, can lead to problems such as low occurrence of some behaviors, or findings that do not represent stable estimates of behaviors of interest" (Gardner, 2000, p. 188). Thus an assumption of the current study is that the, "behavior during the task bears some relationship to participants' style of interacting in more natural settings" (Gardner, 2000, p. 192). This assumption is supported by Dallaire and Weinraub (2005) who reports that within the NICHD data set maternal stimulation and sensitivity displayed relative stability (i.e., parents who were stimulating at 6 months were more likely to be stimulating at 6 years) over the course of birth to age 6. The authors also report that negative maternal behaviors displayed less stability over time. Finally, the authors report that the correlations between stimulation and sensitivity got stronger over time suggesting that there is a greater chance for intervention at younger ages.

Gardner (2000) notes the importance of ensuring that parental behaviors observed in clinic settings are similar to those observed during natural/home settings. Specifically, it is necessary to consider the role of reactivity in the current study as observers are present during the mother-child interactions which occur in a lab setting. One way this study decreased reactivity's threat was by habituating participants to being observed. Because the current study is part of a larger longitudinal study in which participants are observed numerous times both in the lab and at home, it is expected, based on previous research, that over time and numerous observations participant's reactivity would decrease (Gardner, 2000). Several studies have examined systematic factors that influence reactivity and found that mothers demonstrate less reactivity than fathers and older children are more reactive than younger children (Lewis, Kier, Hyder, Prenderville, Pullen, & Stephens, 1996). Other studies have compared methods of recording observations (e.g., paper and pencil vs. audio) and reported no significant differences between method of recording and level of reactivity (Gardner, 2000).

Another consideration for measuring mother-child interactions is the type of task chosen. As Vandermaas-Peeler, Way, and Umpleby (2003) note there are inherent advantages and disadvantages to observing parent-child interactions using structured vs. unstructured tasks. The use of structured tasks (e.g., block building using standardized toys) allows for more quantifiable results that are more easily generalized across individuals, thereby increasing the reliability of the findings. It also allows you to assess the associations between the frequency or quality of certain behaviors and specific outcomes. The use of structured tasks is also valuable because the mother-child experiences will vary.

The joint play tasks chosen for the current study are common activities (e.g., playing with an Etch-a-sketch) for parents and children and are developmentally appropriate. The current study uses a global rating scheme from which observes measured behaviors over a continuous observation time. By utilizing global rating scales, it allows researchers to summarize across a set of related behaviors to provide a single molar rating (Aspland & Gardner, 2003). It is also important to note that, "interactive parent–child tasks that involve problem solving or planning offer opportunities for researchers to capture both the controlling and the warmth dimensions of parenting" which allows for simultaneous measurement of maternal sensitivity and maternal stimulation (Dallaire & Weinraub, 2005, p. 203).

There are, of course, limitations to using more structured tasks in that there is an underlying assumption that all behaviors are equivalent and the tasks are designed to limit the kind of behavior being elicited. It is also suggested that structured tasks may overestimate behaviors in general because the tasks are geared to draw out particular behaviors (Gardner, 2000). Naturalistic observations are also believed to allow for more authentic culturally relevant results. Another important consideration in measuring joint play interactions is that it is uncommon to have a normal distribution of positive and negative behaviors. Research (Gardner et al., 2003) noted that in general adult-child interactions are positive or neutral. The relationship between negative, harsh, or inconsistent parent-child interactions and negative childhood outcomes (i.e. increase in rates of behavioral disorders) is well-established (Gardner, 2000). But research within naturalistic settings has indicated that these negative interactions typically occur in only about 20% of interactions (Gardner et al., 2003). In the current study, it is expected that mother-child interactions will most frequently occur in the neutral or positive category.

Recent research into the measurement of collaborative problem-solving tasks has reported that structured joint play tasks (vs. unstructured joint play tasks) best differentiated hyperactive and non-hyperactive children (Befera & Barkley, 1985).

Specifically, the authors reported that structured problem-solving tasks in which the child could not complete the activity without parental assistance best discriminated between hyperactive and non-hyperactive groups of children. Webster-Stratton (1985 as cited in Gardner, 2000) reported that mothers provided more directive support and provided more frequent positive praise within a laboratory setting and the children displayed more behavioral problems with the home setting. But, more importantly, they reported moderate to high correlations between maternal behaviors across settings.

There are a number of tasks used to measure mother-child interactions. Flick and McSweeney (1987) compared three measures of mother-child interactions (Barnard's Teaching Scale, Schaefer's Attachment Inventory, and Clarke-Stewart's Rating Scales) and reported that the three measures were interrelated but did not share common underlying factors. This lack of a common single underlying factor is not unexpected considering they were each designed to measure different constructs (e.g., attachment). Gardner and others (2003) developed a system that measured mother-child interactions in a naturalistic, home setting by coding the occurrence of joint play based on 30-second intervals. This allowed researchers to examine the amount of time spent in a joint play task during a typical 1 hour observation. But as the authors acknowledge a limitation to this method of measuring mother-child interactions is that, "we did not have a measure of the quality of joint play, which would help elucidate more precisely the parenting and/or child mechanisms contributing to outcome" (2003, p. 374).

The Parent-Child Interaction System (PARCHISY) is more similar to the current study and consists of 13 different 7-point likert scales (Deater-Deckard, Pylas, & Perill, 1997). The parent-child interactions are observed during both unstructured home play and a structured Etch-a-Sketch task similar to the Etch-a-Sketch task used in the current study. The authors report that PARCHISY scales were associated with children's social-emotional status. In sum, Gardner (2000) notes "Observational techniques can summarize the relevant aspects of these complex interchanges and thus test hypotheses about how behavior unfolds over, and how it is influenced by social conditions, including the behavioral triggers and reactions of others" (p. 187).

The Mother-Child Interaction Task

Because the current study will be examining data collected as part of a larger study, the goal of the NICHD researchers in using the mother-child interaction task was to "assess qualities of parenting such as supportive presence, respect for autonomy, hostility, and quality of assistance" (1995, p. 18). The children were presented with three age-appropriate tasks and two of the three tasks were designed and chosen because there were too difficult to be carried out independently by the child and required maternal assistance and support. The tasks selected were similar to tasks used in several other studies (Deater-Deckard et al., 1997; Hess & Shipman, 1965). From these taped interactions data were coded using two different methods: Mother-Child Interaction Task Scoring and Mother's as Mediators of Cognitive Development Scoring.

The first method, mother-child interaction task scoring, was developed specifically for this study. The scales were adapted for the current study based on the work of Pianta (1994) and Egeland and Hiester (1993). Using similar scales, Pianta and Harbers (1996) reported that principal component analysis of maternal-child interaction factors resulted in a single factor with three maternal facets of interaction (quality of instruction, supportive presence, and respect for child's autonomy) and five child aspects interaction (task orientation, affection, self-esteem, negative affect, reliance on mother). The scoring system at 36 and 54 months consisted of mother-child interactions being rated by trained coders on a 7-point global rating scale with 1 = “Very Low” to 7 = “Very High” with six scales reflecting mother’s behavior. The scoring system for 24 months consisted of mother-child interactions being rated by trained coders on a 4 point scale with 1 = “Not at all characteristic” to 4 = “Highly characteristic” with seven scales reflecting mother’s behavior.

The second method, mothers as mediators of cognitive development scoring, involved only the 36 month data and examined 28 positive and negative behaviors (e.g., labeling object, narrating child’s play, asks question, etc) related to mother’s mediating cognitive development. This coding system, which was developed by Friedman & Sherman (1995) for the NICHD study, was applied to 5 minutes of the 15 minutes videotaped session of mother child interaction. Coding was started when the mother and child started using the second box. The coding was carried out using a time sampling technique of observing and then coding 20, 15-second segments of the videotape. From this system a behavioral composite was developed (Total Positive Scaffolding). This composite was computed using the weighted sum of the items that promoted positive cognitive development and included 25 positive behaviors.

The current study will operationalize mother-child interactions by measures of both maternal stimulation and maternal sensitivity. Early stimulation was measured by two scale scores (stimulation of development at 24 months and cognitive stimulation at 36 months) from the mother-child interaction task scoring and one composite score (total positive scaffolding at 36 months) from the mother as a mediator of cognitive development scoring. Late stimulation was measured using three scale scores (cognitive stimulation, goal directed partnership, and quality of assistance) from the mother-child interaction task scoring. Early sensitivity was measured using three scale scores (supportive presence at 36 months, respect for autonomy at 36 months, and sensitivity to distress at 24 months) from the mother-child interaction task scoring. Late sensitivity was measured with two scale scores (supportive presence at 54 months and respect for autonomy at 54 months). The next section will more examine each scale in more detail.

The cognitive stimulation scale is purported to measure the, "degree to which the parent tries to foster his/her child's cognitive and mental development" (NICHD, 1995, p. 23). Parents who receive high scores on this scale, "(a) help their children acquire or master new skills, (b) illustrate or teach concepts or principles, (c) ask questions that encourage problem solving, (d) encourage or reinforce sophisticated pretend play sequences, and so on" (NICHD, 1995, p. 23). Additionally the level of support must be appropriate based on the child's cognitive and developmental ability (e.g., illustrating how to write letters for a 12-month-old would be scored negatively).

Quality of assistance was designed to measure "how well the parent structures the situations so that the child knows what the task objectives are and receives hints or corrections while solving the problems that are: (a) timely to his/her current focus,(b) paced at a rate that allows comprehension and use of each hint, (c) graded in logical steps that the child can understand, and (d) stated clearly without unnecessary digressions to unrelated phenomena or aspects of the task that might only confuse the child" (NICHD, 1995, p. 24). Mothers who receive high scores demonstrate a plan to assist their child but flexibility to change that plan based on the child's abilities.

The total positive scaffolding score was designed to measure, “how the mother conveys cognitive information to her child and the specific kind of information she conveys” (NICHD, 2001, p. 4). Mothers with higher scores represent more frequent and more complex types of cognitive assistance. Seven general areas of behavior were coded: type of mother question, response to child question, reinforce, type of mother directive, type of demonstration/how things function, goals, plans as statements, and type of mother statement and the scores were summed.

Maternal sensitivity is based on three scales. The supportive presence scale measures positive regard and emotional support toward the child. Parents who receive high scores recognize the child’s accomplishments through verbal and physical praise and positive regard and provide support and reassurance to children who are struggling with tasks.

The respect for child’s autonomy scale measures, “the degree to which the parent acted in a way that recognized and respected the validity of the child's individuality, motives, and perspectives in the session” (NICHD, 1995, p. 21). Parents who score high on this scale, “acknowledge the child's perspectives and desires as a valid part of the child's individual identity” (NICHD, 1995, p. 21). This acknowledgement is done through explicitly recognizing and collaborating with the child about the task and roles and validating the child’s intentions, desires, and individuality. The sensitivity to distress scale focuses on, ”how the mother observes and responds to the child's social gestures, expressions, and signals. The key defining characteristic of sensitive interaction is that it is child centered. The sensitive mother is tuned to the child and manifests awareness of the child's needs, moods, interests, and capabilities, and allows this awareness to guide his/her interaction" (NICHD, 1993, p. 38).

Overview of Executive Functions

Recently there has been a flood of research examining executive functions due, in part, to the paramount role the prefrontal lobes play in every aspect of human functioning. Unfortunately, there has yet to be one accepted definition. The term executive cognition is defined by Duffy and Campbell (2001) as "the qualitative organizing principles necessary to navigate the fluctuating and ambiguous challenges confronted in autonomous social behavior" (p. 114). This is compared to Welsh (2002) who defines executive function as, "a cluster of skills that are necessary for efficient and effective future-oriented behavior...planning, inhibition, monitoring, and flexibility" (p. 143). The first definition appears to speak more to the self-monitoring and set-changing where as the second definition focuses on attention and set preservation.

Miyake, Friedman, Emerson, Witzki, Howerter, and Wager (2000) examined a model based on three executive function processes: mental set shifting, inhibition, and updating (i.e., working-memory). This model focuses more on the changes in attention and inhibition than the previous models. Welsh and others (2002) examined a five-factor model consisting of working memory, inhibition, planning, flexibility, and rule induction. Working memory and inhibition jointly influence flexibility, but only working memory covaries with planning and rule induction. Tower of Hanoi-Revised and Matrix Reasoning both loaded on to the rule inductive factor.

Miyake et al. (2000) conclusions are compared to the findings of Senn, Espy, and Kaufmann (2004) who used path analysis to determine the relationship between preschool aged children's performance (n=117) on a complex problem solving task (TOH) and measures of working memory, inhibition, and set shifting. The best fitting model included paths between working memory and inhibition which accounted for 29% of the overall variance in the TOH scores. Interestingly, inhibition more strongly predicted performance in children under age four and working memory was a better predictor in children over age four indicating a protracted course of development. The authors suggest that older children's better developed working memory allow them to solve more complex TOH problems that require greater working memory. This suggests that the underlying components of EF have a complex relationship. As Senn, Espy, and Kaufmann (2004) note, "Clearly, longitudinal studies are necessary to characterize these ontogenetic relations in young children and how they map onto subsequent executive functions during the school-age years" (p. 459).

History of Executive Functions

In 1928, American neurologist Tilney called the period of human evolution the "age of the frontal lobe." The frontal lobes, which are located in the anterior third of the cerebral hemispheres, are evolutionarily the most recent. Although concrete data concerning the frontal lobes are just recently emerging, the frontal lobes have been shown to play a role in nearly every aspect of human functioning from fine motor movement to intricate social situations. Originally researchers attributed executive functions to the dorsolateral and orbital-frontal prefrontal subsystems (Iversen & Dunnett, 1990). But more recent conceptualizations have parsed the executive functions even further with the dorsolateral prefrontal cortex driving planning, working memory, and stragetic reasoning and the ventromedial/orbitofrontal prefrontal cortex responsible for self-monitoring and emotional responses (Banfield, Wyland, & Macrae, 2004). Therefore it receives sensory information from nearly every modality, including somatic, auditory, visual, olfactory, and gustatory senses, and integrates all of these cross-sensory modalities and generates responses (Malloy & Richardson, 2001). The frontal lobes contain some of the most complex reciprocal circuitry. Based on these observations, the human frontal lobes, specifically the prefrontal cortex, are theorized to play key roles in higher-order cognitive processes or executive function.

The frontal lobes account for the largest portion of the total human cortex. The prefrontal cortex results from growth and convergence of primordial fields of the parahippocampal, insular area, and the motor cortex area (Fuster, 1997). The prefrontal cortex is histologically heterogeneous and extensively filled with connections. The cortex of the prefrontal lobe is typically six-layered with a distinct internal granular layer. The prefrontal cortex has rich connections with the limbic system, which play an active role in higher order thinking. Damage to the prefrontal lobes causes deficits in coordination and management of behavior, which is manifested as an inability to integrate sensory information, impoverished behavioral responses, loss of attention, inflexibility, and an inability to self-monitor.

Development of Executive Functions

Executive functions including attentional control, problem solving, and self-regulation are recognized as early as infancy, however at the younger ages executive functions are, “variable, fragile, and bound to external stimulus situation, with increasing stability achieved between 18 and 30 months of age” (Ruff & Rothbarth, 1996, as cited in Isquith, Gioia, & Espy, 2004, p. 405). Specific cognitive process, such as working memory, flexibility, and inhibition, can be accurately measured in preschoolers but more complex problem solving and planning develop along a more protracted course (Espy, Kaufmann, Glisky, & McDiarmid, 2001). It is also reported that, "the emergence and development of executive functions likely varies across individuals in terms of age and the shape of the trajectory of skill acquisition" (Isquith et al., 2004, p. 405).

Researchers who have examined the development of executive functions across 4 different age groups (6-year-olds, 8-year-olds, 10 –year-olds, and 12-year-olds) reported that generally the most active period of development occurred between the ages of 6 and 8 years of age, although inhibition related to mnemonic representations developed around 12 years of age (Becker, Isaac, & Hynd, 1987; Passler, Isaac, & Hynd, 1985). Other researchers (Welsh, Pennington, & Groisser, 1991) examined the development of a greater range of executive functions tasks in children aged 3 to 12 and reported that age at which adult like performance on the tasks was achieved was task dependent. Specifically, they noted that children's performance on simple planning tasks displayed adult like performance around age 6, tasks that required inhibition skills displayed adult performance at age 10, and finally tasks that required complex planning and had a memory component displayed adult like performance at age 12 (Welsh et al., 1991). These studies suggest that the development of executive functions is similar to most complex psychological processes in that it occurs in a multistage fashion with certain simple problem solving skills developing around age 6.

General systems models are one systematic way to identify variables that influence development over time (i.e., executive functions) and to understand how mechanisms may differ by a number of characteristics (e.g., SES). Within a general systems model, there appears to be a hierarchy of factors that promote or prevent development (i.e., risk or protective factors) (Bronfenbrenner & Ceci, 1994). For example researchers have identified specific child characteristics (i.e., temperament, task orientation, gender) related to cognitive outcomes. Development is thought to occur through a dynamic iterative process in which the environment changes in relation to the child's responses.

Burchinal and associates (1997) following a general systems model for cognitive performance theorize that cognitive level of parent has a direct genetic effect on a child's cognitive performance and an indirect influence through care giving characteristics (e.g., interaction styles). Following a general systems model, they suggest that, "frequent responsive and stimulating interactions with caregivers are believed to facilitate children's cognitive development because responsive interactions should provide scaffolded learning experiences" (p. 936). Although there is no general systems model for the development of executive functions, the current study will attempt to understand the indirect and direct parental influences on the development of executive functioning.

Maternal Verbal Ability

An important goal of the current study is to examine the influence of maternal verbal ability on the relationship between SES and executive functions. Specifically, this study will examine if maternal verbal ability, as measured by the Peabody Picture Vocabulary Test –Revised (Dunn & Dunn, 1981) mediates that relationship. It is important to recognize the limitation of using the PPVT-R as it is very culturally bound and more related to an individual's fund of knowledge than to the more fluid, process based measures. Researchers (NICHD Early Child Care Network, 2005) have examined the relationship between attention, memory, and planning from home and school environments used the PPVT-R as a proxy of maternal verbal ability (NICHD, 2005). The researchers reported that, "to the extent that maternal vocabulary controls for heritability, the findings cannot be explained by the shared intelligence of mothers and children, which could be a source of both environmental and cognitive variations among children" (NICHD, 2005, p. 110). The results of the study suggest that after controlling for maternal verbal intelligence, early and late family, classroom, and childcare environments still predicted performance on measures of attention, memory, and planning, although the strength of that relationship was weakened. These findings support the use of PPVT-R as a proxy for maternal verbal ability in the current study. The current study is similar to the NICHD study in that "ideally, we would have liked to control for parents' performance on executive function", unfortunately, due the pragmatic limitations of the data that information is not available (NICHD, 2005, p. 110).

In another study that examined maternal interactions and future development of executive functions, the authors wrote that, "the absence of any measure of mothers' intellectual abilities, genetic backgrounds, or both in the model may raise questions as to whether children's cognitive outcomes are related, in part, to shared genotypes between parents and children" (Landry et al., 2002, p. 37). Based on prior research, this study will examine if maternal verbal intelligence, as measured by the PPVT-R mediates the relationship between SES and later executive functions.

Culture and Measures of Executive Function

As Campbell, Dollaghan, Needleman, and Janosky (1997) note there are conceptual differences between knowledge-based and processing-basing measures, specifically theorizing that knowledge-based (i.e., crystallized) assessments are more influenced by opportunity to learn. These cultural expectations are tied to specific knowledge bases that make it particularly difficult to generalize and interpret the results. Examining the cultural aspects of the TOH specifically, it is purported to be less culturally bound than other measures of EF (Wallner, 1996). For example, the above mentioned grocery-shopping task is similar to the TOH in that it requires configuration of the problem state but differs in that the grocery shopping task requires using culturally based cues. Also the items being purchased are ethnocentrically biased.

Welsh and associates report that "very young children can plan a birthday party or perform well on an errand-running task but have more difficulty on the abstract Tower of Hanoi task" (2006, p.33). Because the TOH task is a novel task with few culturally bound requirements, it allows for a more pure measure of executive functioning without the influence of cultural schemas. As Wallner (1996) notes the TOH requires little domain knowledge as it is based on arbitrary, artificial rules thus when participants encounter the TOH they cannot use specific knowledge they have acquired from past experiences (i.e. they lack a script from which to represent the problem). Thus it is expected because TOH is a novel, processing-based task that cultural biases would be minimized. This is compared to participant's performance on the current measure of short-term memory which is presented verbally and has a crystallized component. It is anticipated that this measure (WJ-R Memory for Names) will be more confounded as a measure of EF because of the lack of distinction been crystallized and fluid knowledge bases.

Measuring Executive Function

One of the greatest hindrances to research examining frontal lobe functioning is the lack of adequate and sensitive tests. The majority of the available executive function tasks were designed to be sensitive to brain damage but lacked a theoretical and empirical foundation within typically developing populations. The lack of consensus regarding the definition of executive functions results in diverse measures of executive functions which potentially map onto many diverse cognitive processes therefore executive functioning could be task dependent (Brocki & Bohlin, 2004). The coordination of these diverse cognitive processes makes executive functions unique. As Espy, McDiarmid, Cwik, Senn, Hamby, and Stalets (2004) note many of the current measures of executive function are quite diverse and should not be considered the same based solely on face validity. As Welsh, Friedman, and Spieker (2006) write, "tests of executive function should vary on a continuum between mind twisters that are completely unfamiliar to the person examined and tests that model real life tasks" (p.33).

Another limitation of many of the current executive function tasks is that they were developed based on principles of frontal lobe functioning in adults as opposed to developmental frameworks (Welsh & Pennington, 1988). For example, the Wisconsin Card Sorting Test is a well known neuropsychological task used to assess executive function (WCST; Miller & Cohen, 2001). This task requires set shifting, creation of strategies, and information organization (i.e., inductive reasoning), together within one task. Using the WCST, Milner (1963) presented research from adult patients with frontal lobe trauma who were able to state the correct rule but unable to complete the task. This compelling evidence led researchers to make a teleological error. It became a common belief that because children were unable to successfully complete the WCST task then they were incapable of executive functions.

Therefore prior to the 1980's, most neurospychologists believed that until puberty executive functions were not engaged (Golden, 1981). As Isquith, Gioia, and Espy note, "Historically they (young children) are perceived as lacking inhibitory control, exhibiting significant distractibility, being inflexible in their ability to solve problems, and not organizing, planning, or monitoring their problem-solving behaviors (2004, p. 404). Since that time, researchers have clearly dispelled this idea and demonstrated that children do in fact possess executive functions (for a review of this literature see Welsh et al, 2006). Currently, literature and research suggests that the development of planful, future-directed, intentional behavior begins in infancy and can be assessed using measures of object permanence (Diamond, 1990). It is also recently recognized that a number of disorders involving executive dysfunction are manifested in preschool years and change over time including ADHD, autism spectrum disorder, obsessive-compulsive disorder, and PKU (Welsh, 2002). Historically speaking the measurement of executive functioning in children is a relatively new area of research.

There are several executive function tasks commonly used with infants and children. Although complex coordination of skills is typically not evident until at least 36 months, Piaget's classic A-not-B task of object permanence is the considered the earliest (12 months) measure of emerging executive function and is reported to be sensitive to frontal lobe damage (Welsh, 2002). Currently the NEPSY Developmental Neuropsychological Assessment is one of the only validated, standardized measures of executive function for preschool and early childhood. It is important to note that the

Tower of London, which is a tower task that is similar, but not isomorphic, to the TOH, is one of the subtests administered under the attention-executive function domain. Another recently developed assessment is the Behavior Rating of Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000). This parent and teacher rating scale attempts to include eco-behavioral validity while assessing a child's inhibition, ability to shift, display of emotional control, ability to initiate, working memory, ability to plan/organize, and ability to monitor. While there are a number of measures of executive function, the next section will describe and examine relevant literature related to measures used in the current study.

Measuring Executive Function in the Current Study

The multi-faceted view of executive function supports differential patterns of development across factors (Welsh et al, 2006). Thus the "measures that are included to tap a single executive function construct inevitably demand multiple executive function abilities for proficient performance" (Senn et al., 2004, p. 469). While the debate about the multi-faceted nature of executive function continues, the empirical research to this point suggests that executive functions are correlated but separable. More specifically, it has been found that different aspects of executive function differentially predict performance on frontal lobe tasks. Thus the current study views executive function from both a unitary and a multi-faceted perspective in that different aspects of executive function work together but can be measured separately. After examining the current theoretical and empirical research and recognizing the limitations of using an archival data set, the current study will measure executive function using measures of planning/problem solving (TOH), inhibition (CPT – commission errors), and memory

(WJ-R memory for names and WJ-R memory for faces). Each of these concepts and relevant literature will be discussed below. *Planning/Problem Solving*

Within the current study, planning is defined as, "the predetermination of a sequence of actions aimed at achieving a goal" (Wallner, 1996, p. 1). Viewed as a future oriented process, planning requires both problem-solving and metacognition. Scholnick and Friedman (1987) suggest that successful planning requires the following components: the ability to construct a representation of the environment, select an appropriate goal, recognize when it is necessary to plan, formulate a successful plan, execute the plan, monitor or change the plan as necessary, and evaluate the effectiveness of the plan. There is an obvious conceptual relationship between the definition of executive function and planning (Wallner, 1996). Specifically, is noted that different executive functions influence different aspects of the planning process. Wallner (1996) examined the overlap between measures of planning and executive function and reported that a common planning task (the grocery store task) accounted for only 25% of the variance on a measure of executive function (TOH). In the current study, planning/problem solving was measured using the TOH.

Tower of Hanoi. The TOH is a problem-solving, disk-transfer task that requires the use of a recursive strategy for optimal performance. The task was originally studied by Simon in 1975 with other prominent TOH researchers including Jean Piaget. The TOH has been used as a measure of frontal lobe function with regards to a variety of neurological-disorders (Malloy & Richardson, 2001) and has demonstrated sensitivity to prefrontal lobe function and dysfunction (Fuster, 1997; Stuss & Benson, 1986). Wallner (1996) writes that the TOH requires that, "individuals must effectively allocate the limited processing resources that are available to construct a sequence of moves in advance of action" (p. 23). The principal investigators of the current study (NICHD Early Child Care Research Network, n.d.) note that the TOH task was chosen because of its extensive research with typically developing adults, sensitivity to age differences and cognitive disabilities, and lack of cultural specific knowledge. Welsh, Pennington, and Groisser (1991) report that children as young as age 6 can display adult-like performance on the simplest TOH problems. But more difficult TOH problems, which typically include an increased number of moves, require more advanced coordination of working memory, inhibition, and attention. Hence adult performance is not achieved until age 12 (Welsh et al., 1991).

Although the majority of the TOH research has been examined with adults, several studies (Bagely, 2002; Scholnick et al., 1997; Welsh, 1991) have examined the development and use of several versions of the TOH with typically developing school-age children. Because there are several different child versions of the TOH (see Scholnick et al., 1997 for a review of differences) and each may tap different underlying processes and were tested using relatively small non-representative sample sizes, it is difficult to make generalizable conclusions across versions. Those limitations being noted, the research with the TOH has indicated in general that the TOH performance varies systematically in relation to age and cognitive ability (Welsh & Pennington, 1988). Although there are several versions of the TOH the current study will use a version most similar to that developed by Welsh (1991) and is briefly described below.

The task consists of moving disks of various sizes on a stand with three equal size posts. The task has the following constraints: (a) disks may only be moved one at a time;

(b) disks may not be set on the table or held in the participant's hand during the movement of another disk; and (c) smaller disks must be placed on larger disks. The object is to move the disks from the start state to the goal state in the fewest number of moves. This is known as the optimal solution path. The TOH is based on a rule-based recursive strategy that, once understood, allows the participant to complete any problem regardless of difficulty level. Goal-recursion is based on cycles of movements necessary to achieve the goal state. Each task is created by smaller sub-goals that require a repeated strategy to solve. This repeated cycle of moves has been theorized to be learned through an implicit or procedural learning process (Bagley et al., 2002; Devine, Welsh, Retzlaff, Yoh, & Adams, 2001) This recursive strategy, which is unique to the TOH, is theorized to reduce the impact of other executive function processes such as planning, working memory, and inhibition (Welsh & Huizinga, 2001).

There are two divergent bodies of literature as to what underlying cognitive processes the TOH really assess. One body of literature suggests that the TOH is a neuropsychological measure of executive function and administration should involve a one trial format with multiple items of increasing difficulty (Bagley et al., 2002; Goldberg, Saint-Cyr & Weinberger, 1990; Welsh, 1991). These researchers observe success with achieving the end goal state regardless of time or a decrease in errors across time. The contrasting view postulates that the TOH is a measure of procedural learning and improvement in performance over successive trails is based on the acquisition of implicit skills. The method of administration involves identical single trials given over multiple sessions to gauge performance improvement. An improvement in performance is measured based on a decrease in the number of moves needed to eventually achieve the goal state. Thus any improvement is considered to be due to procedural learning (i.e., implicit learning). There is much evidence that a variety of cognitive processes are involved in the TOH task. Some of these suggested processes include working memory, (Goel, Pullara, & Grafman, 2001; Senn et al., 2004; Welsh et al., 2002) inhibition (Senn et al., 2004; Welsh, Satterlee-Cartmell, & Stine, 1999), procedural learning/implicit memory (Bagley et al., 2002; Devine et al., 2001; Goldberg et al., 1990), and fluid intelligence/explicit reasoning (Devine et al., 2001; Emick & Welsh, 2005; Lock, Welsh, Adams, & Kurtz, 2002).

Inhibition

For the current study, inhibition is viewed from a neuropsychological perspective in which it is described as the ability to remove non-relevant information during reasoning and withholding a prepotent response. This conceptualization of inhibition covers a broad spectrum of behaviors frequently seen in young children. With regards to other measures of executive function, inhibition is conceptualized as more than a pure withholding of a response but requires cognitive flexibility to keep irrelevant information from interrupting cognitive processes. Inhibition, in other model's of executive function, namely (Barkley, 1997), is theorized to be a primary deficit, which contributes to difficulties with other executive processes that are "downline". Upon reviewing the literature, there are multiple definitions of inhibition. For example, Sergeant and colleagues (2002) reported 12 different definitions of inhibition. When considering development and the ability to selectively attend or inhibit, children improve with age. Schachar and Logan (1990) examined developmental differences on a stop-go inhibition task. They reported on that task that children reached adult level of performance around 2nd grade with the greatest variability in performance at the younger ages.

CPT – commission errors. In the current study inhibition was measured using CPT-commission errors. While commission errors traditionally reflect disinhibition, the majority of the research related to this task comes from ADHD research (see Riccio, Reynolds, & Lowe, 2001 for review). As such, disinhibtion is typically seen as an underlying factor in ADHD. Schachar and Logan (1990), using a stop-go paradigm, reported that individual's with ADHD inhibit less on the task. Research linking inhibition to the TOH has been inconclusive. For example, Welsh et al., (1999) found a relationship between the TOH-R and inhibition (CPT), but the relationship was somewhat weak ($r = .31$, $p=.06$). This is compared to other researchers who reported working memory and inhibition were central to performance on the TOH and accounted for nearly 29% of the variance (Senn et al., 2004).

Memory

Memory influences nearly all mental processes including language, planning, and problem solving. Within the psychological literature memory is encoding, processing, and retrieval of information (Swanson & Cooney, 1991). Memory has been conceptualized in a number of different ways but has traditionally been broken into long-term and short-term memory (Atkinson & Schiffrin, 1968). Research suggests that memory abilities are developmentally relatively stable (Anastasi, 1982). Researchers have examined the influence of parenting behaviors and the development memory and found that certain parenting practices (i.e., when parents talk about current events with their child) contribute to the development of memory ability (Ornstein, Haden, &

Hedrick, 2004). The current study includes measures of both short-term and long-term retrieval.

WJ-R Memory for Sentences (MS). Short-term memory is a capacity limited system that retains information temporarily (Swanson & Cooney, 1991). Short-term memory is related to working memory in that both require a participant to hold information in the conscious awareness but working memory is more future-orientated and short-term memory is more immediate. Short-term memory tasks, such as the one used in the current study, typically require the preservation of sequential information. Within the CHC theory, short-term memory is labeled as Gsm under the memory (MS) label. Gsm is described as the ability to hold information in conscious or immediate awareness and then use it within a few seconds. Hutton and Towse (2001) examined the relationship between short-term memory and cognitive abilities and reported important developmental differences such that the relationship appears to be stronger in younger ages compared to adults. There is also an obvious relationship between short-term and long-term retrieval. Specifically, if short-term memory is deficient than this will interfere with formation of long-term storage and retrieval.

While much of the research related to executive function is focused on working memory, there is some research to support the relationship between short term memory and Raven's matrices. Specifically, Hutton and Towse (2001) examined the relationships between short term memory, working memory, and problem solving skills. In the study, the relationship between the working memory task and the short term memory task was $r=.74$. They reported that the both the short term memory task ($r=.43$) and the working memory task ($r=.53$) correlated moderately with the Raven's matrices task. Importantly, they reported that when processing time was controlled as a factor in the working memory task then “the relationships between STM and abilities (referring to Matrices, reading, and math tasks) were quantitatively superior to the WM scores. Furthermore, WM measures no longer correlated with matrices or number task after controlling for processing time” (Hutton & Towse, 2001, p. 391). Examining the literature related to the WJ-R Memory for Sentences, Dean and Woodcock (1999) examined the predictive validity of the WJ-R Memory for Sentences with closed head injury and brief loss of consciousness from those with a psychiatric diagnosis of depression and/or anxiety. They reported that performance on the Memory for Sentences task significantly discriminated between groups. It is important to note that there is a crystallized knowledge based component to this task such that verbal comprehension is secondary but important requirement of the task. Other researchers, NICHD Early Child Care Network, using the NICHD SECCYD dataset have reported that both early and late maternal behaviors influences the development of short-term memory as measured by the WJ-R Memory for Sentences (2005a). While it may have been preferable to use a measure of working memory in the current study, there is some empirical literature to suggest a relationship between executive function and short-term memory that supports its use in the current study.

WJ-R Memory for Names (MN). Long-term storage retrieval is defined as information storage that is relatively permanent and resistant to forgetting, although not always readily recalled (Atkinson & Schiffrin, 1968). The ability to retrieve information is strongly dependent on a number of factors including an individual’s ability to recall and adequate storage. While information within long-term storage is typically coded semantically, the current task is visually coded. Long term storage and retrieval, Glr as conceptualized by the CHC theory, is defined as, "the ability to store information in and fluently retrieve new or previously acquired information (e.g., concepts, ideas, and names) from the long term memory" (Flanagan, McGrew, & Ortiz, 2000). The MN task does not require knowledge itself but rather the ability to store and to consciously search for relevant information. Dean and Woodcock (1999) examined results from a sample of 1,315 clinical patients, age 5 to 81 years. They reported that the majority of the clinical groups experienced their most severe problems with three subtests from the WJ-R with MN being one of those subtests.

Osmon, Smerz, Braun, and Plambeck (2006) measured the relationship between executive function and both short term (Gsm) and long term memory (Glr). In the study executive function was measured by both the Category Test and the Benton Judgment of Line Orientation. Long-term memory (Glr) was measured using subtests from the WJ-R (i.e., Memory for Names and Visual-Auditory Learning) and short-term memory (Gsm) was measured using the Memory for Sentences and Memory for Words. The authors reported that the measures of short term memory correlated with the Category Test at r=.-.028 and with the Benton Judgment of Line Orientation at r=.202. Importantly the long-term memory measures correlated with the Category test at r=.227 and with the Benton Judgment Line Orientation at r=.371.

Also notably data from the K-ABC-II standardization reported a correlation between measures of Atlantis and Rover. The Atlantis subtest (Glr) was designed, "to measure a child's ability to learn new information using attractive, intrinsically interesting stimuli, much like the Memory for Names subtest on the Woodcock-Johnson

Psycho-Educational Battery-Revised" (Kaufman & Kaufman, 2004, p. 64). The Rover subtest was designed primarily, "to measure the executive functions associated with the frontal lobe" (Kaufman & Kaufman, 2004, p. 64). The authors reported that the task was inspired by the Tower of Hanoi. Notably, the correlations between the two tasks varied as a function of age with the correlation increasing over time. Specifically the relationship was $r=.17$ at age 6 and $r=.29$ at age 15. This suggests that development may be a factor in the relationship between executive function and long-term memory.

Research related to long-term storage retrieval has suggested that, "the processes involved in entering memory trace into long-term store are important sources of ability group differences in children's long-term recall" (p. 32). There has been a significant amount of research observing the connection between the TOH task and procedural learning which is one type of long-term storage (Bagley et al., 2002; Devine, 2000; Goldberg et al., 1990). Schmand, Brand, and Kuipers (1992) found that schizophrenic patients could score within normal range on a version of the TOH even with a loss of declarative memory and that performance on the TOH could improve based on practice without explicit knowledge of how to perform the task. Bagley (2001) and Devine (2000) observed the connection ($r = -.315$, $p<.05$, and $r = -.511$, $p<.05$ respectively) between procedural learning (as measured by Mirror Tracing) and the TOH-R.

Mother-Child Interactions and Executive Function

After reviewing the current literature, the parallels between maternal behavior and executive function become apparent. First it must be noted that mother-child interactions and executive function share some external similarities. In order to engage in appropriate shared interactions it requires that children coordinate basic cognitive processes including attention, inhibition, and self-regulation within framework of a social situation. This is similar to the behaviors associated with executive functioning such as: the ability to maintain set, the ability to inhibit a response, flexibility, self-monitoring, and planning (Welsh & Huizinga, 2001). Many of the behaviors associated with executive function are necessary to engage and sustain mother-child interactions. There are very few studies that have tested the relationship between maternal behaviors and the development of executive function. The following four studies have researched that relationship: Henderson and Moore (1980); Nichols, Fox, and Mundy (2005); NICHD Early Childcare Network (2005a); and Landry, Miller-Loncar, Smith, and Swank (2002). The direction of the current study is based, in part, on this past research. It is important to note that across studies both maternal behaviors and executive functions are measured using a number of different methods and conceptualizations.

Henderson and Moore (1980) examined the influence of adult interaction, specifically intrusiveness and responsiveness, during childhood exploratory play. Complexity in play has been linked to executive functioning. Children (n=48) aged 42 months to 60 months were assigned to either a high curiosity or a low curiosity group based on play complexity scores from a previous study. The high curiosity and low curiosity groups were then randomly assigned, controlling for gender and level of curiosity, to one of three experimental (demonstration, responsive, or nonresponsive) groups or one control group. These groups varied on two dimensions of adult interaction: intrusiveness and responsiveness. Each participant then participated in seven 10-minute play sessions with the seventh session being a measure of generalization that included a different non-familiar adult.

Overall, the researchers reported significant differences between the high curiosity and low curiosity groups. They found that in general children with high curiosity levels displayed more complex play than the low curiosity group with the exception of the non-responsive condition. During the non-responsive condition, the high curiosity levels did not ask additional questions if they were unanswered as compared to the high responsive condition. Researchers also noted that there was not an increase in the complexity of play or curiosity over the six sessions for the low curiosity group. This suggests that reinforcement of these concepts requires more intensive daily interactions such as those provided by parents. This study appears to support the notion of individual differences in children's play complexity and that certain types of adult-children interaction styles can influence the complexity and curiosity during play.

Research from neuroscience has also supported the relationship between executive function and mother-child interactions. In a recent longitudinal study, infants were assessed at 14, 16, and 18 months and researchers examined the relationship between mother-child interactions and prefrontal lobe functioning as measured by EEG indices of left-frontal activity (Nichols et al., 2005). Nonverbal mother-child interactions were measured using a structured assessment in which the child was seated on the mother's lap and presented with various stimuli, a delayed nonmatching to sample paradigm task was used to measure ventromedial prefrontal cortex functioning, and a means end task was used to measure dorsalmedial prefrontal cortex functioning. Using hierarchical regression analysis, the researchers reported that the ventromedial prefrontal cortex is related to mother-child joint attention. While the current study did not directly measure brain functioning, several prior studies within the same laboratory (see Mundy, Fox, & Card, 2003) had defined the relationship between these tasks and brain functioning. The ventromedial prefrontal cortex is also recognized as playing a crucial role in executive functioning skills such as, “establishing and inhibiting stimulus-reward associations and for being flexible in the application and modification of social rewards” (Nichols et al., 2005, p. 37). These findings show emerging support for the importance of the ventromedial prefrontal cortex in, “the capacity to monitor and be aware and be aware of one’s reactions to the world and then use this self-awareness to stimulate the awareness of others” which is quite similar to the more recent conceptualizations of executive functioning (Nichols et al., 2005, p. 47). Although, related to the current study, it is important to note the TOH task is thought to tap the dorsalateral prefrontal cortex.

In another directly related study, NICHD Early Child Care Research Network (2005a) examined the link between the quality of children’s early childhood experiences (including maternal and caregiver sensitivity and stimulation) and the development of attention, memory, and planning, specifically examining the influence of the first 3 years of a child’s experiences on their outcomes. Using hierarchical regression the authors reported that there was a significant cumulative influence of the quality of the child-rearing environment on attention and memory but not on planning. Also, importantly, they noted that the family environment, as opposed to the child care and school environment, was more strongly predictive of attention and memory. Finally, the authors reported that quality of the child-rearing environment during both early (6 to 36 months) and later (54 months and 1st grade) predicted performance on measures of attention and memory but not planning.

The current study is based, in part, on a study by Landry, Miller-Loncar, Smith, and Swank (2002) which examined the influence of maternal scaffolding at ages 3 and 4 on the development of executive function at age 6. The study also assessed students' performance on a set of skills (language, nonverbal problem-solving, and memory) that are theorized to be perquisite for the development of executive function. Specifically, the study measured language, memory, and nonverbal problem solving at age 4. The study was part of a larger longitudinal study that examined parenting behaviors and preterm infants' outcomes and the study included both term (n=90) and preterm (n=163) children.

Within the current study scaffolding was measured by frequency of occurrence during a 70 minute observation within the family home. For the first ten minutes of the observation mothers were instructed to play with toys provided by the researchers. The remaining sixty minutes of the observation parents were instructed to go about their typical routine and observers recorded their behavior. Researchers were trained to consider the nature of the content of maternal verbal support to determine if it qualified as scaffolding. Maternal verbalizations were coded as scaffolding when, "they provided conceptual links between objects, persons, activities, or functions. This form of verbal input was considered more facilitative of problem-solving skills because it begins to place more responsibility for problem-solving on the child" (Landry et al., 2002, p. 21).

Children's receptive and expressive language skills were assessed using the Clinical Evaluation of Language Fundamentals at ages 4 and 6. Nonverbal problem solving ability was assessed using the Nonverbal Scale Score from the Stanford Binet Intelligence Test, fourth edition. Memory skills were assessed using the Memory Scale Score also from the Stanford Binet. Executive function was assessed using two tasks, Spatial Reversal Task and independent goal directed play behavior task. The Spatial Reversal Task is a traditional executive function task that requires individuals to identify the rule, inhibit incorrect responses, and demonstrate flexibility to shift set over time. The independent goal directed play behavior task required the child to develop play goals and strategies for achieving those goals. Scores were assigned based on the complexity and length of play.

Using structural equation modeling, the researchers reported a number of direct and indirect relationships. For example, they reported that maternal scaffolding at age 3 indirectly influenced executive functioning (i.e., Spatial Reversal Task) by directly influencing language abilities at age 4. Thus enriched verbal scaffolding at a young age increased language development which in turn predicted future executive functioning development. The path from language skills to the independent goal directed play behaviors task was non-significant possibly due to the fact that the task has fewer rule-based strategies as compared to the Spatial Reversal Task.

Maternal scaffolding at age 3 also indirectly influenced executive function (i.e., independent goal directed play) via nonverbal problem solving skills at age 4. Thus it appears that the scaffolding at age 3 strengthened nonverbal problem solving. The authors hypothesize that when a mother is helping the child identify salient features of a specific problem (e.g., the shape of a puzzle piece is important) those skills are later generalized into nonverbal play tasks. The path from nonverbal skills to the Spatial Reversal Task was non-significant possibly because the ability to mentally represent objects appears to be more closely related to language ability.

Another cognitive factor that was examined, but did not influence executive processing, was short-term memory. Not surprisingly, maternal scaffolding significantly influenced short-term memory skills. The lack of relationship between executive function and short-term memory is less clear as other empirical findings have supported a relationship (Miayke et al., 2000; Senn et al., 2004). Also of significance within the model was that 4-year old scaffolding did not directly or indirectly influence executive function. This suggests that there is may be a sensitive period when scaffolding provides unique support for the development of executive function.

The findings for the Landry et al. (2002) study are relevant to the current study for several reasons. First, it is one of the few studies to identify, "common paths of direct influence from mothers' directness to both goal-directed and initiating skills but different paths of indirect influence" (Landry et al., 2002, p. 370). Secondly, the study supported the concept of a sensitive period for development which is in contrast to the results of the NICHD Early Childcare Network (2005a) study. Based on these studies, the current study will examine the direct and indirect impact of maternal support at 36 months and 54 months. As mentioned in the previous section of this literature review a major limitation of the study was, "the absence of any measure of mothers' intellectual abilities, genetic backgrounds, or both in the model may raise questions as to whether children's cognitive outcomes are related, in part, to shared genotypes between parents and children" (Landry et al., 2002, p. 37). The current study will include a measure of maternal verbal ability and consider the role ethnicity in order to better examine the influence of maternal support on executive function.

The current empirical and theoretical research indicates a potential relationship between the development of maternal behaviors and executive function. Research supports the concept that the quality and frequency of the maternal interactions in early childhood has long-term implications. It has been suggested that during these mother-child interactions children learn problem solving skills. Although executive function is central to everyday experiences, little is known about what influences its development. Using data from the NICHD SECCYD and building on the current theoretical and empirical knowledge, the current study used structural equation modeling to examine the relationship between the development of executive function and maternal behaviors.

CHAPTER III

Methodology

Participants

As part of a 1991 research NICHD SECCYD study, 1364 participants were recruited from 10 research sites throughout the United States (Little Rock, AR, Orange County, CA, Lawrence, KS, Boston, MA, Pittsburgh, PA, Philadelphia, PA, Charlottesville, VA, Seattle, WA, Morgantown, NC, and Madison, WI). Although the NICHD SECCYD is a longitudinal study that followed individuals from birth through 10^{th} grade, the current study only focused on data from birth to 1^{st} grade. The overall NICHD SECCYD sample was selected based on a conditional random sampling plan that focused on the maternal employment and demographic diversity within each of the 10 research sites. The NICHD SECCYD study was designed to include mothers who intended to work full-time (60%) or part time (20%) in the first year of the child's life as well as mothers who intended to stay at home (20%). Participants were excluded from the NICHD SECCYD study, and by extension the current study, if their mothers were less then 18 years of age at the time of birth, if the family did not plan to stay within the site area for three years, if there were obvious disabilities at birth, if the child was hospitalized more than seven days following birth, if the mother had a known substance abuse problem, or if the mother was not sufficiently conversant in English (NICHD Early Child Care Research Network, 1993). It is important to recognize that the above conditional sampling plan based on maternal employment and the exclusion criteria were pre-existing decisions within the archival dataset. Obviously, these pre-existing decisions within the NICHD SECCYD dataset limited the generalizability of the overall dataset, as it was not designed to be nationally representative, and did not include paternal measures thus limiting the current study to examining maternal factors.

Four hundred and seventy participant's data were included in the current study with roughly equivalent number of females (n=238, 50.6%) and males (n=232, 49.4%). The ethnicity of the participants in the current study was the following: 87.9% were White, non-Hispanic, 5.5% were African American, non-Hispanic, 4.3% were Hispanic, 1.5% were Asian-Pacific, less than 1% were American Indian, and .4% were classified as Other. While the current study has similar proportion of males and females as the overall NICHD study, there are notable differences in the breakdown of racial/ethnic membership as compared to the overall NICHD study. The ethnicity of the participants of the overall NICHD study consisted of 75% White, non-Hispanic, 13% being African American, non-Hispanic, 6% being Hispanic, 1% being Asian-Pacific, and less than 1% being American Indian, and 3% being Other. While it is somewhat unclear as to what caused these differences, there appeared to be differential attrition rates such that more ethnic minorities, namely African Americans, had either missing data or chose not to remain in the study. As mentioned above the current study was not designed to be nationally representative but the small number of participants within each ethnic minority group makes multi-group comparison difficult and decreases the generalizability of the current findings.

Examining Table 2 it appears that there were some notable differences between the current study sample, the total NICHD study sample, and data from 1991 U.S. Census. As noted above, these differences are attributed to differential attrition and missing data rates as the sample for the current study only included individuals with full set of data. In a review of the NICHD study (NICHD Early Child Care Research Network, 2001) researchers compared the demographic characteristics of the families in the NICHD sample to the 1991 U.S. Census data. The results suggested that the families in the NICHD study were generally more well-educated, more likely to receive public assistance, and less likely to include Hispanic participants then the actual U.S. population (see data in Table 1). The data from participants in the current study represent a further departure from data reported in the U.S. census such that it under-represents minorities, particularly African Americans and Hispanics, and over-represents individuals with higher education.

Table 1.

Demographic Variables for participants and families in the Current Study sample (N=470), NICHD Study sample (N=1364), and the entire United States.

		Current Study sample	NICHD Study Sample	1991 U.S.[a] Census Data
Gender	Female	238 (50.6%)	659(48.3%)	N/A
	Male	232 (49.4%)	705(51.7%)	N/A
Ethnicity	American Indian	2 (.4%)	5(.4%)	.9%
	Asian American	7 (1.5%)	20(1.5%)	3.6%
	Hispanic	20 (4.3%)	90(6.6%)	15.3%
	African American	26 (5.5%)	175(12.8%)	15.7%
	Caucasian	413 (87.9%)	1023(75.0%)	64.9%
	Other	2 (.4%)	51(3.7%)	N/A
Income-to-Needs Ratio	Poor	29 (6.2%)	181(13.4%)	N/A
	Near Poor	65 (13.8%)	218(16.1%)	N/A
	Not Poor	376 (80.0%)	956(70.5%)	N/A
Mean Income		$43,079.88	$37,781.28	$36,875.31
Mother's Education	< 12 years	15 (2.3)	142(10.4%)	24.6%
	High School/GED	83 (17.7%)	288(21.1%)	30.1%
	Some college	163 (34.7%)	453(33.2%)	26.7%
	Bachelor's Degree	128 (27.2%)	284(20.8%)	12.3%
	Graduate school	81 (17.3%)	198(14.5%)	6.3%

[a] US Bureau of the Census 1991 birth data.

Procedures and Materials

Socioeconomic Status (SES)

SES is a single composite score composed of the following three indicators: maternal educational level, income-to-needs, and neighborhood safety. SES is defined as the amount and quality of economic resources available to an individual. While SES could have been measured through the use of formative indicators because of the overall instability within the model a single composite score was used (See Kline, 2006).

Maternal education level (1 month). Level of maternal education was assessed when the child was 1 month old. The current study will measure maternal education level using the number of years of school attended.

Income-to-needs (6 to 36 months). This was calculated by dividing total family income by the poverty threshold for the appropriate family size as defined by the U.S. Census Bureau in 1991. Income-to-needs ratios less than 1 indicate poverty status with scores of 5 and above indicate relative affluence. The current study will use a composite score to represent the average income-to-needs ratio based on total income over 1 to 36 months.

Neighborhood Safety (1st grade). The current study used the Neighborhood Safety scale from the Neighborhood Satisfaction and Involvement Questionnaire to assess maternal perceptions of neighborhood safety. The Neighborhood Safety scale includes 5 questions that are originally asked on a 7-point likert scale and then rescaled by the NICHD Early Child Care Network to a 10-point scale. The Neighborhood Safety scale was administered to participant's mothers at 1st grade. The Neighborhood Satisfaction and Involvement Questionnaire was originally developed for the multi-site FAST Track

Intervention Project (Greenberg et al., 1999). Vandell and Piere (1998) examined the validity of the Neighborhood Questionnaire and reported that maternal perception of the Neighborhood Safety was negatively correlated ($r = -.24$ to $-.58$) with the police records of property and violent crimes in that neighborhood over the course of 3 years. The alphas for the overall NICHD study are $r=.74$ and .71 for the Neighborhood Safety scale and the Neighborhood Social involvement scale, respectively.

Maternal Sensitivity and Maternal Stimulation

Mother-Child Interaction Task. In the current study maternal sensitivity and maternal stimulation were measured during the Mother-Child interaction task using three scoring systems. The Mother-Child interaction task involves three activities during a semi-structured 15 minute interactions, although only 12 minutes of useable interaction was required to be validly scored. Activities chosen for the 24, 36, and 54 month interactions were similar to those used in other studies (Hess & Shipman, 1965). Two of the three activities were designed and chosen because they were too difficult to be carried out independently by the child and required maternal assistance and support. The third activity was selected to encourage pretend play.

At the beginning of the task the mother is presented with three sequentially numbered boxes and instructed to help their child play with the items in the three boxes for 15 minutes. The toys were selected based on three criteria. The toys must be interesting and developmentally appropriate, foster different types of activities, and general enough to be used differently by children and their mothers (NICHD, 2001).

At 24 months, the first activity was a picture book. The second activity was a model kitchen that included kitchen accessories. The third activity was a discovery cottage which included toy figurines.

At 36 months, the first activity was to coordinate the use of stencils thus the first box contained markers, a pad of blank paper, and 4 stencils of animals. The second activity was developed to stimulate pretend play thus the second box contained dress up clothes (men's shoes, women's shoes, a vest, and a cape) and a cash register. The final activity required collaborative play thus the third box contained a Duplo Building Set with a laminated color picture of the model design.

At 54 months, the first activity required completion of a maze using an Etch-A-Sketch thus the first box contained an Etch-A-Sketch which was altered by attaching a maze to the screen. The goal of the second activity was to form rectangular cube towers from wooden blocks thus the second box contained irregularly shaped wooden blocks. The goal of the third activity was pretend play thus the third box contained six animal hand puppets (2 parrots, 2 frogs, and 2 alligators).

Task Scoring. From these taped interactions at 24, 36, and 54 months data were coded using three different methods.

The first method, called the mother-child interaction task scoring at 24 months, was developed specifically for this study and was modified from Egeland and Hiester (1993). The mother-child interactions at 24 months were rated by trained coders on a 4-point global rating scale with 1 = "Not at all characteristic" to 4 = "Highly characteristic". Inter-rater reliability data from selected tapes from the overall NICHD data set (n=212) of the 24 month mother-child interaction task scoring indicated Pearson correlation coefficients of .67 for the maternal sensitivity composite at 24 months and .57 for the maternal stimulation scale at 24 months.

The second method, the mother-child interaction task scoring at 36 and 54 months, used a 7-point global rating scale with 1 = “Very Low” to 7 = “Very High”. Inter-rater reliability data from selected tapes from the overall NICHD data set (n=242) of the 54 month mother-child interaction task scoring indicated Pearson correlation coefficients of .78 for the maternal sensitivity composite at 54 months and .68 for the maternal stimulation scale at 54 months. The internal consistency scores of the composite profiles indicate maternal sensitivity r =.84.

The third method, mothers as mediators of cognitive development scoring, involved only the 36 month data and examined 28 behaviors (e.g., labeling object, narrating child’s play, asks question) related to mother’s behavior mediating cognitive development. This coding system, which was developed by Friedman & Sherman (1985) for the NICHD study, was applied to 5 minutes of the 15 minutes videotaped session of mother-child interaction at 36 months. Coding was started when the mother and child started using the second box. The coding was carried out using a time sampling technique of observing and then coding each of 20 15-second segments of the videotape. From this system a behavioral composite was developed (Total Positive Scaffolding). From the overall data set, reliability data as coded by two trained observers was obtained for 63 children. Pearson correlation coefficient for the behavior composite (Total Positive Scaffolding) was reported at 0.96 (NICHD, 1999). Within the overall NICHD dataset, scores ranged from -2 to 232 with higher scores indicating more positive scaffolding. The 25 items used to create the total positive scaffolding score had low internal reliability (Cronbach's alpha = 0.45).

Early Maternal Stimulation (24 and 36 months). The current study will use one scale score (cognitive stimulation) from the 24 month mother-child interaction task scoring, one scale score (cognitive stimulation) from the 36 month mother-child interaction task scoring, and one composite score (positive scaffolding) from the mother as mediator of cognitive development scoring.

Early Maternal Sensitivity (24 and 36 months). The current study will use one scale score (positive regard) from the 24 month mother-child interaction task scoring and two scale scores (respect for autonomy and supportive presence) from the 36 month mother-child interaction task scoring.

Late Maternal Stimulation (54 months). The current study will use three scale scores (cognitive stimulation, goal directed partnership, quality of assistance) from the mother-child interaction task scoring for maternal stimulation at 54 months.

Late Maternal Sensitivity (54 months). The current study will use two scale scores (supportive presence and respect for autonomy) from the mother-child interaction task scoring at 54 months.

Maternal Verbal Ability

Peabody Picture Vocabulary Test - Revised (PPVT-R) (36 months). The current study will use the Peabody Picture Vocabulary Test - Revised (PPVT-R) edition form M to measure maternal verbal ability (Dunn & Dunn, 1981). The PPVT-R was designed for individuals aged 2 ½ to 90 years of age. The task requires receptive knowledge of vocabulary and involves items of increasing difficulty. The task was administered to the participants' mothers during the 36 month lab visit. The task takes about 10 to 20 minutes to complete although the task is un-timed. Participants are presented with plates that include four pictures on each plate and are asked in indicate which picture best tells the meaning. Reliability for the PPVT-R comes from a nationally representative adult sample (n=800) based on age, gender, geography, and occupation. Internal spilt-half consistency ranged from .80 to .83.

Research using the PPVT-R with typically functioning elderly adults (n=91) as measure of intelligence indicates that it significantly correlated with the short form WAIS-R FSIQ (r = .61) (Snitz, Bieliauskas, Crossland, Basso, & Roper, 2000). Other researchers (Altepeter & Johnson, 1989) reported that the PPVT-R correlated positively and significantly with the WAIS-FSIQ r =.47, the WAIS-R Verbal r = .53, and the WAIS-R Performance r = .24 thus demonstrating convergent and divergent validity. Finally Carvajal, Kixmiller, Knapp, Vitt, and Weaver (1991) examined the relationship between the PPVT-R and the Stanford Binet 4^{th} edition for college students (n=31) and reported a positive correlation (r=.59).

Language

Reynell Developmental Language Scale (RDLS) (36 months). The current study will use the Reynell Developmental Language Scale (RDLS) (Reynell, 1990). The RDLS was developed as a test of verbal comprehension and expressive language skills and was designed to detect changes in language development in children aged 1 to 7. The test was administered during the 36 month lab visit. The RDLS has two 67-item scales: Verbal Comprehension and Expressive Language and produces two separate scores. Reliability for the RDLS comes from a nationally representative sample (age, gender, geography, and parental education) based on data from the 1987 U.S. census with participants (n=619) aged 1 year to 6 years 11 months. Of the overall RDLS national sample, nearly 100 (n=99) participants were between the age of 36 and 48 months. Internal split-half reliability for the Verbal Comprehension form (A) was r = .93 and for Expressive Language was r = .86. Inter-scale correlations between the Verbal Comprehension and Expressive Language scale was .76.

Validity data comes from several sources. Both the Expressive Language and the Receptive Language scales highly correlated with the Language Development Survey (LDS) at .71 and .56 respectively (Rescorla & Alley, 2001). Additionally, Expressive Language (.78 and .81) and Receptive Language (.56 and .58) were highly correlated with the LDS over time (23 day test-retest). The Expressive Language scale demonstrated discriminate validity between at risk toddlers (n=33) and a matched (gender and SES) control group (n=33). There were significant group differences $t(40.18) = 4.97$, $p<.001$ with the at risk participants scoring about 6 months below average. Other studies reported that the Verbal Comprehension scale and the Predictive Screen Test of Articulation correlated at r = .43 and the Expressive Language scale and the Predictive Screen Test of Articulation correlated at r = .56 (Reynell, 1990). The Verbal Comprehension scale and the Goodenough-Harris Draw-a-Man Test correlated at .51 and the Expressive Comprehension scale and the Goodenough-Harris Draw-a-Man Test correlated at .46. Predictive validity was reported between the British version of the RDLS and the WISC. Predictive validity between the Receptive Language Scale at 7 years of age was .71 for the WISC Full Scale and .69 for the WISC Verbal. Predictive validity for the Expressive

Language Scale at 4 years of age with the WISC at 7 years of age was .63 for the WISC Full Scale and .67 for the WISC Verbal Comprehension.

Preschool Language Scale–3 (PLS-3) (54 months). The current study will use the Preschool Language Scale–3 (PLS-3) which was designed to assess vocabulary, grammar, morphology, and language reasoning (Zimmerman, Steiner, & Pond, 1992). The test was developed for use with children between 2 weeks and 6 years, 11 months of age. The test was administered during the 54 month home visit within the current study. The PLS-3 has 2 scales: Auditory Comprehension and Expressive Communication and produces two separate scores as well as a Total Language score. The manual reports test-retest stability coefficients ranging between .82 and .92 for subscales and .91 to .94 for the Total Language score (Zimmerman et al., 1992). Internal consistency scores range from .47 to .90. Concurrent validity scores between the PLS-3 with the PLS-R were reported at .66 for the Auditory Comprehension Scale and .86 for the Expressive Language Scale.

Other research with the PLS-3 indicates its reliability and validity for use with African American children. Qi, Kaiser, Milan, Yzquierdo, and Hancock (2003) examined the performance of low SES African American preschoolers aged 36 to 52 months (n=701) and a comparison group of European American preschoolers (n=50). The authors reported PLS-3 internal consistency for Auditory Comprehension = .86, Expressive Communication =.87, and Total Score = .92. The authors also reported that the total PLS-3 score correlated with the Expressive Vocabulary Test r=.48 for African American participants and r=.64 for European American participants. Although the African American participants performed about 1 SD below the expected means, t tests showed no significant differences between the two groups. Overall, the authors noted concerns about the use of the PLS-3 as a sole clinical indicator of a language disability for African American children but reported that the PLS-3 "produces a range of scores that are meaningfully related to other measures of language use" (Qi et al., 2003, p. 589).

Woodcock-Johnson Picture Vocabulary Subtest (54 months). Children's vocabulary performance was assessed at 54 months using the Picture Vocabulary subtest of the Woodcock-Johnson Psychoeducational Battery-Revised (WJ-R; Woodcock & Mather, 1989). The task requires participants to name familiar and unfamiliar pictured items. The test has a mean score of 100 with a standard deviation of 15. Within the overall NICHD data sample the internal task reliability was .76.

Attention

Solitary Play. (36 months). Focused attention (i.e., engagement with objects through exploration) was measured by presenting the participants with different age appropriate toys. The participants were seated on the floor and video taped for 15 minutes. The interactions were coded for both visual and tactile exploration using a voice-activated computer coding system (Breznitz & Friedman, 1988). The coder inputted information about the child's engagement and the computer automatically recorded the amount of time the child attended to each object. The current study will use average time attending to a toy and total time off-task.

Although validity data are not available for the current measure because the solitary play task was developed specifically for the NICHD study, this methodology (i.e., direct observation of attention) is a commonly used and accepted method in developmental research (Barkley, 1994). Other researchers have reported that focused attention is typically consistent across situations and reliable across objects (Ruff & Rothbart, 1996).

Child Behavior Checklist (CBCL) (54 months). Mothers and an alternative care giver completed the CBCL (Achenbach, 1991). The parent version contains 118 items that describe a range of child behaviors and emotions. Mother's rate how well the item describes their child in the last six months based on the following scale: 0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true. Higher scores indicate overall more problems. Standard scores range from 50 to 100. The Attention Problems Subscale contains 11 items and purports to measure impulsivity and inattention (e.g., can't pay attention for long). The CBCL has high 1-week test–retest reliabilities (ranging from .63 to .97) and high internal consistency (ranging from .66 to .92) (Achenbach, 1991). Convergent validity for the CBCL Attention Problems scale score was reported with the Child Symptom Inventory–4 (CSI–4) ADHD combined type (r=.65). Achenbach, Howell, McConaughy, and Stanger (1995) reported that the Attention Problems scale score of children assessed at age 4 through 12 years via parent reports and reassessed at 3 and 6 years via parent, teacher, and self-reports and were found to be developmentally stable.

Delay of Gratification (DOG) (54 months). The Delay of Gratification (DOG) task is administered in the laboratory during the 54 month visit. The task is designed to assess a child's ability to delay gratification and attend to a task by offering the child an option between waiting for the bigger food prize or obtaining a smaller food prize by not waiting. The current study uses the amount of time waited. While it is necessary to recognize the DOG task does include aspects of inhibition (see Welsh & Pennington, 1988), the ability to attend to the task is also thought to be a central aspect of the task.

After choosing which of three foods the child most likes, M&Ms, animal crackers, or pretzels, the child is offered a choice between waiting (for 7 minutes) until the examiner returns to the room to receive a larger quantity of their chosen food or ringing a bell and to bring the examiner back into the room and receive a smaller amount of food. Both larger and smaller amounts of food are placed in front of the child.

A number of studies have examined the relationship between quality of environment and the capacity to delay food reward. Several studies have reported that children in lower SES environments or children with less responsive parents are significantly less able to delay reward (Aber, Rodriguez, Michel, & Shoda, 1995). Other researchers (Shoda, Mischel, & Peake, 1990; Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000) have reported long term positive effects of preschoolers who can delay gratification. Specifically they report more self-regulation and greater ability to cope during adolescents.

Continuous Performance Task (CPT) (54 months). At 54 months children completed the CPT (Rosvold, Mirsky, Sarason, Bransome, & Beck, 1965). This individually administered task is presented at the end of the 54 month lab visit. The task required participants to press a button “as fast as you can” when a target stimulus (i.e., a familiar object) was presented on a screen. 220 total stimuli were presented in 22 blocks. Within each block the target stimulus were randomly presented but appeared twice within each of the 22 blocks. Each stimulus appeared on the screen for 500 msec. The task required the participant to not only press the button when he/she saw the target stimulus but to also inhibit pressing the button when other non-target stimuli are presented. The task takes 7 minutes and 20 seconds to complete.

The current study will use the errors of omission score to measure sustained attention. Errors of omission occur when the participant fails to press the button when the target stimulus is presented. It is expected that children with greater ability to sustain attention would have fewer errors of omission thus lower scores indicate higher levels of sustained attention. Reliability data from 138 non-referred 7-11 year old ethnically diverse males reported adequate test-retest reliability (r = .65 - .74) (Halperin, Sharma, Greenblatt, & Schwartz, 1991). The task has been found to be sensitive to individual differences and group differences and widely researched with individuals with attention deficit/hyperactivity disorder (Barkely, 1994). The CPT was reported to be significantly related to the reading/decoding ability as measured by the WRAT-R but not related to vocabulary as measured by the PPVT-R (Halperin et al., 1991).

Executive Function

Tower of Hanoi (TOH) (1st grade). The TOH is reviewed extensively in Chapter 2 therefore the following is a brief overview with more detail about administration and scoring. The current study used the TOH as one measure of the child’s executive functioning ability. The TOH task consists of moving four colored rings of increasing diameters among three vertical pegs. Participants are presented with an initial tower configuration with the goal being to move the rings among the pegs to construct a tower (largest rings on the bottom and smallest on the top) on a specified peg. The following rules were employed: (a) only one disk is allowed to be moved at a time; (b) a disk cannot be set on the table or held in the participants hand during the movement of another disk; (c) a larger disk cannot be set on top of a smaller disk. Participants have unlimited time to complete the task. In order to be successful participants must construct the tower in the fewest number of moves. Participants were presented with several practice problems and a set of six test problems.

Several children (n=11) were not able to complete the practice items and were excluded from the analyses for that reason. The 6 test problems ranged in degree of difficulty from involving three disks and four moves for completion (least difficult) to including four disks and eleven moves (most difficult). The problems were presented from least to most difficult. The child must successfully complete a problem twice in succession before he or she progressed to a higher level of difficult. Successful completion of a problem was defined as transforming the initial configuration into the goal configuration in the fewest possible number of moves while not violating any rules. A single problem was presented to the child a maximum of 6 times. The child had a maximum of 20 moves per trial to try to solve the problem.

Participants were given several scores but the current study will use the Total Efficiency Planning score as it reflects the number of trials needed to successfully complete a task and provides an overall performance score (Borys, Spitz, & Dorans, 1982). As mentioned above students must get two successive trials correct, thus the maximum score of 6 is assigned if the problem is successfully completed in the first or second trials; a score of 5 is assigned if the problem is successfully completed in the second and third trials; a score of 4 is assigned if the problem is successfully completed in the third and fourth trials; a score of 3 is assigned if the problem is successfully completed in the fourth and fifth trials; a score of 2 is assigned if the problem is successfully completed in the fifth and sixth trials; and a 0 is assigned for no consecutive correct solutions (a score of 1 cannot be obtained).

The scores on the individual items were summed to yield the Total Efficiency Planning scores. Scores in the NICHD dataset ranged from 0 to 34 with higher scores indicating greater executive functioning. The items used to create the Total Efficiency Planning score have moderate internal reliability (Cronbach's alpha = .70). In the current NICHD dataset, correlations between the TOH and the Continuous Performance Task (CPT) ranged from -.155 to .123 (Welsh, 2005). Examining the relationship further, participants who had a greater number of omission errors on the CPT also had lower scores on the TOH. Other researchers observed a significant positive relationship, $r = .36$, $p<.05$, between one working memory test (Letter-Number-Sequencing from the WAIS) and performance on the Tower of Hanoi-Revised. A positive significant relationship ($r = .549$, $p< .05$) between Matrix Reasoning (a measure of nonverbal reasoning/fluid intelligence similar to Raven's Matrices) and the Tower of Hanoi-Revised was also reported (Lock et al., 2002).

Memory for Sentences (MS) (1st grade). The MS was administered in the 1st grade. Memory for Sentences, which is part of the Woodcock-Johnson Psychoeducational Battery-Revised (1989), measures short-term memory as well as comprehension knowledge. The task involves participant's recalling and repeating simple words, phrases, and sentences which were presented via tape player. The task also required that the participant use sentence meaning to aid recall. The normative data for this sub-test are based upon a nationally standardized sample of 6,359 subjects, aged 24 months to 90 years of age. Split-half reliability for the MS task is reported to be .897 (McGrew, 1986).

Memory for Names (MN) (1st Grade). The MN was administered in the 1st grade. Memory for Names, which is part of the Woodcock-Johnson Psychoeducational Battery-Revised (1989), measures long-term retrieval. The task requires participants learn associations between unfamiliar auditory and visual stimuli (a space creature). The participant is presented with an unfamiliar stimuli, told the stimuli's name, and then asked to recognize and name the stimuli from a sheet of nine space creatures. Participant's errors are corrected. The level of difficulty increased as the task continued. The normative data for this sub-test are based upon a nationally standardized sample of 6,359 subjects, aged 24 months to 90 years of age. Split-half reliability for the MN task is reported to be .909 (McGrew, 1986).

Continuous Performance Task (CPT) (1st Grade). The CPT was administered in the 1st grade. The administration procedure was very similar to the 54 month procedure expect that the stimuli were presented in 30 blocks with ten stimuli in each block. Each stimulus was displayed for 200 msec with 1500 msec between stimuli. The target stimulus (a dot matrix letter X) was randomly presented within each block and appeared twice in each block. The test took 350 sec. to administer. The current study will use the errors of commission score to measure inhibition. Commission errors are generally seen as reflecting disinhibition. Much the research to support the use of commission errors has come from research related to ADHD (see Riccio et al., 2001 for review).

Data Analysis

The major goal of the current study was to examine the relationship between maternal behaviors and the future development of executive function. Structural equation modeling was chosen as it provided more flexibility than multiple regression, controlled for measurement error, and provided an overall model fit (Frazier et al., 2004). As recommended by Hoyle (1995) confirmatory structural equation modeling, as opposed to exploratory modeling, was used in the current study. Jorekog and Sorbom (1996 as cited in MaCallum & Austin, 2000) recognize three strategies in confirmatory modeling. The first strategy is described as being strictly confirmatory where a single a priori model is specified and recognized. This strategy as not ideal as it requires the researcher to evaluate a single model in isolation and rules out few possibilities if that model does not fit well. The second method is model generation and involves specifying a single model and then modifying that model as warranted to best fit the data. This method is discouraged as it is misleading and frequently leads to misinterpretation.

Finally, the alternative model approach, which is the method that was used in the current study, involved the specification of several a priori models prior to estimation of the target model so that nested comparisons could be made. Although all three methods of structural equation modeling were considered for the current study, the literature suggests that," the strongest SEM analysis proposes a target model based on careful consultation of relevant theory and prior research and then compares that model with one or more previously specified competing model indicated by other theoretical positions, contradictions in the research literature, or parsimony" (Hoyle & Panter, 1995, p. 171). MacCallum and Austin (2000) note that the use of multiple a priori models will reduce the potential for confirmation bias of the targeted model and write that, "any effort to examine alternative models can provide some protection against a confirmation bias and bolster support of a favored model" (2000, p. 213). Within the current study, latent variables were used as they provide more accurate and stable measures of effects of one variable on another by estimating errors of measurement separately from the model (MaCallum & Austin, 2000).

Within the current study, several constructs had only a few indicators (e.g., early language and early attention). Research related to the number of the indicators necessary to arrive at proper solutions suggests that one is more likely to arrive at a proper solution with more accurate parameter estimates. Additionally, there is greater reliability with an increasing number of indicators. But, importantly, researchers have also reported that a larger N, such as the size of the current study, compensated for a small number of indicators. While the best practice would have been to have both a large N and a large number of indicators, the archival nature of the data limited that possibility (Marsh, Hau, Balla, & Grayson, 1998).

In structural equation modeling there are several fit indices that are considered when examining a model but there is no “universally accepted criterion to judge how will the model fits the data, thus leaving room for subjective opinions, and consequently disagreements” (Crowley & Fan, 1997, p. 515). Given that there is not a single accepted criterion in assessing model fit the current study considered several fit indices. First two parsimonious fit indices were used to determine each of the three competing models badness of fit Akaike Information Criteria (AIC) and Root Mean Square Error of Approximation (RSMEA). The AIC was chosen because it takes both fit and estimated parameters into account and is able to be used to compare two or more models. RSMEA was chosen because it is relatively insensitive to sample size, adjusts for parsimony, and provides confidence intervals. Parsimonious fit indices are necessary because the current study is using a nested series of models and the fit of the model always improves with fewer parameters. For example, if one parameter is freed from each observed variance then a better fit can be achieved but the model may have little overall value. Thus the parsimonious fit indices penalize the use of additional parameters and indicate which model is best fitting and most parsimonious.

After determining the most parsimonious model, the next step will be to examine incremental fit indices. Incremental fit examines the degree to which the model in question is superior to an alternative model. Specifically the study will use Chi square probability (which assesses the model's fit to the data by assuming all the variable are exogenous and unrelated), Standardized Root Mean-Square Error (represents the average value across all standardized residuals), and Bentler's Comparative Fit Index (alternative fit index that assess the degree to which the model fails to fit the data).

Current Models

In the current study a series of nested and non-nested models were specified to represent different hypothesized relationships. Those relationships were postulated based on the available empirical evidence and theoretical rationales. See Table 2 for a list of variables identified for inclusion into the study.

Model 1. The first model suggested that early maternal behaviors will indirectly influence executive function at first grade through a direct influence on attention and language skills at 36 months and an indirect influence on attention and language skills at 54 months. Socioeconomic status will have both direct and indirect (i.e., via attention, language, maternal sensitivity, and maternal stimulation) effects on executive function in the first grade. *Maternal behaviors at 54 months will not influence executive function at first grade.*

Model 2. The second model suggested that early maternal behaviors will indirectly influence executive function at first grade through a direct influence on attention and language skills at 36 months and an indirect influence on attention and language skills at 54 months. Socioeconomic status will have both direct and indirect (i.e., via attention, language, maternal sensitivity, and maternal stimulation) effects on executive function in the first grade. *Maternal behaviors at 54 months will indirectly influence executive function at first grade via attention and language at 54 months.*

Model 3. The third model suggested that early maternal behaviors at 36 months will indirectly influence executive function at first grade through a direct influence on attention and language skills at 36 months and an indirect influence on attention and language skills at 54 months. Socioeconomic status will have both direct and indirect (i.e., via attention, language, maternal sensitivity, and maternal stimulation) effects on executive function in the first grade. *Maternal behaviors at 54 months will directly and indirectly (via attention and language) influence executive function at first grade.*

Ethnicity as a Moderator. Nested models will also be used to examine if the relationship holds across two ethnic groups (Caucasian and African American) using the most tenable model in the overall group analyses. These analyses will indicate whether estimates of model parameters remained invariant across groups, or whether group membership (Caucasian or African American) moderated the relationships specified in the model (Frazier et al., 2004). *It is hypothesized that ethnicity will have a moderating effect on executive function at first grade.*

Maternal Verbal Ability as a Mediator. Non-nested models will be used to analyze maternal verbal ability as a mediator between SES and executive function

(Frazier et al., 2004). Using the most tenable model in the single group analysis, comparisons will be made between the overall fit of that model and a model that includes maternal verbal ability as a mediator. *It is anticipated that maternal verbal ability will serve as a partial mediator between SES and executive which will result in a stronger predictive relationship between SES and executive function*.

Table 2
Variables Identified for Inclusion in the Structural Equation Modeling

Latent Construct		Indicator
F1 Socio Economic Status		
	V1	SES Composite Score
		Composed of : Mother's Education at 1 Month
		Neighborhood Safety at 1st grade
		Total Income-to-Needs Ratio at 36 Months
F2 Early Maternal Sensitivity		
	V2	Positive Regard at 24 Months
	V3	Supportive Presence at 36 Months
	V4	Respect for Autonomy at 36 Months
F3 Early Maternal Stimulation		
	V5	Cognitive Stimulation at 24 Months
	V6	Cognitive Stimulation at 36 Months
	V7	Total Positive Scaffolding at 36 Months
F4 Early Language		
	V8	Reynell: Vocabulary at 36 Months
	V9	Reynell: Expressive Language at 36 Months
F5 Early Attention		
	V10	Average Time Attending at 36 Months
	V11	Total Time Off-Task at 36 Months
F6 Late Stimulation		
	V12	Cognitive Stimulation at 54 Months
	V13	Quality of Assistance at 54 Months
	V14	Goal Directed Partnership at 54 Months
F7 Late Sensitivity		
	V15	Supportive Presence at 54 Months
	V16	Respect for Autonomy at 54 Months
F8 Late Language		
	V17	PLS: Auditory Comprehension at 54 Months
	V18	PLS: Expressive Language at 54 Months
	V19	WJ-R Picture Vocabulary at 54 Months
F9 Late Attention		
	V20	CBCL-Mother: Attention at 54 Months
	V21	CBCL-Other: Attention at 54 Months
	V22	Delay of Gratification at 54 Months
	V23	CPT: Omission Errors at 54 Months
F10 Executive Functioning		
	V24	WJ-R: Long Term Memory at 1st Grade
	V25	WJ-R: Short Term Memory at 1st Grade
	V26	CPT: Commission Errors at 1st Grade
	V27	TOH: Total Planning Efficiency at 1st Grade
F11 Maternal Verbal Ability		
	V28	PPVT-R: Mother’s Verbal Ability at 36 months

CHAPTER IV

Results

Before addressing the major research questions posed in this investigation, descriptive statistics (e.g., mean, range, and standard deviation) are provided for all of the variables used in the analyses. This will be followed by results for each of the three research questions as well as additional analyses used to examine each research question. Table A.1 in Appendix A contains the first order correlations among all study variables. References to specific relationships will be addressed as it relates to each research question.

Descriptive Statistics

Table 3 compares the means from individuals in the current study to the entire NICHD study on indicators included in the study to examine if patterns of differences arise as a result of differences in the sample. Examining these differences there appears to be a general, stable trend across the two samples in which participants in the current study have more desirable behavior (e.g., more expressive language ability) although, more importantly across tasks, the effect sizes were small in size and had little practical significance. This suggests that the current study sample is similar to the greater NICHD study population.

Table 3

Descriptive Statistics and Effect Sizes for Indicator Variables included in the current study sample (N=470) and NICHD Study sample (N=1364) (*p<.05)

		Current Study sample		NICHD Study sample		
		Mean	Std. Dev.	Mean	Std. Dev.	Effect Size
F1	*Socio Economic Status*					
V1	SES Composite Score	26.77	5.15	26.40	5.43	0.07
	Neighborhood Safety at 1st grade	8.25	1.30	8.09	1.50	0.11*
	Total Income-to-Needs Ratio at 36 Months	3.85	3.22	3.38	2.70	0.17*
	Mother's Education at 1 Month	14.67	2.32	14.23	2.51	0.18*
F2	*Early Maternal Sensitivity*					
V2	Positive Regard at 24 Months	2.87	0.66	2.82	.70	0.07
V3	Supportive Presence at 36 Months	5.47	1.04	5.28	1.32	0.14*
V4	Respect for Autonomy at 36 Months	5.44	0.88	5.29	1.10	0.14*
F3	*Early Maternal Stimulation*					
V5	Cognitive Stimulation at 24 Months	2.77	0.71	2.71	.74	0.08
V6	Cognitive Stimulation at 36 Months	4.64	1.35	4.47	1.44	0.12*
V7	Total Positive Scaffolding at 36 Months	119.64	36.90	114.35	40.19	0.13*
F4	*Early Language*					
V8	Reynell: Vocabulary at 36 Months	100.70	14.08	97.85	15.85	0.18*
V9	Reynell: Expressive Language at 36 Months	99.07	13.52	96.88	14.53	0.15*
F5	*Early Attention*					
V10	Average Time Attending at 36 Months	166.66	159.74	166.37	57.04	0.01
V11	Total Time Off-Task at 36 Months	28.59	29.23	28.08	30.34	0.02
F6	*Late Stimulation*					
V12	Cognitive Stimulation at 54 Months	4.50	1.12	4.36	1.29	0.11*
V13	Quality of Assistance at 54 Months	4.79	1.25	4.66	1.39	0.09
V14	Goal Directed Partnership at 54 Months	4.85	1.27	4.72	1.35	0.10
F7	*Late Sensitivity*					
V15	Supportive Presence at 54 Months	5.30	1.10	5.16	1.30	0.11*
V16	Respect for Autonomy at 54 Months	5.33	0.99	5.22	1.11	0.10
F8	*Late Language*					
V17	PLS: Auditory Comprehension at 54 Months	101.48	18.32	98.34	19.92	0.16*
V18	PLS: Expressive Language at 54 Months	103.64	16.61	100.62	19.95	0.15*
V19	WJ-R Picture Vocabulary at 54 Months	102.59	13.25	100.24	15.03	0.16*
F9	*Late Attention*					
V20	CBCL-Mother: Attention at 54 Months	2.55	2.10	2.74	2.40	-0.08
V21	CBCL-Other: Attention at 54 Months	2.57	2.22	2.67	2.36	-0.04
V22	Delay of Gratification at 54 Months	4.89	2.80	4.48	3.00	0.14*
V23	CPT: Omission Errors at 54 Months	8.06	6.77	9.13	7.60	-0.14*

Table 3 (continued)

Descriptive Statistics and Effect Sizes for Indicator Variables included in the current study sample (N=470) and NICHD Study sample (N=1364) (*p<.05)

		Current Study sample		NICHD Study sample		
		Mean	Std. Dev.	Mean	Std. Dev.	Effect Size
F10	*Executive Function*					
V24	WJ-R: Long Term Memory at 1st Grade	99.84	13.75	98.51	14.09	0.09
V25	WJ-R: Short Term Memory at 1st Grade	102.15	14.70	101.54	14.94	0.04
V26	CPT: Commission Errors at 1st Grade	5.13	7.96	6.11	10.64	-0.09*
V27	TOH: Planning Efficiency at 1st Grade	14.67	6.52	14.38	6.76	0.04
F11	*Maternal Verbal Ability*					
V28	PPVT-R: Mother's Verbal Ability	101.97	16.23	99.01	18.35	0.16*

In the current study, only participants who have a complete set of data available for each variable and were able to successfully complete practice items for each task were included in the data set. After applying these exclusionary criteria and because list-wide deletion is the recommended approach with structural equation modeling, participants with missing data were excluded from the modeling. An effort has been made to include as many subjects as possible in the modeling, but there are obvious limitations. It is acknowledge that listwise deletion can produce biased estimates of the effects for the full sample if the people who are excluded from analysis are different in important ways from those who are included. More specifically, the data in the current study may provide unbiased results for the subset sample with complete data, but this sample may not be representative of the population found in the NICHD SECCYD study.

Table 4 compares the means of the indicators from individuals in the current study to means from individuals whose data was not included in current study as a result of listwise deletion to examine if patterns of differences arise as a result of selection bias.

Examining these differences there appears to be a general, stable trend across the two samples in which participants in the current study have more desirable behavior. Examining the effect sizes, while the majority were statistically significant at a $p<.05$ level, the majority of the effect sizes were small and had little practical significance. This suggests that there are differences between the current study and data excluded from the current study but that these differences do not appear to have practical implications.

Table 4

Descriptive Statistics and Effect Sizes for Indicator Variables included in the current study sample (N=470) and data excluded from the current study sample based on exclusionary criteria (n=297 to 862) (*p<.05)

		Current Study sample		Excluded Data		
		Mean	Std. Dev.	Mean	Std. Dev.	Effect Size
F1	*Socio Economic Status*					
V1	SES Composite Score	26.77	5.15	25.5	5.54	.23*
	Neighborhood Safety at 1st grade	8.25	1.30	7.95	1.62	.19*
	Total Income-to-Needs Ratio at 36 Months	3.85	3.22	3.3	2.93	.19*
	Mother's Education at 1 Month	14.67	2.32	13.9	2.53	.32*
F2	*Early Maternal Sensitivity*					
V2	Positive Regard at 24 Months	2.87	0.66	2.75	.7	.17*
V3	Supportive Presence at 36 Months	5.47	1.04	5.07	1.41	.29*
V4	Respect for Autonomy at 36 Months	5.44	0.88	5.09	1.18	.30*
F3	*Early Maternal Stimulation*					
V5	Cognitive Stimulation at 24 Months	2.77	0.71	2.62	.73	.21*
V6	Cognitive Stimulation at 36 Months	4.64	1.35	4.27	1.43	.26*
V7	Total Positive Scaffolding at 36 Months	119.64	36.90	108	40.9	.29*
F4	*Early Language*					
V8	Reynell: Vocabulary at 36 Months	100.70	14.08	94.3	15.7	.41*
V9	Reynell: Expressive Language at 36 Months	99.07	13.52	94.3	14.7	.32*
F5	*Early Attention*					
V10	Average Time Attending at 36 Months	166.66	159.74	166	146	.00
V11	Total Time Off-Task at 36 Months	28.59	29.23	27.8	29.9	.03
F6	*Late Stimulation*					
V12	Cognitive Stimulation at 54 Months	4.50	1.12	4.11	1.35	.29*
V13	Quality of Assistance at 54 Months	4.79	1.25	4.43	1.44	.25*
V14	Goal Directed Partnership at 54 Months	4.85	1.27	4.54	1.37	.23*
F7	*Late Sensitivity*					
V15	Supportive Presence at 54 Months	5.30	1.10	4.9	1.3	.31*
V16	Respect for Autonomy at 54 Months	5.33	0.99	5.02	1.14	.27*
F8	*Late Language*					
V17	PLS: Auditory Comprehension at 54 Months	101.48	18.32	93.8	19.9	.39*
V18	PLS: Expressive Language at 54 Months	103.64	16.61	101.1	20.1	.15*
V19	WJ-R Picture Vocabulary at 54 Months	102.59	13.25	96.9	15	.38*
F9	*Late Attention*					
V20	CBCL-Mother: Attention at 54 Months	2.55	2.10	2.78	2.2	-.10
V21	CBCL-Other: Attention at 54 Months	2.57	2.22	2.62	2.04	-.02
V22	Delay of Gratification at 54 Months	4.89	2.80	3.9	3.1	.32*
V23	CPT: Omission Errors at 54 Months	8.06	6.77	10.1	8.1	-.25*

Table 4 (continued)

Descriptive Statistics and Effect Sizes for Indicator Variables included in the current study sample (N=470) and data excluded from the current study sample based on exclusionary criteria (n=297 to 862) (*p<.05)

		Current Study sample		NICHD Study sample		
		Mean	Std. Dev.	Mean	Std. Dev.	Effect Size
F10	*Executive Function*					
V24	WJ-R: Long Term Memory at 1st Grade	99.84	13.75	96.9	14.3	.23*
V25	WJ-R: Short Term Memory at 1st Grade	102.15	14.70	101	14.3	.09
V26	CPT: Commission Errors at 1st Grade	5.13	7.96	7.39	12.6	-.18*
V27	TOH: Planning Efficiency at 1st Grade	14.67	6.52	13.6	6.83	.16*
F11	*Maternal Verbal Ability*					
V28	PPVT-R: Mother's Verbal Ability	101.97	16.23	95.5	18.5	.35*

Examining descriptive statistics for the current study (Table 5) it is important to note that several of the indicators for early attention are non-normal and highly positively skewed. This suggests that high levels of inattention occurred relatively infrequently within the sample at 36 months. Also it is necessary to note that scores from standardized assessments (PPVT-R, WJ-R Memory for Names, WJ-R Memory for Sentences, WJ-R Picture Vocabulary, PLS Auditory, PLS Expressive, Reynell Expressive, and Reynell Vocabulary) that were administered across time (at 36 months, 54 months, and 1st grade), across constructs (Executive Function, Early Language, Late Language, and Maternal Verbal Ability), and across participants' (mother and child), indicate that the participants mean scores represent average performance (i.e., mean = 100, s.d. = 15) as compared to the samples by which the standardized assessments were normed.

Table 5

Descriptive Statistics for Indicator Variables (n=470)

	Mean	Min.	Max.	Std. Dev.
F1 Socio Economic Status				
V1 SES Composite Score	21.27	10.11	49.22	4.83
Neighborhood Safety at 1st grade	8.25	2.33	10.00	1.42
Total Income-to-Needs Ratio at 36 Months	3.85	0.14	28.50	3.06
Mother's Education at 1 Month	14.67	7.00	21.00	2.36
F2 Early Maternal Sensitivity				
V2 Positive Regard at 24 Months	2.87	1.00	4.00	0.69
V3 Supportive Presence at 36 Months	5.47	1.00	7.00	1.18
V4 Respect for Autonomy at 36 Months	5.44	1.00	7.00	1.00
F3 Early Maternal Stimulation				
V5 Cognitive Stimulation at 24 Months	2.77	1.00	4.00	0.72
V6 Cognitive Stimulation at 36 Months	4.64	1.00	7.00	1.41
V7 Total Positive Scaffolding at 36 Months	119.64	0.00	223.00	38.78
F4 Early Language				
V8 Reynell: Vocabulary at 36 Months	100.70	62.00	134.00	15.24
V9 Reynell: Expressive Language at 36 Months	99.07	62.00	138.00	13.90
F5 Early Attention				
V10 Average Time Attending at 36 Months	166.66	0.00	900.00	150.84
V11 Total Time Off-Task at 36 Months	28.59	0.00	131.00	29.51
F6 Late Stimulation				
V12 Cognitive Stimulation at 54 Months	4.50	1.00	7.00	1.23
V13 Quality of Assistance at 54 Months	4.79	1.00	7.00	1.34
V14 Goal Directed Partnership at 54 Months	4.85	1.00	7.00	1.31
F7 Late Sensitivity				
V15 Supportive Presence at 54 Months	5.30	1.00	7.00	1.21
V16 Respect for Autonomy at 54 Months	5.33	1.00	7.00	1.08
F8 Late Language				
V17 PLS: Auditory Comp. at 54 Months	101.48	53.00	139.00	19.15
V18 PLS: Expressive Language at 54 Months	103.64	50.00	127.00	18.44
V19 WJ-R: Picture Vocabulary at 54 Months	102.59	10.00	143.00	14.15
F9 Late Attention				
V20 CBCL-Mother: Attention at 54 Months	2.55	0.00	12.00	2.19
V21 CBCL-Other: Attention at 54 Months	2.57	0.00	14.00	2.23
V22 Delay of Gratification at 54 Months	4.89	0.00	7.00	2.86
V23 CPT: Omission Errors at 54 Months	8.06	0.00	37.00	6.80
F10 Executive Function				
V24 WJ-R: Long Term Memory at 1st Grade	99.84	2.00	154.00	14.68
V25 WJ-R: Short Term Memory At 1st Grade	102.15	43.000	151.00	13.87
V26 CPT: Commission Errors at 1st Grade	5.13	0.00	58.00	8.23
V27 TOH: Total Planning Efficiency at 1st Grade	14.67	0.00	31.00	6.56
F11 Maternal Verbal Ability				
V28 PPVT-R: Mother’s Verbal Ability	101.97	44.00	159.00	17.69

Research Questions

Question 1. Does maternal stimulation and sensitivity at 54 months during a joint play task influence performance on a later executive function task? If so, is that influence direct or indirect through the effect on children's early language and attention skills?

In order to answer this question, structural equation modeling was used. Modeling proceeded in the following manner: A measurement model was first developed in which all factors were allowed to correlate (i.e., no restrictions were placed on the relation between constructs) and a priori error terms were allowed to covary. The a priori decision to allow the residuals to covary was largely based on the effects of shared method or shared respondents. After the measurement model, the a priori structural paths were modeled and their fit indices were compared. Because several variables within the model, particularly related to the construct of attention, were non-normal, the Sattora Bentler (S-B) robust procedure was used (Satorra, & Bentler, 1988). The S-B scaling method is recommended with continuous non-normal data and has been shown to outperform the maximum likelihood method (Curran, West, & Finch, 1996; Yu & Muthen, 2002). The S-B scaling method adjusts the x^2, fit indices, and standard error by a factor based on the amount of non-normality in the data. The S-B procedure adjusts the maximum likelihood x^2 in order to better approximate the distribution and incorporates the kurtosis of the variables into the adjustment. Using the S-B x^2 does not permit direct comparison of the x^2 for nested models but instead requires the following adjustments:

1. $k_0 = T_0 / \overline{T_0}$, where $T_0 = MLx^2$ and $\overline{T_0} = \text{S-B } x^2$

2. $k_1 = T_1 / \overline{T_1}$, where $T_1 = MLx^2$ and $\overline{T_1} = \text{S-B } x^2$

3. $\triangle x^2 = T_0 - T_1$

4. S-B scaling coefficient $= k = (d_0\, k_0 - d_1\, k_1)\, / d$, where $d = d_0 - d_1$, where d = degrees of freedom

5. $\triangle\text{S-B } x^2 = \overline{D} = D/k$

Measurement Model. The confirmatory factor analysis (CFA) model is shown in Figure 1. The CFA analysis model allowed all latent constructs to correlate as well as the a priori residual error terms. One factor loading for each latent factor was fixed to one. Factors were fixed to one based on hypothesized factor loadings. Non-hypothesized factor loadings were constrained to zero. Initial problems with model convergence led to the addition of several indicators from earlier time periods to the constructs of Early Maternal Sensitivity (Sensitivity to Distress at 24 months), Early Maternal Stimulation (Cognitive Stimulation at 24 months), and Late Attention (Delay of Gratification). As expected, the addition of these indicators resulted in an adequately fitting model ($x^2(274) = 579.772$, $p < .001$ (S-B $x^2(274) = 570.5004$, $p < .001$), CFI =.931 (.926), SRMR (.053), RMSEA = .049 (.048), RMSEA 90% confidence interval: .043-.054 (.042-.054) (See Table 6).

Table 6

Summary of Maximum Likelihood (and) Robust Model-Fit Statistics

Model	x^2	df	*p*-value	CFI	SRMR	RMSEA	90% Confidence Interval RMSEA	S-B Δx^2	AIC
Measurement Model	579.772 (570.5004)	274	.000	.931 (.926)	.053	.049 (.048)	.043 - .054 (.042 - .054)		
1. Structural Model: No Relationship	1340.817 (1323.4924)	304	.000	.766 (.746)	.116	.085 (.085)	.081 - .090 (.080 - .090)		
2. Structural Model: Indirect Relationship	1325.092 (1311.0427)	300	.000	.769 (.748)	.117	.085 (.085)	.081 - .090 (.080 - .089)		
Difference between Model 2 and Model 1								13.521*	
3. Structural Model: Direct and Indirect Relationship	1323.769 (1308.5512)	298	.000	.768 (.748)	.117	.086 (.085)	.081 - .090 (.080 - .090)		
Difference between Model 3 and Model 2								1.85	
4. Mediator Model	1424.940 (1413.7154)	325	.000	.763 (.741)	.118	.085 (.085)	.080-.089 (.080-.089)		
AIC Difference between Mediator Model and Model 2									49.849 (52.673)

*p<.05

Note. CFI = comparative fit index; SRMR = standardized root mean-square error of approximation; RMSEA = root mean-square error of approximation; AIC = Akaike Information Criterion. Robust Fit Statistics are in ( )

As expected based on the different measurement scales entered into a single model, the standardized and unstandardized parameter estimates for the measurement model (See Table 7) varied greatly. The standardized estimates will be examined as they allow you to evaluate the relative value of each predictor variable. Not all of the statistics are significant, particularly measures of executive function and late attention. Examining the relative contribution of indicators within a construct, the most notable differences are within the construct of early attention (i.e., average time attending = .031 and total time off-task =.979). While it may have been beneficial to remove indicators that are redundant or contribute little to overall construct, the current study was limited by an archival data set. Thus having achieved a measurement model that adequately reflected the data, the next step was to impose the a priori structural paths and compare the fit indices between three nested models.

Table 7

Unstandardized, Standardized, and Significance Levels for Measurement Model in Figure 2 (Standard Errors in Parentheses; N = 470)

Parameter Estimate	Error	Unstandardized	Standardized
Measurement Model Estimates			
SES → SES composite (V1)	.000	1.00	1.00
Early Maternal Sensitivity → Positive Regard for Child at 24 months (V2)	.948	5.59(.044)*	.318
Early Maternal Sensitivity → Supportive Presence at 36 months (V3)	.603	1.00	.798
Early Maternal Sensitivity → Respect for Child's Identity at 36 months (V4)	.625	9.536 (.085)*	.781
Early Maternal Stimulation → Cognitive Stimulation at 24 months (V5)	.877	8.420 (.002)*	.480
Early Maternal Stimulation → Cognitive Stimulation at 36 months (V6)	.641	10.990 (.004)*	.768

Table 7 (continued)

Unstandardized, Standardized, and Significance Levels for Measurement Model in Figure 2 (Standard Errors in Parentheses; N = 470)

Parameter Estimate	Error	Unstandardized	Standardized
Early Maternal Stimulation → Total Positive Scaffolding Score at 36 months (V7)	.757	1.00	.654
Early Language → Reynell Vocab. at 36 months (V8)	.398	1.00	.917
Early Language → Reynell Expressive at 36 months (V9)	.824	11.725(.049)*	.567
Early Attention → Average time attending at 36 months (V10)	1.00	1.00	.031
Early Attention → Total time off-task at 36 months (V11)	.203	2.865(.423)	.979
Late Maternal Stimulation→ Cognitive Stimulation at 54 months (V12)	.637	1.00	.771
Late Maternal Stimulation →Quality of Assistance at 54 months (V13)	.409	20.039 (.066)*	.913
Late Maternal Stimulation →Goal Directed Partnership at 54 months (V14)	.605	17.223 (.067)*	.796
Late Maternal Sensitivity →Supportive Presence at 54 months (V15)	.630	1.00	.777
Late Maternal Sensitivity →Respect for Autonomy at 54 months (V16)	.429	8.237 (.125)*	.903
Late Language →Preschool Language Scale Auditory at 54 months (V17)	.616	1.00	.788
Late Language → Preschool Language Scale Expressive at 54 months (V18)	.673	18.972(.046)*	.739
Late Language →WJ-R Picture Vocab. at 54 months (V19)	.702	15.442(.042)*	.713
Late Attention → CBCL Mother Report at 54 months (V20)	.994	1.00	.107
Late Attention → CBCL Other Caregiver Report at 54 months (V21)	.966	1.586(1.601)	.260
Late Attention → Delay of Gratification at 54 months (V22)	.917	1.451(.874)	.398

Table 7 (continued)

Unstandardized, Standardized, and Significance Levels for Measurement Model in Figure 2 (Standard Errors in Parentheses; N = 470)

Parameter Estimate	Error	Unstandardized	Standardized
Late Attention → CPT Omission Errors at 54 months (V23)	.888	1.396(9.738)	.460
Executive Function → WJ-R Memory for Sentences at 1st Grade (V24)	.707	3.702(2.086)*	.707
Executive Function → WJ-R Memory for Names at 1st Grade (V25)	.934	3.371(1.076)*	.358
Executive Function → CPT Commission Errors at 1st Grade (V26)	.980	-2.709(.433)	-.199
Executive Function → Tower of Hanoi Planning Efficiency at 1st Grade (V27)	.979	1.00	.204

*p<.05

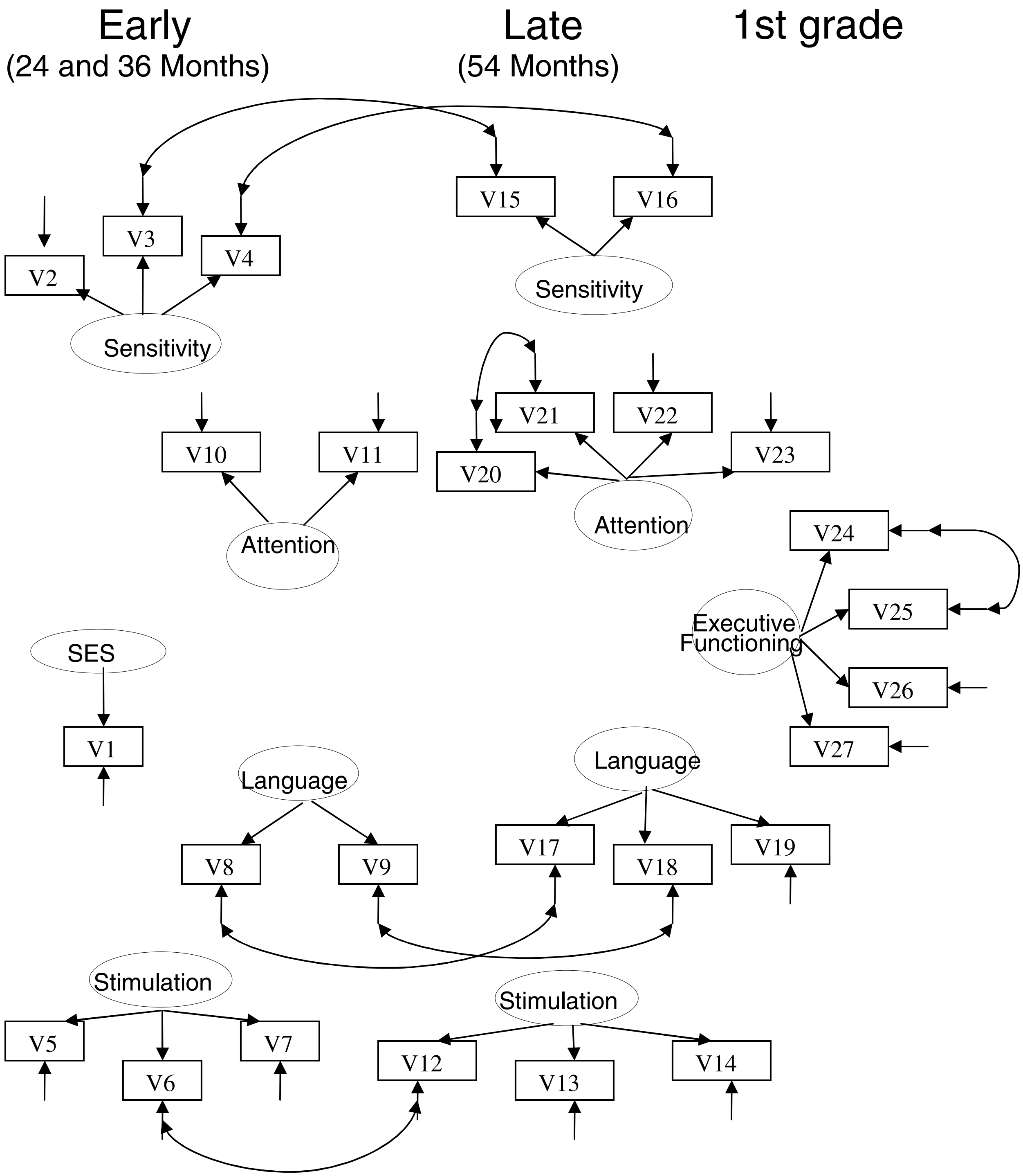


Figure 1. Measurement Relationship between Maternal Behaviors, Executive Function, Attention, and Language

Model 1. The first structural model (see Figure 2) suggests that early maternal stimulation and early maternal sensitivity will indirectly influence executive function at first grade through a direct influence on early attention and early language skills and an indirect influence on late attention and late language skills. Socioeconomic status will have both direct and indirect (i.e., via attention, language, maternal sensitivity, and maternal stimulation) effects on executive function in the first grade. Maternal sensitivity and maternal stimulation at 54 months will not influence executive function at first grade. The model fit was less than ideal ($x^2(304)$ = 1340.817, p< .000 (S-B $x^2(304)$ = 1323.4924, p<.000), CFI =.766 (.746), SRMR (.116), RMSEA = .085 (.085), RMSEA 90% confidence interval: .081-.090 (.080-.090) (See Table 6). This suggested that the structural paths did not reflect the data.

The squared multiple correlations for Model 1 indicate that the model accounted for 14 percent of the variance in early maternal sensitivity, 14 percent of the variance in early maternal stimulation, 40 percent of the variance in early language, 63 percent of the variance in early attention, 29 percent of the variance in late maternal sensitivity, 24 percent of the variance in late maternal stimulation, 90 percent of the variance late language, 50 percent of the variance in late attention, and 70 percent of the variance in executive function. Because the model did not fit the data well it is difficult to appropriately interpret the percent of variance accounted for by the model. The large amount of variance explained does suggest that the indicators are indeed measuring the underlying construct despite the poor overall fit of the model. The next step was to examine if the addition of indirect paths better reflected the data.

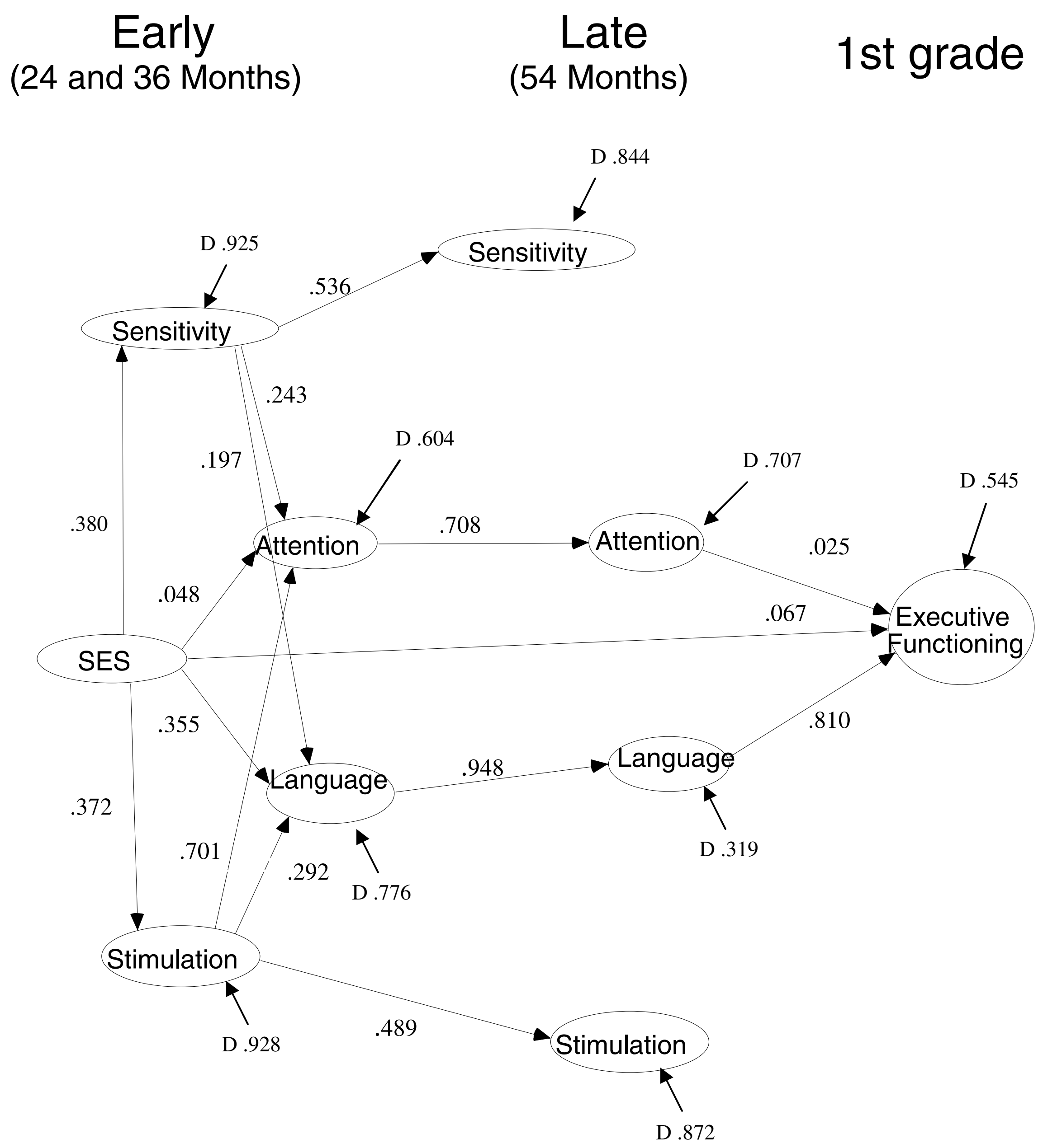


Figure 2. Structural Relationship between Maternal Behaviors, Executive Function, Attention, and Language: No Relationship between Maternal Behaviors at 54 months and Executive Function at 1st grade

Model 2. Model 2 is identical to Model 1 (see Figure 3) except that late maternal sensitivity and late maternal stimulation indirectly influence executive function at first grade via late attention and late language. Once again the model fit was poor (x^2(300) = 1325.092, p<.000 (S-B x^2(300) = 1311.0427, p< .000), CFI =.769 (.748), SRMR (.117), RMSEA = .085 (.085), RMSEA 90% confidence interval: .081-.090 (.080-.089) (See Table 6). Importantly there were significant differences when comparing model 2 and model 1 (Δ S-B x^2 (4) = 13.521, p<.05) which suggests the addition of the indirect path improves the model.

The squared multiple correlations for Model 2 were very similar to Model 1 and show that the model accounted for 14 percent of the variance in early maternal sensitivity, 13 percent of the variance in early maternal stimulation, 38 percent of the variance in early language, 48 percent of the variance in early attention, 28 percent of the variance in late maternal sensitivity, 22 percent of the variance in late maternal stimulation, 89 percent of the variance late language, 46 percent of the variance in late attention, and 70 percent of the variance in executive function.

Because Model 2 reflects the most parsimonious model as compared to model 1 and model 3, the standardized total effects for the paths directly and indirectly linking the model will be further examined (See Table 8). The effects indicate similar strength of influence between SES and early maternal behaviors. SES strongly directly and indirectly influenced early language ability but had a smaller effect on early attention. Both late maternal stimulation and maternal sensitivity were similarly influenced by SES. Both early language ability and SES had large effects on late langue ability. Late attention was strongly indirectly influenced by early maternal stimulation and directly by early attention. Finally, executive function was moderately influenced directly and indirectly by SES and, surprisingly, strongly influenced directly and indirectly by early and late language ability.

Table 8

Decomposition of Standardized Effects for Structural Paths of Indirect Model

Paths		Direct Effect	Indirect Effect	Total Effect
DV: Early Maternal Sensitivity				
	SES	.379	--	.379
DV: Early Maternal Stimulation				
	SES	.366	--	.366
DV: Early Language				
	SES	.362	.172	.534
	Early Maternal Sensitivity	.190	--	.190
	Early Maternal Stimulation	.273	--	.273
DV: Early Attention				
	SES	.008	.304	.312
	Early Maternal Sensitivity	.180	--	.180
	Early Maternal Stimulation	.644	--	.644
DV: Late Maternal Sensitivity				
	SES	--	.200	.200
	Early Maternal Sensitivity	.530	--	.530
DV: Late Maternal Stimulation				
	SES	--	.170	.170
	Early Maternal Stimulation	.464	--	.464

Table 8 (Continued)

Decomposition of Standardized Effects for Structural Paths of Indirect Model

Paths		Direct Effect	Indirect Effect	Total Effect
DV: Late Language				
	SES	--	.553	.553
	Early Maternal Sensitivity	--	.213	.213
	Early Maternal Stimulation	--	.263	.263
	Early Language	.930	--	.930
	Late Maternal Sensitivity	.160	--	.160
	Late Maternal Stimulation	.258	--	.258
DV: Late Attention				
	SES	--	.235	.235
	Early Maternal Sensitivity	--	.176	.176
	Early Maternal Stimulation	--	.447	.447
	Early Attention	.508	--	.508
	Late Maternal Sensitivity	.067	--	.067
	Late Maternal Stimulation	.019	--	.019
DV: Executive Function				
	SES	.066	.416	.482
	Early Maternal Sensitivity	--	.173	.173
	Early Maternal Stimulation	--	.216	.216
	Early Language	--	.751	.751
	Early Attention	--	.005	.005
	Late Maternal Sensitivity	--	.055	.055
	Late Maternal Stimulation	--	.0176	.0176
	Late Language	.807	--	.807
	Late Attention	.009	--	.009

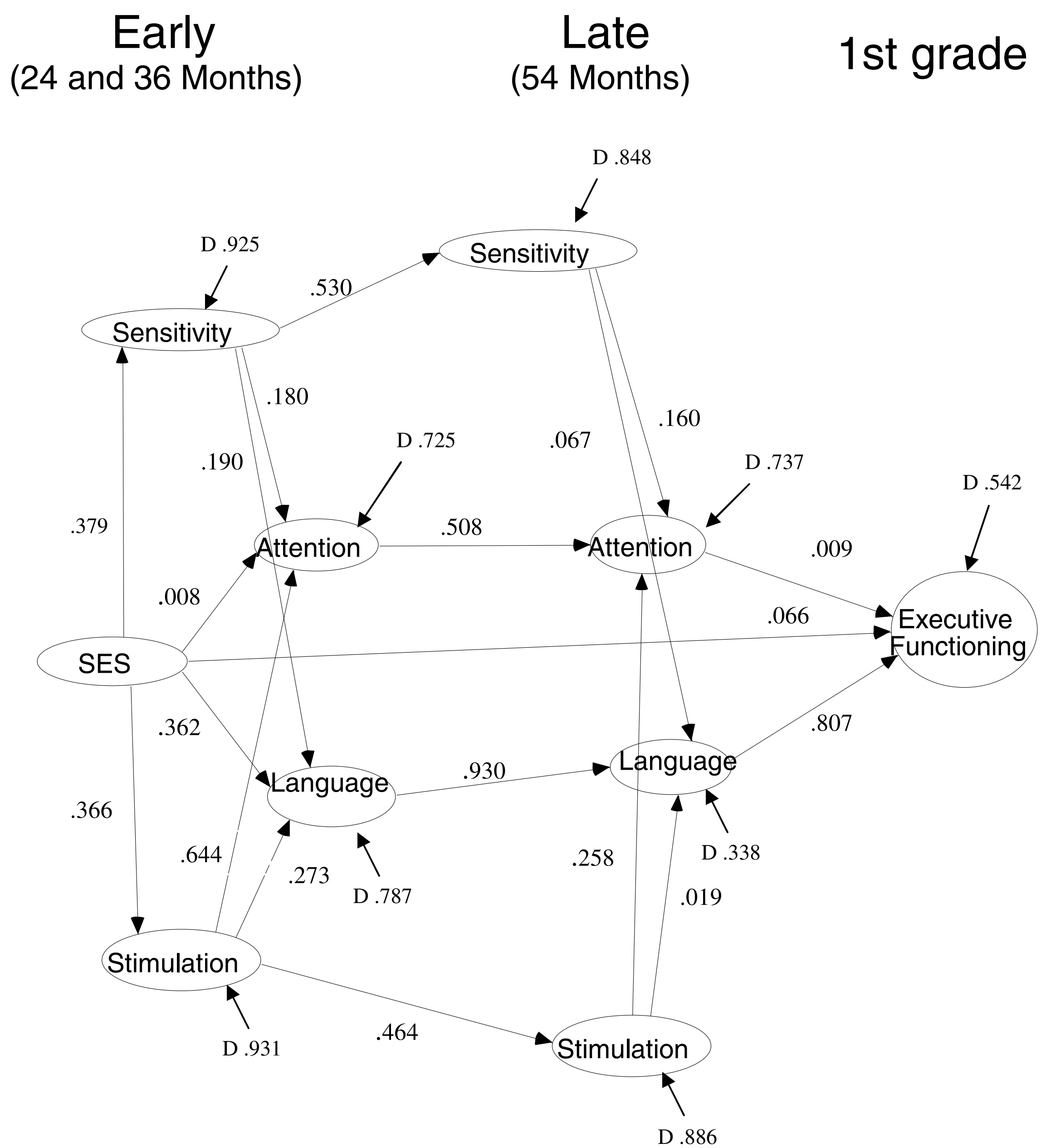


Figure 3. Structural Relationship between Maternal Behaviors, Executive Function, Attention, and Language: Indirect Relationship between Maternal Behaviors at 54 months and Executive Function at 1st grade

Model 3. The third model is identical to the model 1 and 2 (See figure 4) except that late maternal sensitivity and late maternal stimulation both directly and indirectly influence executive function at first grade. The model fit remained poor (x^2(298) = 1323.769, p<.000 (S-B x^2(298) = 1308.5512, p<.000), CFI =.768 (.748), SRMR (.117), RMSEA = .086 (.085), RMSEA 90% confidence interval: .081-.090 (.080-.090) (See Table 6). There was not a significant difference between model 3 and model 2 (Δ S-B x^2 (2) = 1.858, p >.05) which suggests the addition of the direct paths between late maternal sensitivity and late maternal stimulation to executive function is redundant. The squared multiple correlations for Model 3 were nearly identical to Model 1 and 2 thus will not be presented.

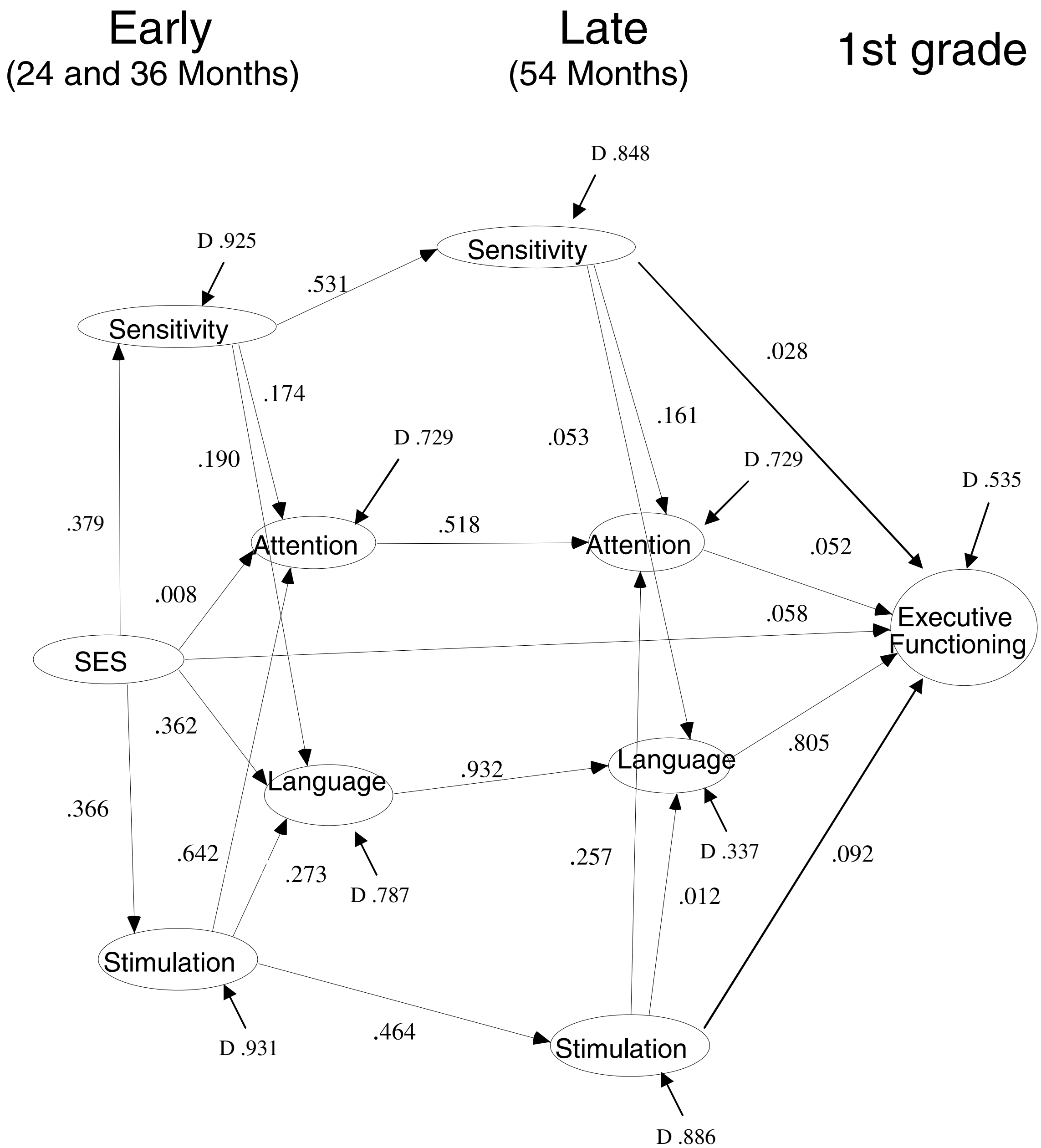


Figure 4. Structural Relationship between Maternal Behaviors, Executive Function, Attention, and Language: Indirect and Direct Relationship between Maternal Behaviors at 54 months and Executive Function at 1st grade

Supplementary Analyses for Question 1

In order to further examine the findings of structural equation models which suggested an overall poor fit, the constructs were further examined. The purpose for these additional analyses was to determine possible explanations for the poor fit of the model, specifically examining the data for support of the theorized constructs. In order to examine the constructs, the intercorrelations among the constructs and factor analysis of the theorized constructs were examined.

Maternal Sensitivity. First, the intercorrelations among measures of maternal sensitivity were examined in Table 9. The correlational analyses of maternal sensitivity measures indicated weak to moderate relationships among measures of maternal sensitivity with the strongest relationships occurring within the same time period (i.e., measures at 36 months most highly correlate with other measures at 36 months and so forth). Because similar tasks and scoring were used across tasks, it is expected that the correlations would be increased based on methodological similarities. Factor analysis for the indicators of the early sensitivity construct indicated that 60% of the variance was accounted by a single factor. Two factors accounted for 88% of the variance with the 36 month tasks loading on factor one and the 24 month task loading on factor two. Factor analysis for the indicators of the late sensitivity indicated that 84% of the variance was accounted for by a single factor. As expected this provides support for convergent validity of the construct of maternal sensitivity.

Table 9

Intercorrelations Among measures of Maternal Sensitivity

	Positive regard at 24 Months	Supportive Presence at 36 Months	Respect for Autonomy at 36 Months	Supportive Presence at 54 Months
Supportive Presence at 36 Months	0.256***			
Respect for Autonomy at 36 Months	0.206***	0.637***		
Supportive Presence at 54 Months	0.285***	0.369***	0.304***	
Respect for Autonomy at 54 Months	0.277***	0.352***	0.378***	0.699***

*p<.05, **p<.01, ***p<.001

Maternal Stimulation. Correlations among measures of maternal stimulation indicated weak to moderate relationships, of similar strength to the analogous correlations among measures of maternal sensitivity (See Table 10). Once again the strongest relationships occurred within the same time period (i.e., measures at 36 months most highly correlate with other measures at 36 months and so forth). Again the method of administration and scoring was similar across tasks. Factor analysis for the indicators of the early stimulation construct indicated that 60% of the variance was accounted by a single factor. Two factors accounted for 85% of the variance with the 36 month tasks loading on factor one and the 24 month task loading on factor two. Factor analysis for indicators of the late stimulation construct indicated that 78% of the variance was accounted for by a single factor. Once again this provided convergent validity for maternal stimulation as a construct.

Table 10

Intercorrelations Among measures of Maternal Stimulation

	Cognitive Stimulation at 24 Months	Cognitive Stimulation at 36 months	Total Positive Scaffolding at 36 Months	Cognitive Stimulation at 54 Months	Quality of Assistance at 54 Months
Cognitive Stimulation at 36 Months	0.338***				
Total Positive Scaffolding at 36 Months	0.303***	0.552***			
Cognitive Stimulation at 54 Months	0.259***	0.347***	0.321***		
Quality of Assistance at 54 Months.	0.229***	0.285***	0.238***	0.701***	
Goal Directed Partnership at 54 Months	0.201***	0.238***	0.208***	0.595***	0.733***

*p<.05, **p<.01, ***p<.001

Maternal Sensitivity and Maternal Stimulation. These findings are remarkably similar to the findings for maternal stimulation. Thus factor analysis was run to examine if maternal sensitivity and maternal stimulation were indeed two separate constructs. Although sensitivity and stimulation were originally hypothesized as unidimensional, there is some literature to suggest otherwise. Factor analyses of the variables that comprised these constructs (maternal sensitivity and maternal stimulation) indicates that there are three distinct constructs but the factors are based on the longitudinal nature of the data (e.g., all indicators at 24 months loaded on single factor, all indicators at 36 months loaded on a single factor, and all indicators at 54 months loaded on a single factor). Further factor analysis across indicators of maternal sensitivity and maternal stimulation (all measures of maternal sensitivity and maternal stimulation at 54 months) indicated in a single factor was underlying the constructs of maternal sensitivity and maternal stimulation and explained 70% of the variance. This lack of divergent validity will be further examined in the discussion section.

Language Measures. The analyses generally indicated moderate relationships across language measures (See Table 11). While the intercorrelation of .76 is reported between the Reynell Expressive and Reynell Vocabulary by the test publishers, they intercorrelate at r = .536 in the current study. While this is notable, the descriptive statistics indicate means and standard deviations in line with the greater population. Factor analysis for the early language construct indicated that 76% of variance was accounted by a single factor. Factor analysis for the late language construct indicated that 70% of the variance was accounted by one factor and two factors accounted for 87% of the variance.

Table 11

Intercorrelations Among Language Measures

	Reynell: Vocabulary at 36 Months	Reynell: Expressive Language at 36 Months	PLS: Auditory Comp. at 54 Months	PLS: Expressive Language at 54 Months
Reynell: Expressive Language at 36 Months	0.536***			
PLS: Auditory Comp. at 54 Months	0.698***	0.426***		
PLS: Expressive Language at 54 Months	0.640***	0.428***	0.618***	
WJ-R: Picture Vocabulary at 54 Months	0.542***	0.367***	0.528***	0.526***

*p<.05, **p<.01, ***p<.001

Attention Measures. The analyses generally indicated weak or no relationship across attention measures with the CBCL mother and CBCL alternative caregiver relationship being the notable exception (See Table 12). Based on the principles of structural equation modeling, it is generally desirable to have moderate correlations. Weak correlations may suggest that several different constructs are being measured. As expected the child behavior questionnaire negatively correlated with the CBCL and the CPT, as higher scores indicated an increased tendency to maintain attentional focus upon task-related channels. Factor analysis of the measures of the early attention indicated that 49% of variance was accounted by a single factor. Factor analysis for the indicators of the late attention construct indicated that 67% of variance was accounted by two factors. While the indicators for attention were specifically designed to be heterotypic in nature and do represent measurement using multiple methods and multiple sources, the low correlations between the measures indicate that a weak relationship which makes the measurement of the construct of attention suspect in this case.

Table 12

Intercorrelations Among measures of Attention

	Average Time Attending at 36 Months	Total Time Off-Task at 36 Months	CBCL-Mother: Attention at 54 Months	CBCL-Other: Attention at 54 Months	Delay of Gratification at 54 Months
Total Time Off-Task at 36 Months	0.003				
CBCL-Mother: Attention at 54 Months	0.025	-0.062			
CBCL-Other: Attention at 54 Months	0.009	-0.067	0.463***		
Delay of Gratification at 54 Months	-0.030	-0.016	0.047	0.109*	
CPT: Omission Errors at 54 Months	-0.005	-0.079	0.042	.112*	.212***

*p<.05, **p<.01, ***p<.001

Executive Function. The analyses generally indicated weak or no relationship across executive function measures with short term (WJ-R Memory for Sentences) and long term memory (WJ-R Memory for Names) having a moderate relationship (See Table 13). As expected the relationships between the CPT: Commission Errors and the other measures of executive function were negative. Higher scores on the CPT: Commission task indicated decreased ability to inhibit a prepotent response and decreased sustained attention where as higher scores on the other measures of executive function indicated greater planning and memory abilities. Factor analysis for measures of executive function indicated that 35% of the variance was accounted for by a single factor and that 61% of the variance was accounted for by two factors, and 82% of the variance was accounted for by three factors. While the third factor in the three factor solution has an Eigenvalue of .845 it is important to note the three factors are similar to a proposed three factor model of executive function that includes aspects of planning, memory and inhibition. It should be noted that traditional models of executive function includes measures of working memory, while the current study defines memory through short-term memory and long-term memory. These results will be further examined in the discussion section.

Table 13

Intercorrelations Among Executive Function Measures at 1st grade

	CPT: Comission Errors at 1st Grade	WJ-R: Memory for Names at 1st Grade	WJ-R: Memory for Sentences at 1st Grade
WJ-R: Memory for Names at 1st Grade	-0.065		
WJ-R: Memory for Sentences at 1st Grade	-0.074	0.304***	
TOH: Total Planning Efficiency Score at 1st Grade	-0.153***	0.116*	0.099*

*p<.05, **p<.01, ***p<.001

Summary

In summary, there were significant differences between the three models with the model that included an indirect path (Model 2) between maternal sensitivity and maternal stimulation and executive function providing the most parsimonious representation of the data. The significant differences aside, the overall fit of the model was poor which suggests that the current model does not adequately reflect the data. Further, as the intercorrelations among the indicators suggest, there is little convergent or divergent validity among the indicators of several constructs (i.e., attention, maternal sensitivity, and maternal stimulation) which in turn makes accurate interpretation of the model difficult.

Question 2: Does ethnicity, African American and Caucasian group membership, moderate the strength of the relationship between maternal stimulation and maternal sensitivity and executive function?

When the current study was designed, it was anticipated that there would be large enough subsamples to allow for analysis by ethnicity. This was not the case. Due to the sample size of each group (African America n= 26, Caucasian n = 413) the nested multiple group models did not converge on a solution. This is not surprising based on the low power of the African American group. Therefore the current study was unable to examine whether ethnic group membership moderates the relationship between maternal behaviors and executive functioning. The literature does suggest that, even if the model had converged, differences would be difficult to detect because of the large differences in the sample sizes (Hancock, 2006).

Supplementary analysis for question 2

Although it is not possible to examine multi-group differences using structural equation modeling, direct comparison of mean differences suggests significant differences between both groups with the Caucasian participants demonstrating higher performance across the majority of the measures (See Table 14). Examining the effect sizes, 10 were strong (above .8) and 9 were moderate (.5 to .8) suggesting important differences between the two populations.

Table 14

Descriptive Statistics for Caucasian (N=427) and African American (N=26) (*p<.05)

	Caucasian		African American		
	Mean	Std. Dev.	Mean	Std. Dev.	Effect Size
F1 *Socio Economic Status*					
V1 SES Composite Score	27.45	5.15	22.53	2.01	2.45*
Neighborhood Safety at 1st grade	8.38	1.30	7.15	1.59	0.78*
Total Income-to-Needs Ratio at 36 Months	4.14	3.22	2.00	1.37	1.56*
Mother's Education at 1 Month	14.93	2.32	13.38	1.10	0.66*
F2 *Early Maternal Sensitivity*					
V2 Positive Regard at 24 Months	2.97	0.66	2.50	0.76	0.61*
V3 Supportive Presence at 36 Months	5.66	1.04	4.38	1.53	0.83*
V4 Respect for Autonomy at 36 Months	5.61	0.88	4.73	1.22	0.72*
F3 *Early Maternal Stimulation*					
V5 Cognitive Stimulation at 24 Months	2.87	0.71	2.23	0.76	0.83*
V6 Cognitive Stimulation at 36 Months	4.80	1.35	3.69	1.72	0.65*
V7 Total Positive Scaffolding at 36 Months	124.02	36.90	100.59	38.83	0.60*
F4 *Early Language*					
V8 Reynell: Vocabulary at 36 Months	103.47	14.08	86.19	14.02	1.23*
V9 Reynell: Expressive Language at 36 Months	100.54	13.52	94.92	12.73	0.44*
F5 *Early Attention*					
V10 Average Time Attending at 36 Months	166.73	159.74	167.21	103.66	0.00
V11 Total Time Off-Task at 36 Months	28.99	29.23	23.00	32.47	0.18*
F6 *Late Stimulation*					
V12 Cognitive Stimulation at 54 Months	4.67	1.12	4.04	1.25	0.51*
V13 Quality of Assistance at 54 Months	4.96	1.25	4.00	1.47	0.65*
V14 Goal Directed Partnership at 54 Months	4.94	1.27	4.31	1.54	0.41*
F7 *Late Sensitivity*					
V15 Supportive Presence at 54 Months	5.47	1.10	4.54	1.70	0.55*
V16 Respect for Autonomy at 54 Months	5.51	0.99	4.69	1.26	0.65*
F8 *Late Language*					
V17 PLS: Auditory Comprehension at 54 Months	104.91	18.32	86.00	15.34	1.23*
V18 PLS: Expressive Language at 54 Months	106.60	16.61	88.85	21.14	0.84*
V19 WJ-R Picture Vocabulary at 54 Months	104.82	13.25	88.81	10.32	1.55*

Table 14, continued
Descriptive Statistics for Caucasian (N=427) and African American (N=26) (*p<.05)

		Caucasian		African American		
		Mean	Std. Dev.	Mean	Std. Dev.	Effect Size
F9	*Late Attention*					
V20	CBCL-Mother: Attention at 54 Months	2.40	2.10	2.42	2.72	-0.01
V21	CBCL-Other: Attention at 54 Months	2.51	2.22	2.77	2.61	-0.10
V22	Delay of Gratification at 54 Months	5.05	2.80	2.65	2.83	0.85*
V23	CPT: Omission Errors at 54 Months	8.03	6.77	9.33	5.08	-0.25
F10	*Executive Function*					
V24	WJ-R: Long Term Memory at 1st Grade	102.63	13.75	98.19	11.92	0.37*
V25	WJ-R: Short Term Memory at 1st Grade	101.14	14.70	91.88	10.66	0.87*
V26	CPT: Commission Errors at 1st Grade	4.78	7.96	4.27	6.46	0.08
V27	TOH: Total Planning Efficiency at 1st Grade	15.21	6.52	11.46	6.87	0.55*
F11	*Maternal Verbal Ability*					
V28	PPVT-R: Mother's Verbal Ability	105.27	16.23	82.96	16.48	1.35*

Summary

In conclusion, the original proposed multi-group analysis (Caucasian vs. African American) was not possible due to the small sample size. Examination of the effect sizes for the study indicators does indicate a number of large and moderate differences which would be expected to have important implications. While it is not possible to understand this influence in relation to the proposed model, in the next chapter these effect sizes will be discussed in relation to current theory and literature relating to ethnicity, SES, and the development of executive functions.

Question 3: Does maternal verbal ability mediate the relationship between SES and executive functioning?

In order to answer this question, structural equation modeling was used. Using model 2, which includes an indirect relationship between maternal behaviors at 54 months and executive function at 1st grade as a base model, maternal verbal ability was added as a mediator between SES and executive functioning while retaining a direct path between SES and executive functioning (See Figure 6). The overall model fit remained poor ($x^2(325) = 1424.940$, p< .000 (S-B $x^2(325) = 1413.7154$, p< .000), CFI =.763 (.741), SRMR (.118), RMSEA = .085 (.085), RMSEA 90% confidence interval: .080-.089 (.080-.089) (See Table 6). Comparisons were next made between the AIC fit index of the current model and model 2. Model 2's AIC fit index was smaller than the mediator model. This suggests that the fit of Model 2 fit is more parsimonious and more desirable and that the addition of maternal verbal ability in the mediator model is not making a useful contribution.

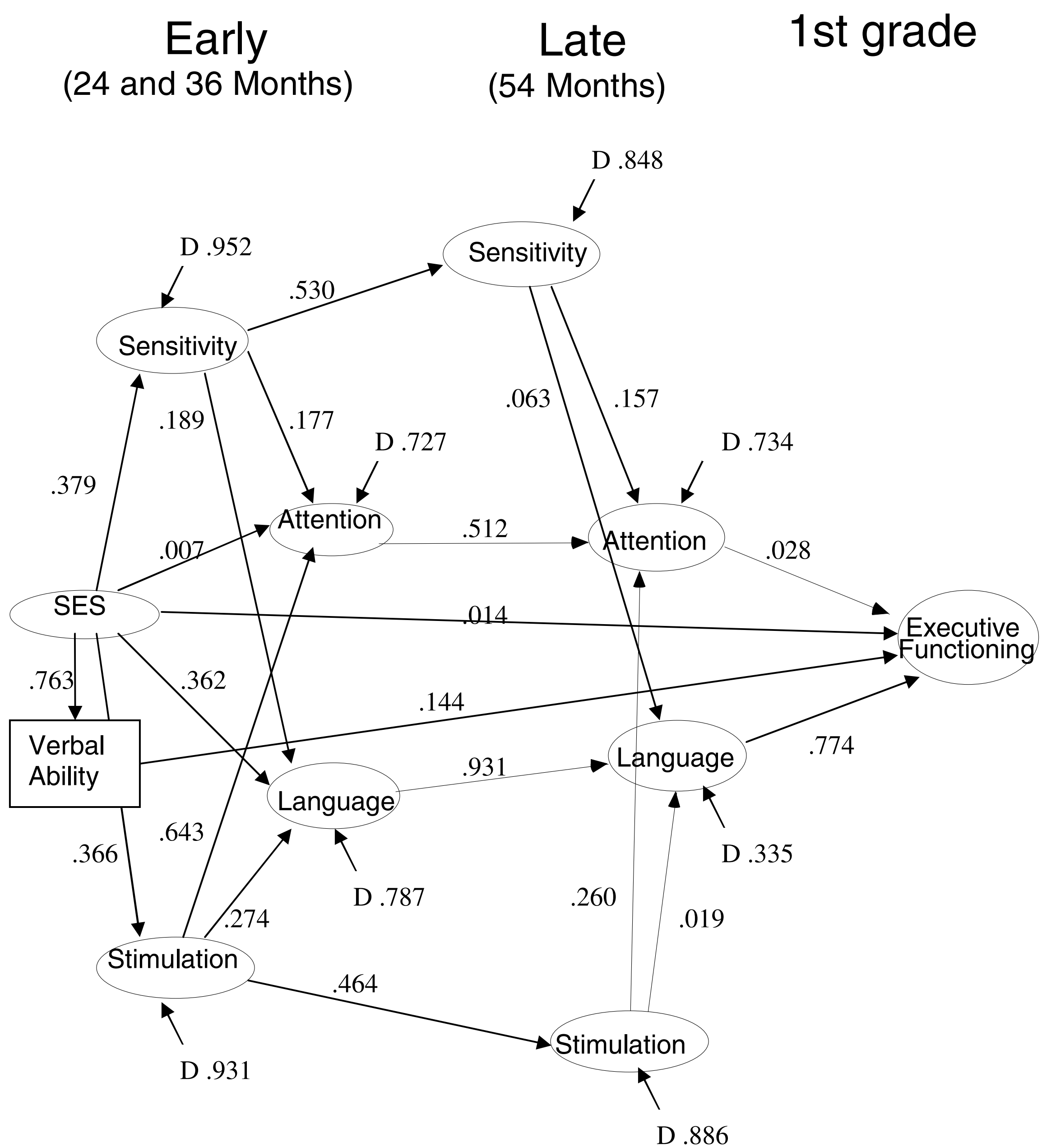


Figure 5. Structural Relationship between SES, Maternal Verbal Ability, Maternal Behaviors, Executive Function, Attention, and Language: Direct and Indirect Relationships via Maternal Verbal Ability between SES and Executive Function.

Supplementary analysis for question 3

Because the theoretical relationship between maternal verbal ability, SES, and executive functioning is unclear, two other models were examined. In the first alternative model (See Figure 6) in which maternal verbal ability replaced SES, the model did not converge on a solution. In a second model SES directly influenced maternal verbal ability which in turn directly and indirectly influenced maternal behaviors, attention, language, and executive functioning. This model (See Figure 7) failed to result in a solution as there was not enough information in the model.

Summary

In conclusion, the addition of maternal verbal ability did not produce significantly different results. This suggests that within the current model maternal verbal ability does not mediate the relationship between SES and executive function. The findings of the supplemental analysis continue to support that the model does not accurately reflect the data and is generally unstable.

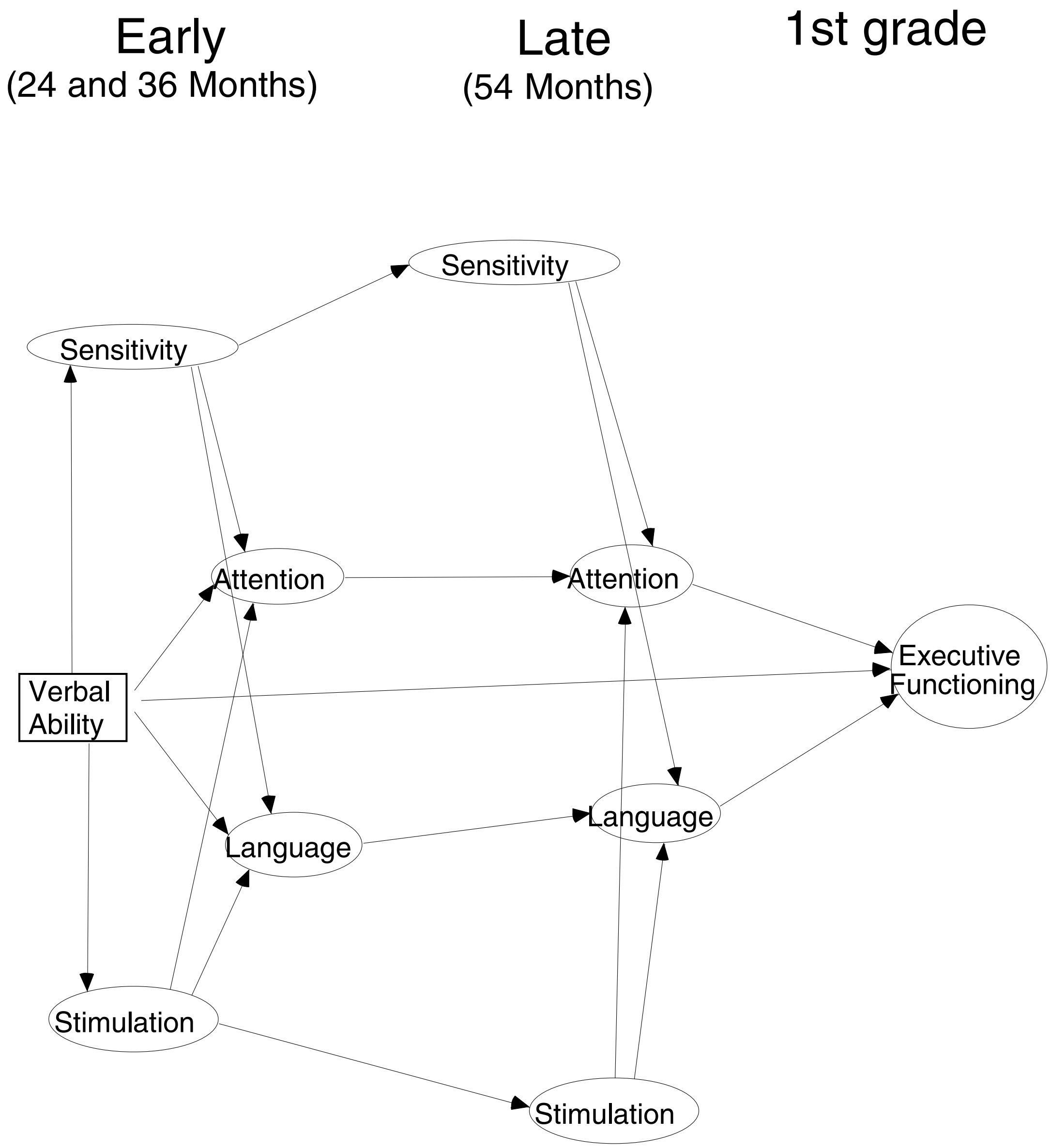


Figure 6. Proposed Structural Relationship between SES, Maternal Verbal Ability, Maternal Behaviors, Executive Function, Attention, and Language: Maternal Verbal Ability in place of SES

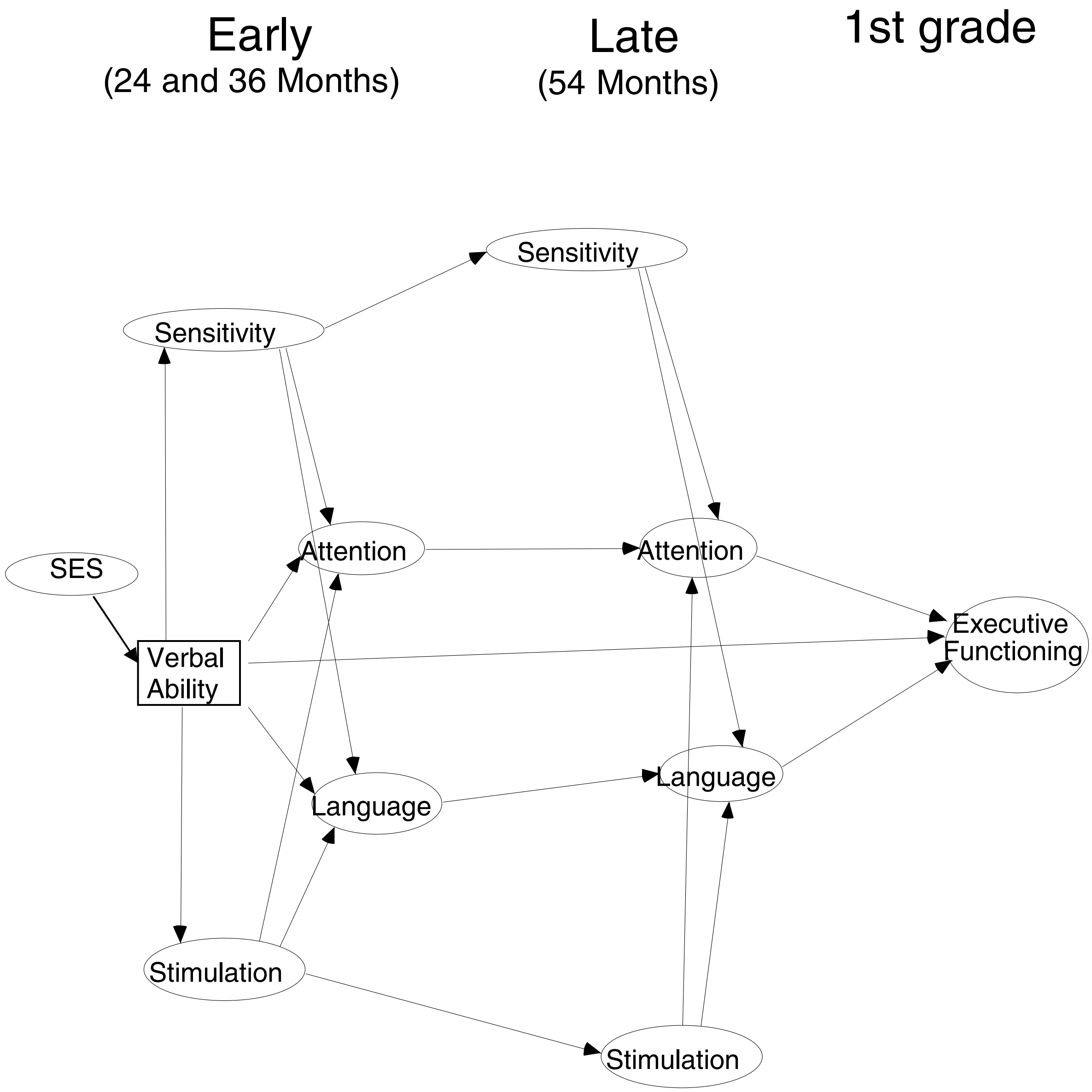


Figure 7. Proposed Structural Relationship between SES, Maternal Verbal Ability, Maternal Behaviors, Executive Function, Attention, and Language: Indirect Relationship via Maternal Verbal ability between SES and Executive Function

CHAPTER V

Discussion

The present study examined the relationship between maternal behaviors, specifically maternal sensitivity and maternal stimulation, and later development of executive functioning. In order to do this, data from the NICHD SECCYD were analyzed. The relationships between children's performance on measures of executive function at 1st grade and early and late maternal behaviors as well as early and late child attention and child language abilities were examined. The study had several strengths. First, the data set was relatively large which allowed for the detection of fairly small effects. Additionally, constructs typically included several, well-known measures. Another positive aspect of the current study is the strength of the structural equation methodology which allowed for the examination of both direct and indirect paths as well as the examination of mediator variables. Finally, through supplementary analyses additional important insights have been gained about the constructs of maternal sensitivity, maternal stimulation, and executive functioning. Overall, there were significant differences between the three proposed models but the poor fit of the models suggest that they do not accurately represent the data. Below, each of the research questions is discussed including the hypotheses and the supplementary analyses. Finally, limitations and recommendations for future research are presented.

Question 1. Does maternal stimulation and maternal sensitivity at 54 months influence performance on later executive functioning tasks? If so, is that influence direct or indirect through the effect on children's early language and attention skills?

The main goal of the current study was to examine the influence of maternal stimulation and maternal sensitivity on later executive functioning. It was expected that later maternal sensitivity and maternal stimulation would have less influence on development of executive functioning as compared to the influence of early maternal stimulation and sensitivity. This hypothesis was based on the work of Landry and others (2002) which found that early maternal behaviors had a greater impact on the development of executive functioning. Conversely, however, an NICHD Early Child Care Research Network study (2005a) that used the NICHD SECCYD dataset found that a child's early environment as well as later environment, including maternal behaviors, influenced the later development of attention and memory but not planning.

The findings from the current study support both of these studies in that there were significant differences between the models. Specifically, Model 2, which included an indirect path between late maternal behaviors and executive functioning via late attention and late language abilities, represented the best fitting model. This finding supports Landry's (2002) research which suggests that there is not a direct effect between later maternal behaviors and the development of executive functioning but instead a indirect path between early maternal behaviors (verbal scaffolding at 3 years) and later executive processes (search retrieval task at 6 years) via language skills at 4 years. Notably, Landry's (2002) research was limited in that it *only* examined direct paths between later maternal behaviors and the development of executive function. Thus findings from the current study build on Landry's work and suggest that later maternal behaviors do indirectly influence the development of executive functioning by directly influencing language and attention. The findings also support the results of the NICHD Early Child Care Research Network study (2005a) which found, using hierarchal regression, that statistically both early and late maternal behaviors play important roles in the development of executive function. While hierarchal regression did not allow the researchers to examine if that relationship was direct or indirect, it does provide validity for the current study. Overall these findings suggest that later maternal behaviors do uniquely contribute over and above early maternal behaviors. The current study does not discount the importance of early maternal behaviors but suggests that later maternal behaviors are also important by supporting the basic cognitive and language processes necessary for children to develop executive functions.

While the proposed model did not fit the data well, these results do suggest that later maternal sensitivity and maternal stimulation do not directly influence executive functioning in the 1st grade but instead influence the development through assisting the child in development of attention and language skills. Importantly, language skills had a particularly strong influence on the development of executive functioning. A number of other executive function researchers have supported the notion that language ability is related to the development of executive function (see Barkely, 1997; Saxton, 1997; Stuss & Benson, 1990). For example, within Barkley's model of executive function, language plays a prominent role in the development of verbal self-regulation and verbal heuristics that are used as reference points during problem-solving. Benson (1997) writes, "Language is a tool that supports higher-order mental processes that are key for internalizing what children initially learn through their action and for imposing order and structure on action" (p. 53). Benson hypothesizes that through verbalizing their temporal sequence, children are able discuss the future which then influences their ability to plan what is a recognized component of executive function.

Other notable researchers, namely Vygotsky (1934/1962) and Luria (1961), regarded internal speech as having a necessary role in self-regulation. Specifically, Vygotsky presented the notion that internal speech impacts an individual's ability to attend to their environment and master multi-step actions. Vygotsky theorized that internal speech developed in three stages. The first stage of internal speech begins with externalized utterances that resemble social speech. The second stage involves verbalizations with self-regulatory function. In the final stage, verbalizations become internal, ending with silent thoughts. Bivens and Berk (1990) reported evidence in support of Vygotsky's theory of the relationship between internal speech and self regulation. These researchers found support for a developmental progression from external self-stimulating and task-irrelevant verbalizations to task relevant external manifestations of inner speech (i.e., inaudible muttering and lip and tongue movement). While the current study suggests that there may be a relationship between language (specifically self-directed speech) and executive function, there is limited emerging empirical support for this claim. In a related study, Kopecky, Chang, Klorman, Thatcher, and Borgstedt (2005) examined executive function performance on the TOH and self-regulatory verbalizations with children with and without ADHD. They reported that children in all groups exhibited higher rates of self regulatory verbalizations compared to non-self-regulatory verbalizations during the TOH task.

Another important avenue to consider related to both language development and executive function is the role of theory of mind. Notably, the development of executive functioning is thought to influence the developmental unfolding of the theory of mind. Several studies have shown that performance on false-belief and other theory of mind tasks can be predicted from response inhibition, cognitive conflict resolution, and working memory (all executive functioning skills) even after controlling for verbal ability (Frye, Zelazo, & Palfai, 1995; Hughes, 1998; Perner & Lang, 2000). Researchers theorize that children who fail theory of mind tasks may do so “not because they lack an understanding of false belief, but because of the peripheral executive demands that these tasks pose” (Sabbagh, Xu, Carlson, Moses, & Lee, 2006, p.75). Therefore, as a child’s executive abilities increase so should their ability to perform theory of mind tasks.

While the role of language in the development of executive function and theory of mind is not clear, there is data to suggest that there is a significant positive relationship between impairments in language and executive function, as evidenced by commonly known neurodevelopmental disorders such as autism. Russell (1997) theorized that individuals with autism are less able to use verbal self-regulation, which makes them more vulnerable to errors that require an individual to inhibit a prepotent response, such as the TOH task. The most robust evidence of executive dysfunction in autism has come from the Tower of Hanoi (Ozonoff, Pennington, & Rogers, 1991). In a study comparing performance of autistic children with non-autistic children on measures of executive function, Joseph and colleagues (2005) found that children with autism performed significantly worse than the comparison group on the Tower of Hanoi task. The authors reported that children with autism did not use their language skills during the TOH task to verbally encode and rehearse the sequence of correct moves. The finding that individuals with autism have consistently worse performance on the TOH task has been replicated in a number of laboratories and with participants with a range of IQ's.

Recent research has supported the hypotheses that language ability accounts for a significant amount of variance in performance on executive function tasks and that language ability predicts performance on measures of executive function. This may be due to language's shared variance with intelligence. Kalback (2004) examined the developmental language differences and executive functioning in deaf children. He reported that " not only was language ability predictive of overall executive function performance, but when examining individual components, language ability also predicted performance in a working memory task and ratings of inhibitory behavior" (p. 147). This suggests that language development is uniquely tied to executive function development.

As expected, the executive function tasks chosen for the current study were not clearly linear (i.e., they typically taped more than one skill or ability). The most prominent example being the TOH task, which is recognized as requiring higher-order cognitive abilities such as advanced planning but also includes several single component skills (i.e., memory) (Scholnick & Friedman, 1993). To this end, conceptualization of executive functioning is further complicated by the fact that it requires the application of basic processes. Therefore it is recognized that poor performance on the TOH may be the result of deficiency in a single competent skill or a deficiency in the coordination of those skills for higher-order tasks.

Based on previous empirical and theoretical work, the executive functioning tasks were expected to be interdependent and to some extent predictive of performance of one another (NICHD Early Child Care Network, 2005a). The extremely low intercorrelations (-.065 - .304) among the measures of executive function in the current study suggest that they are largely independent in the current study. This finding is in contrast to recent work (Friedman, Miyake, Corley, Young, DeFries, & Hewitt, 2006) that reports intercorrelations of .10 to .58 among measures of executive function (inhibiting, updating, and shifting) with the majority of the intercorrelations being between .21 to .25. They further reported that the interfactor correlations among inhibiting, updating, and shifting ranged from .64 to .39. This lack of relationship between measures of executive function, particularly the TOH, suggests that the tasks were not functioning as originally expected and as they have in previous studies.

This lack of replication is difficult to explain as the measures used have been empirically validated and traditionally administered. A notable limitation of the current study was the lack of information about the stability of the TOH measure in the NICHD study. Within the NICHD SECCYD data set the TOH was administered at 1st, 3rd, and 5th grades, unfortunately only the data set through 1st grade is currently available to qualified researchers. Therefore at the current time is not possible to get an accurate estimate about the predictive validity of the TOH as well as the correlation between the administrations of the TOH across time. Some researchers (e.g., Borys et al., 1982) have reported a number of practice effects with the TOH on both normative and mentally retarded populations while others (Bishop, Aamodt-Leeper, Creswell, McGurk, & Skuse, 2001) have found little or no practice effects with a normative childhood population. In the future, this will be important to examine as the TOH data in the current study had lower correlations in the current study than expected.

It is recognized that a myriad of factors can differentially influence performance on measures of executive function. For example, planning is influenced by a number of factors, namely motivation, emotion, and social context (Scholnick & Friedman, 1993). Of interest to the current study, Ellis and Seigler (1997) noted reasons why individuals fail to plan. They noted that children may fail to plan with the expectation that someone (i.e., a parent) else will take care of it for them. This type of inappropriate scaffolding or intrusiveness over time may result in a decrease the ability to solve tasks, such as the TOH, that requires coordination of multiple components but would less likely influence the development of short-term memory. Unfortunately the current study was unable to tease out those effects due, in part, to the archival nature of the data.

Another important factor when considering executive function was the measures of inhibition and executive function. Errors of omission occur when the participant fails to respond to the target stimulus while errors of commission occur when the target responds to a non target stimulus (Conners, Epstein, Angold, & Klaric, 2003). Based on these definitions, researchers and practitioners have used measures of errors of commission to represent inhibition and measures of errors of omission to represent attention, or more specifically inattention. Unfortunately, attempts to empirically support these distinctions have produced inconclusive results (Barkley, 1991). Within the current study both measures of commission and measures of omission were used to measure different constructs at different points in time. Specifically, at 54 months errors of omission loaded on the attention factor and at 1st grade errors of commission loaded on the executive function factor.

Conners, Epstein, Angold, and Klaric (2003) analyzed data from a normative sample of the CPT test, a measure similar to that used in the current study, and discovered several notable findings. First, they reported that males tended to have quicker response times and make more commission errors than their female counterparts. In line with the current study, the authors did not find ethnic differences within the sample. Second, the measures associated with the CPT were strongly affected by age. However, for the different measures associated with the CPT, namely attention and inhibition, the developmental trajectory varied. Conners and associates (2003) note limitations related to measurement of commission errors, namely difficulty truly understanding what is being measured. They report that some commission errors are the result of "sluggishness in response" while others are the result of true impulsive behavior. In relation to the current study, the distinction between each type of error representing a behavioral topography may have been artificial and may not have accurately represented the underlying data thus contributing to a poor fit within the model.

Another important implication of the current study is the relationship between maternal sensitivity and maternal stimulation. Exploratory factor analysis suggests that these variables in this data set form a single construct. This may be due to the shared methodology or due to lack of differentiation in the operationalization of the constructs. While available literature does appear to recognize theoretical differences between maternal sensitivity and maternal stimulation, upon further examination of the grain size of the construct used in the current study it would seem that the differences may not have been clearly operationalized. This lack of differentiation between scores for maternal sensitivity and maternal stimulation is especially prominent in the lower scores (i.e., scores of 1, 2, or 3). There appeared to be measurable and conceptual differences in the operationalization of higher scores. Unfortunately, there was much less differentiation across the lower scores such that if a mother was not attentive or if they were inappropriately over attentive they would receive low scores across both measures of sensitivity and stimulation. This appears to be the result of both theoretical and measurement limitations of the construct such that positive parenting behaviors are more uniquely measured as compared to negative parenting behaviors which are typically characterized by either ignoring or intrusiveness.

Conclusion

While the overall fit of the model suggested it did not accurately reflect the data, several tentative findings did emerge. First, the results of the current study are in line with other recent research and suggest that both early and later maternal behaviors play important roles in the development of executive function. Secondly, language ability played a more prominent role in the development of executive function than previously thought and should be further investigated. Third, in the current study the measures of executive function were less interdependent than previously theorized making it difficult to truly conceptualize executive function. Finally, the results from the current study should act as a cautionary tale for other studies using the constructs of maternal sensitivity and maternal stimulation. The results from the current study would suggest that maternal sensitivity and maternal stimulation actually represent a single construct, possibly due to the lack of specificity in the operational definition of the construct.

Question 2. Does ethnicity, African American and Caucasian group membership, moderate the strength of the relationship between maternal stimulation and maternal sensitivity and executive function?

The relationship between maternal behaviors on the development of executive function across two ethnicities (Caucasian and African American) is difficult to ascertain. As noted in the results section, multi-group comparison using structural equation modeling was not possible due to the small sample size of African American participants. Using other methods, the current study found surprisingly large effect size differences between Caucasian and African American participants' scores across several variables. Notably, the biggest effect size difference was the SES overall composite score. This suggests that diverging childhood outcomes with families of different ethnicities may be related to membership in a lower socioeconomic group as opposed to ethnic group membership. To this end, the next section will examine the influence of SES, specifically parental educational level and affluence, on the development of executive functioning.

Socioeconomic Status and Executive Function

Affluence. According to the United States Census Bureau (2003) among all children under age 18, African American children are three times as likely to live in poverty (30 percent) as compared to their non-Hispanic White counterparts (10 percent). The researchers also reported that 23 percent of African Americans lived below the poverty level as compared to 8 percent of non-Hispanic Whites. Duncan, Yeung, Brooks-Gunn, and Smith (1998), using data from the National Longitudinal Survey of Youth-Child Supplement (NLSY-CS), reported that income effects are most influential during early childhood.

Other studies related to the current data set have reported on the effect of affluence. Dearing, McCartney, and Taylor (2001) reported using the NICHD SECCYD database that changes in income-to-needs ratio for non-poor individuals had little effect, as compared to changes for poor individuals. Poverty level had the greatest effects on measures of school readiness, receptive language, expressive language, positive social behavior, and behavior problems. Thus change in income-to-needs status matters more for children with less. In another study, the NICHD Early Child Care Research Network (2005b) examined the influence of timing and duration of poverty on maternal behaviors and subsequent child outcomes. They reported that mothers in chronically low income families displayed steady decreases in maternal sensitivity over time. Importantly, they noted that income gain was associated with increases in quality of maternal behaviors, including maternal sensitivity, as well as improved child cognitive and language outcomes.

Other researchers have noted that low-income mothers, compared to their upper income counterparts, are less likely to engage in maternal behaviors found to be associated with future reading and language abilities such as use of prompts, cues, positive reinforcement, and use of open-ended questions (Portes, 1991). Mistry, Biesanz, Taylor, Burchinal, and Cox (2004) examined the impact of the quality of maternal-child interactions as one potential mediator between income and child development. Using the NICHD data measures of maternal stimulation at 6, 15, 24, and 36 month, the authors reported that (a) income and family processes, namely maternal sensitivity, influenced both social and cognitive development (b) income influenced cognitive development above and beyond family processes and (c) behavioral outcomes were solely mediated by family processes. They also reported that income had a greater impact on individuals living in poverty than those not living in poverty. The authors write that, "On average, low-income parents (or those facing economic loss), compared with more affluent parents, are less child-centered and nurturing in interactions with their children and are more parent-centered, rejecting, and inconsistent when disciplining their children" (p. 728).

As expected in the current study, the largest effect size is the SES composite score, while the income-to-needs ratio effect is also very large and nearly twice the effect size for maternal education level and neighborhood safety. Welsh (2005) examined the relationship between affluence (i.e., income-to-needs ratio) and 1st grade student's performance on the TOH (i.e., planning efficiency score) and reported a statistically significant relationship ($p<.05$) between affluence and performance on the TOH with the correlation of .14 which accounting for 2% of the total variability in the TOH scores. The current study found similar results for the TOH but higher relationships between other measures of executive function and affluence. This suggests that affluence as a single indicator does play a small but significant role in performance on measures of executive function.

Parental Educational Level. Ardila, Rosseli, Matute, and Guajardo (2005) examined the influence of educational variables on the development of executive functions in children from Mexico and Colombia. The researchers administered eight measures of executive function to participants ($n=276$) aged 5 to 14 who were enrolled in either public or private school. It is important to note that years of education is at best an imprecise measure for determining education. As Helms (1997) reports, years of education fails to account for the quality of education which is more likely to be inferior for African Americans. While the authors reported that there were significant effects for age and type of school attended, they also noted that parents' educational level contributed significantly over and above individual student factors, particularly on measures of executive function that required more verbal ability.

This finding was supported by the current study. The only measure of executive function (WJ-R short term memory) that included a crystallized knowledge base had the largest effect size. It is suspected, based on the large effect size differences on measures of language, that differences between measures of executive function that included crystallized knowledge will be confounded with maternal educational level and maternal verbal ability. This is supported by the maternal scores on the PPVT-R which were also quite large. While there is a more clear connection (i.e., verbal ability) between measures of executive function that require a crystallized knowledge base and SES, what is less clear is the relationship for measures of executive function that require process-based knowledge.

Process-Based Measures of Executive Function

The next step is to examine effect sizes on other measures of executive function that did not include crystallized knowledge bases which should then be theoretically less driven by maternal education. Differences in student's performance on the WJ-R measure of long-term memory remained moderate, although much smaller than the WJ-R short term memory. Conversely performance on the CPT commission errors indicated no practical difference. This finding is inline with Mezzacappa's findings (2004). He examined executive attention, which is theorized to be a correlate of executive function, and reported that, as expected, older children performed better on the tasks than younger children. However, they also reported that African American and Hispanic children did better at resisting interference than their peers. Finally, examining the performance of participants in the current study on the TOH task, which as a measure relies more on process than crystallized knowledge, there was a moderate effect size difference.

Ethnic Differences

While the current data suggests between-group differences are difficult to tease apart, Welsh (2005) more closely examined errors of participant's (white/non-Hispanic and Other) on TOH performance using the SECCYD dataset. Welsh reported that white/non-Hispanic children performed significantly better on certain TOH problems (i.e., items 2, 3, and 5) and had significantly higher total efficiency planning scores. The study also reported that there were significant differences in the type of errors committed by participants. White/non-Hispanic participants were more likely to build towers with more than the required number of moves and the group consisting of all other ethnicities in the sample was more likely to build towers on the wrong peg. This suggests while/non-Hispanic children may have more difficulty inhibiting the prepotent response while the the non-white ethnic group had more difficulty with the basic visual spatial aspect of the task. While this provides some insight into the between group performance differences on the TOH, it does not allow for a more fine grain analyses of ethnic group differences.

Conclusion

The current study echo the findings of Noble, Norman, and Farah (2005) who examined the neurocogntive correlates of 30 low SES and 30 middle SES kindergarten children. The authors reported that, “SES differences were associated with disparities in performance in both the language and executive function systems” (p. 83). The disparities appeared be greatest in knowledge-based tasks as compared to process-based tasks (Campbell, Dollaghan, Needleman, & Janosky, 1997). While the current study originally theorized that cultural differences in the amount and type of scaffolding support provided would significantly contribute to differences in the development of executive functioning, it appears that it not possible to separate ethnicity and SES. Specifically it appears that SES influences the development of language which in turn influences the development of executive functioning. This topic should be further examined in order to provide culturally sensitive, educational interventions so that *all* parents can best assist their children in optimal development.

Question 3. Does maternal verbal ability mediate the relationship between SES and executive functioning?

This question was developed to better understand the relationship between maternal verbal ability, SES, and executive functioning. As expected there was a strong moderate correlation between the SES composite score and maternal PPVT-R (r=.530) but conceptually it was expected that the addition of a measure of maternal verbal ability would improve the fit of the overall model. It was theorized that mothers who have higher verbal ability would provide greater verbal variety and sophistication in their interactions with their children which over time may influence the development of executive function. While SES refers to the amount and quality of economic resources available to an individual, it does not specifically consider the role of language in the development of executive function.

While several different models were examined, only one model appropriately converged on a solution. Comparing the AIC index, the inclusion of maternal verbal ability as a mediator did not improve the model fit. This may be because of the strong relationship between SES and maternal verbal ability. Thus, maternal verbal ability may not have provided additional non-redundant information.

The other proposed models either did not converge or resulted in a Heywood case in which the estimated correlation between the indicator and its factor is greater than 1. Heywood cases are caused by misspecification in the model such as outliers, small samples sizes with only two indicators on a latent variable, or very high or low population correlations. While the instability within the current model is not surprising given what is now known about the proposed constructs, it not possible to conceptually understand these findings.

Conclusion

The results of the current study suggest that the addition of maternal verbal ability to model as a mediator between SES and executive function does not significantly improve the fit of the model. While this finding is important, the overall lack stability in the model should be considered when interpreting this finding.

Limitations

While the current study had a number of strengths, it is necessary to understand the study's limitations as well. First the study was limited by the constructs that underlie the model. Obviously if the constructs are not valid or reliable then the overall model is not representing what it was intended to represent. Specifically it appeared that the constructs of early and late attention, early and late maternal sensitivity, and early and late stimulation are suspect. Another notable limitation is the lack of agreed-upon definition and measurement of executive function. While the current model has utilized a commonly accepted definition of executive function, the operationalization of executive function is limited by the measures available in the archival data set. While the measures were chosen based on theoretical and empirical literature, it is recognized that they, particularly TOH, mostly likely were not solely measures of the process of interest. Additionally, there are concerns about the measures of memory not best representing the type of memory that theoretically underlies executive function. While there is some limited literature to support the use of short-term and long-term memory, as related to both working memory and executive functioning, it is important to note that they don't represent the traditional working memory tasks that are most commonly associated with executive functioning. This is an important confounding factor causing the models reviewed in the current study to be limited in their ability to define and operationalize constructs.

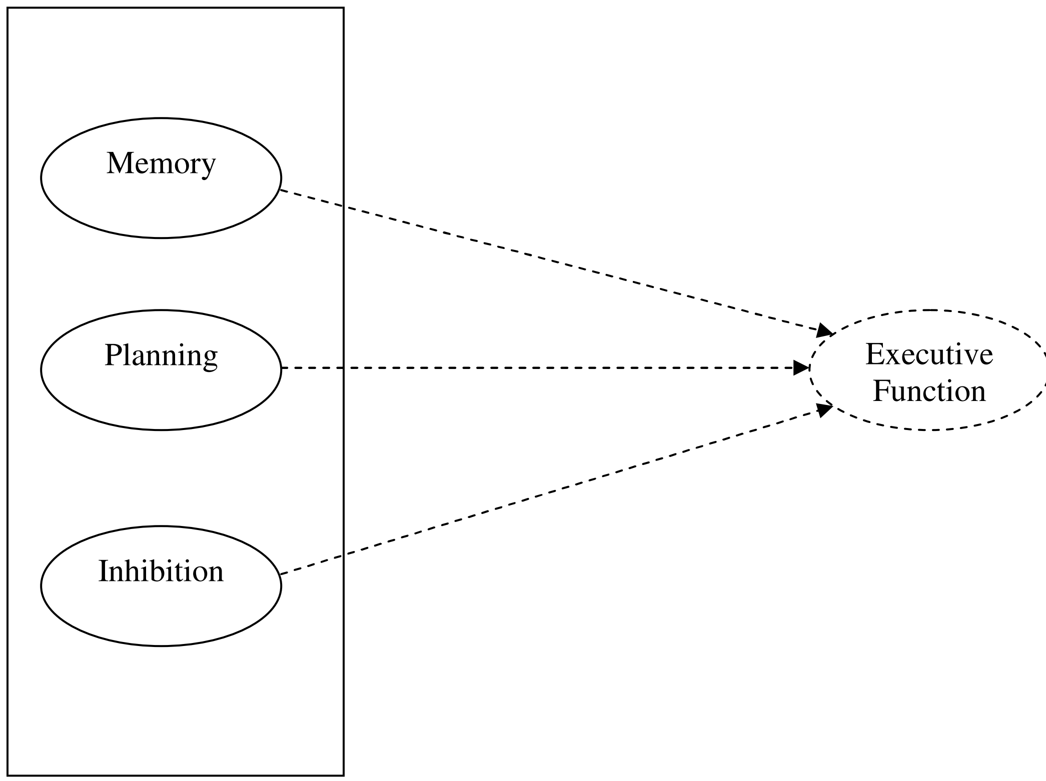
Future Research

The current study attempted to measure the development of executive function but executive function needs to be more clearly defined before developmental mechanisms can be examined. The current study has resulted in few tentative findings which suggest that language is a possible mechanism by which executive function develops. This relationship between language and executive function is not well established and frequently confounded by SES but should be a point of future research possibly using the SECCYD data, specifically examining the various areas of language ability (expressive vs. receptive).

Secondly the underlying model of executive function needs to be more clearly understood. While the current model suggested a single construct of executive function, in fact the underlying structure may be more similar to that depicted in Figure 8. Before empirical research can be applied, these basic theoretical questions need to be answered.

Figure 8

Possible Model of Executive Function



Finally, in order to understand important differences in how ethnicity and culture influences the development of executive function, analysis may need to go beyond mean differences in performance (Ellis & Seigler, 1997). For example, it may be necessary to instead examine error type and planning time and to look for similarities in response patterns within and across constructs of executive function. This may provide additional information about the mechanism by which ethnicity influences the development of executive function. It is also necessary that future research attempts to disentangle the confounding relationship between SES and ethnicity by either examining the development of executive function within a single SES strata or matching participants based on SES or suitable proxy.

Appendix A

Correlations Among All Study Variables n=470 (*p<.05, **p<.01)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2	Neighborhood Safety at 1st grade	.139 **																		
3	Mother's Education at 1 Month	.477 **	.183 **																	
4	Positive Regard at 24 Months	0.09	.100 *	.202 **																
5	Supportive Presence at 36 Months	.239 **	.153 **	.271 **	.256 **															
6	Respect for Autonomy at 36 Months	.167 **	.178 **	.280 **	.206 **	.637 **														
7	Cognitive Stimulation at 24 Months	.260 **	.122 **	.217 **	.223 **	.694 **	.420 **													
8	Total Positive Scaffolding at 36 Months	.133 **	.082	.147 **	.178 **	.427 **	.225 **	.552 **												
9	Cognitive Stimulation at 36 Months	.172 **	.181 **	.248 **	.546 **	.317 **	.227 **	.338 **	.303 **											
10	Reynell: Vocabulary at 36 Months	.371 **	.248 **	.429 **	.153 **	.357 **	.325 **	.347 **	.194 **	.332 **										
11	Reynell: Expressive Language at 36 Months	.197 **	.093 *	.286 **	.110 *	.197 **	.206 **	.212 **	.150 **	.177 **	.536 **									

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
23	CBCL-Other: Attention at 54 Months	-.041	-.042	-.126**	-.076	-.097*	-.117*	-.124**	-.062	-.039	-.175**	-.103*	.009	-.067	-.112*	-.127**	-.131**	-.175**	-.122**	-.218**
24	CPT: Omission Errors at 54 Months	-.068	-.104*	-.123**	-.068	-.105*	-.111*	-.163**	-.131**	-.177**	-.264**	-.154**	-.005	-.079	-.205**	-.210**	-.263**	-.209**	-.201**	-.227**
25	Delay of Gratification at 54 Months	-.137**	-.078	-.146**	-.087	-.158**	-.175**	-.147**	-.127**	-.109*	-.257**	-.068	-0.03	-.016	-.175**	-.174**	-.154**	-.153**	-.155**	-.273**
26	CPT: Commission Errors at 1st Grade	-.105*	-.119**	-.109*	-0.032	-.091*	-.165**	-.061	-0.05	-.128**	-.202**	-.113*	.031	-.012	-.054	.011	-0.07	-.066	-.064	-.152**
27	WJ-R: Short Term Memory at 1st Grade	.226**	.059	.192**	.083	.089	.077	.153**	.045	.058	.192**	.098*	.125**	.024	.121**	.085	.073	.106*	.107*	.185**
28	WJ-R: Long Term Memory at 1st Grade	.224**	.089	.302**	.064	.250**	.227**	.234**	.127**	.135**	.517**	.346**	.018	0.02	.197**	.166**	.138**	.187**	.204**	.468**
29	TOH: Total Planning Efficiency at 1st Grade	.179**	.00	.113*	-.046	.002	.065	.007	-.061	.013	.156**	.015	.049	.068	-.014	.108*	.098*	0.09	.130**	.161**
30	PPVT-R: Mother's Verbal Ability	.35**	.134**	.553**	.144**	.269**	.274**	.185**	.165**	.183**	.413**	.262**	-.027	.043	.318**	.260**	.187**	.291**	.311**	.396**

		20	21	22	23	24	25	26	27	28	29
21	WJ-R: Picture Vocabulary at 54 Months	.526 **									
22	CBCL-Mother: Attention at 54 Months	-.042	-.005								
23	CBCL-Other: Attention at 54 Months	-.133 **	-.039	.463 **							
24	CPT: Omission Errors at 54 Months	-.254 **	-.172 **	.042	.112 *						
25	Delay of Gratification at 54 Months	-.26 **	-.291 **	.047	.109 *	.212 **					
26	CPT: Commission Errors at 1st Grade	-.188 **	-.074	.176 **	.125 **	.099 *	.062				
27	WJ-R: Short Term Memory at 1st Grade	.183 **	.277 **	-.021	-.022	-.091 *	-.135 **	-.065			
28	WJ-R: Long Term Memory at 1st Grade	.440 **	.473 **	-.061	-.107 *	-.132 **	-.154 **	-.074	.304 **		
29	TOH: Total Planning Efficiency at 1st Grade	.134 **	.119 **	-.135 **	-.083	-.160 **	-.057	-.153 **	.116 *	.099 *	
30	PPVT-R: Mother's Verbal Ability	.325 **	.447 **	-.112 *	-.105 *	-.110 *	-.203 **	-.059	.236 **	.355 **	.037

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Education

University of Maryland, College Park, MD
Doctor of Philosophy, Expected May, 2007
Major: School Psychology
Dissertation: "The development of executive functioning and maternal behaviors: Secondary analysis of longitudinal data"
Dissertation Chair: Dr. William Strein, PhD
G.P.A. 3.8/4.0

University of Northern Colorado, Greeley, CO
Master of Arts Degree, May 2003
Major: Human Neuropsychology
Thesis: "Formal operational reasoning as a predictor of performance on the Tower of Hanoi-Revised"
Thesis Advisor: Dr. Marilyn Welsh, PhD
G.P.A. 3.8/4.0

University of Toledo, Toledo, OH
Bachelor of Arts Degree, May 2001
Major: Psychology with a developmental concentration
Minor: Biological Chemistry
Senior Project: "The effect of contour deletion on object recognition in preschool children"
Graduated with departmental and university honors (G.P.A. 3.5/4.0)

Honors and Awards

CAPS Dissertation Award, *University of Maryland Department of Counseling and Personnel Services,* 2006

Goldhauber Travel Grant, *University of Maryland Graduate School*, 2006

Colorado Graduate Fellowship, *University of Northern Colorado Department of Psychology,* 2002-2003

Excellence in Psychology Award, *University of Toledo*, 2001 (Cash Award)

Dean's and President's List, *University of Toledo*, 1997-2001

Publications

Emick, J., Mann, H., & Kopriva, R. (2006). *New ELLs and large-scale test validity*. Manuscript under preparation.

Kopriva, R., Emick, J., & Hipolito-Delgado, C. (2006). *Do proper accommodation assignments make a difference? Examining the impact of improved decision-making on scores for ELLs*. Manuscript accepted for publication.

Kopriva, R., Winter, P., Emick, J., & Chen, S. (2006). *Achieving accurate results for diverse learners- Access-based item development*. Manuscript accepted for publication.

Strein, W., Rahill, S.A., Emick, J.E., & Benn, A.E. (2005). *Social competency interventions for students with learning disabilities: A meta-analytic review*. Manuscript submitted for publication.

Winter, P., Kopriva, R., Chen, S., Emick, J. (2006). Exploring individual and item factors that affect assessment validity for diverse learners: Results from a large-scale cognitive lab. *Learning and Individual Differences, 16,* 267-276.

Emick, J.E. & Welsh, M. (2005). Association between formal operational thought and executive function as measured by the Tower of Hanoi-Revised *Learning and Individual Differences*, *15,* 177-188.

Karlin, N.J., Emick, J., Mehls, E. & Murry, F.R. (2005). Comparison of Efficacy and Ageism Levels Between Psychology and Nursing Students. *Gerontology and Geriatrics Education*, 26(2), 81-96.

Conference Presentations

Johnstone, C., Allman, C., Altman, Emick, J., Hall, T., Ketterlin-Gellar, L., Thurlow, M., & Tindal, G. (April, 2007). *Universal Design of Assessment: Report from a Researchers' Summit*. Presented at the American Educational Research Association national meeting, Chicago, IL.

Emick, J., & Kopriva, R. (April, 2007) *The Validity of Large-Scale Assessment Scores for ELLs Under Best Practices Testing Conditions: Does Validity Vary by Language Proficiency?* Presented at the American Educational Research Association national meeting, Chicago, IL.

Emick, J. (April, 2006). *Joint play and executive function: Secondary analysis of*

longitudinal data. A poster presented at the 2006 American Educational Research Association national meeting, San Francisco, CA.

Emick, J., Mann, H., Kopriva, R., & Ming-Yi, C. (April, 2006). *Language Liaisons: A novel accommodation for new ELLs.* A paper discussion presented at the 2006 American Educational Research Association national meeting, San Francisco, CA.

Emick, J., Kopriva, R., Chen Su, C., Mislevy, R., & Carr, T. (April, 2006). *Achieving accurate results for diverse learners: Access-enhanced item development.* A paper discussion presented at the 2006 American Educational Research Association national meeting, San Francisco, CA.

Koran, J., Emick, J., & Kopriva, R. (April, 2006). *Teacher evaluation of a computerized accommodations recommendation system for English Language Learners.* A paper discussion presented at the 2006 American Educational Research Association national meeting, San Francisco, CA.

Koran, J., Kopriva, R., Emick, J., Monroe, R., Walker Webb, P., & Garavaglia, D. (April, 2006). *A multiple measures approach for gathering information to make individualized test accommodation decisions for English Language Learners*. A paper presentation presented at the 2006 National Council on Measurement Education meeting, San Francisco, CA.

Welsh, M., Tlustos, S., Howell, Z., & Emick, J. (February, 2005). *Formal operational thought and executive functions in college freshmen and seniors.* A poster presented at the 2005 International Neuropsychological Society meeting, St. Louis, MI.

Emick, J.E., Welsh, M., Howe, Z, & Chandran, S. (Feburary, 2004). *Formal operational reasoning as a predictor of performance on the Tower of Hanoi-Revised.* A poster presented at the 2004 International Neuropsychological Society meeting, Baltimore, MD.

Karlin, N.J., Emick, J.E., & Mehls, E. E. (April, 2003). *Ageism and nursing students.* A presentation at the Annual Conference of the Rocky Mountain Psychological Association, Denver, CO.

O'Reilly-Wolf C., Welsh M., McNeil H., Emick J.E., & Gonzalez S. (February, 2003).*Individual differences in self-efficacy and tower task performance*. A poster presented at the 2003 International Neuropsychological Society meeting, Honolulu, HI.

O'Reilly-Wolf C., Welsh M., McNeil H., Emick J.E., & Gonzalez S. (May, 2002). *Individual differences in self-efficacy and tower task performance.* A poster presented at the 2002 Annual University of Northern Colorado Research

Symposium, Greeley, CO.

Emick, J.E. & Haaf, R.A. (May, 2001). *The role of contour deletion in object recognition by preschool children.* A poster presented at the Annual Conference of the Midwestern Psychological Association, Chicago, IL.

Related Professional Activities

Project Manger, *Center for the Study of Assessment Validity and Evaluation, 2005-2006*
Duties: Served as project manger for multi-year grant, Achieving Accurate Results for Diverse Learners. Over-saw the creation of access-based large-scale test items for ELLs and students with high frequency disabilities in conjunction with the South Carolina Department of Education. Assisted in the development of the research design for a comparability field test. Maintained responsibility for daily management and allocation of resources.

Graduate Assistant, *Center for the Study of Assessment Validity and Evaluation, 2003-2005*
Duties: Provided research, statistical, writing, and administrative assistance to multi-year federal grants (Valid Assessment of English Language Learners, The Taxonomy for English Language Learners, and Achieving Accurate Results for Diverse Learners) geared to assessing the effectiveness of accommodation and accommodation use for English Language Learners. Served as science content editor in the development of access-enhanced large-scale achievement test items.

Graduate Research Assistant, *Center for the Study of Assessment Validity and Evaluation, 2004*
Duties: Assisted Rebecca Kopriva, PhD in the writing and editing of *Building Validity for English Language Learners into Large Scale Achievement Tests* (Erlbaum Publishing).

Graduate Research Assistant, *Philip Merril College of Journalism, 2003*
Duties: Assisted the university dean with gathering, configuring, and reporting enrollment data and programmed career events for journalism students.

Graduate Assistant, *Assault Survivors Advocacy Program, 2001-2003*
Duties: Provided victim advocacy/crisis services for students and significant others, developed and evaluated prevention education programs, recruited, trained, and supervised student advocates/interns, and assisted with grant writing and grant administration.

Counselor, *Residential Youth Treatment Center, 2002-2003*
Duties: Maintained a safe and therapeutic environment through the principles of behaviorism for kids aged 4-12 and provided therapeutic crisis intervention.

Counselor, *National Depression Screening Day, 2002*
Duties: Assessed scores, provided individual education, referrals, and support to clients.

Counselor, *National Alcohol and Drug Screening Day, 2002-2003*
Duties: Assessed scores, provided individual education, referrals, and support to clients.

Program Assistant, *Women's Resource Center, 2000-2001*
Duties: Facilitated domestic violence/self sufficiency support groups, provided comprehensive multi-program evaluation, supervised student interns, and assisted in planning national and campus events.

Resident Advisor, *Resident Life Staff*, 1998-2000
Duties: Provided programmatic, mediation, and resident support to 50+ freshman women while maintaining a safe and positive living environment.

Counselor, *Upward Bound*, 2000
Duties: Coordinated summer learning initiative, served as a resource and conflict intermediary, and specialized in educational diversity.

Professional Membership

American Psychological Association (2003-Current)
Maryland School Psychologists' Association (2004-2006)
American Educational Research Association (2005- Current)

Skills

Experience handling large sets of data.
Ability to effectively train/present to individuals and groups on a variety of topics.
Experience aligning access-based test items to educational agencies standards.
Excellent knowledge of Front page, Publisher, Excel, and Internet Research.

Training Experience/Invited Presentations

Invited Participant, *National Center on Educational Outcome: Universal Design Summit*, 2006
Duties: Invited ELL expert for Universal Design Summit. The summit brought together experts to share research related to Universal Design and develop common definitions and approaches for dissemination.

Presenter, *University of Maryland,* 2005-2006
Duties: Co-presented Enhancing School Success to the University of Maryland community with Dr. Beth Warner. The talk provided practical ways to improve a

child's educational success and presented information on the special education and assessment process in the state of Maryland.

Trainer, *Riverside Publishing Company*, 2004-2007
Duties: Consultant for Riverside Publishing training customers (ranging from 10 to 50 participants per 7 hour training session) regionally and nationally on the technical adequacy and administration of the *Battelle Developmental Inventory 2nd Edition*. Clients have included: Prince George County Public School District, Delaware Department of Education, North Cambria School District, and Capital Area Independent Unit.

Trainer, *Valid Assessment of English Language Learners*, 2004
Duties: Provided training for 300 undergraduate student employees on how to administrator accommodations for large-scale standardized assessments in elementary schools.

Guest lecturer, *Women and Violence*, 2002
Duties: Invited to lecture to 150 women's health students on the topic of the cultural context of women and violence.

Guest lecturer, *Sexual Assault Prevention and Gender Education*, 2001-2003
Duties: Developed educational presentations for campus wide use, lead classroom discussion, and trained graduate and undergraduate volunteers to be educational lecturers.

Teaching Assistant, *Leadership U.T.,* 2000-2001
Duties: Co-taught third year leadership class, developed leadership theory-based curriculum, evaluated assignments, and initiated highly successful service learning project.

Practica and Internship Experience

Internship*, Clark County School District, Las Vegas, NV,* 2006-2007 (Supervisor: Dr. Joan Silverstein, Ph.D)
Duties: Acted as a school psychologist under the supervision of a licensed psychologist in two elementary schools with high populations of English Language Learners and one high school for the performing arts with exceptional mental health needs. Served as a member of the Student Intervention Team and multidisciplinary team and provided consultation for staff and families. Received exceptional training in response to intervention, comprehensive mental health services including group and individual therapy, and autism assessment. Training included individual and group supervision, as well as didactic and professional development training.

Externship, *University Parent Consultation & Child Evaluation Service/University Counseling Center*, 2005-2006 (Supervisor: Dr. Beth Warner, Ph.D)

Duties: Engaged in individual and group therapy as well as parent and teacher consultation through observation and direct services, conducted psychological assessments, supervision of graduate students on cognitive assessments, and co-presented parent workshops (Enhancing School Success & Managing Externalizing Behaviors).

Group Counseling, *Prince George County Schools*, 2005 (Supervisor: Dr. Lee Rothman, Ph.D)
Duties: Co-facilitated counseling groups for elementary aged students using the Structure/Themes/Open Communication/Reflection/Individuality/Experiential Learning/Social Problem-Solving (STORIES) program.

Practica, *Prince George County Schools*, 2004-2005 (Supervisor: Dr. Lee Rothman, Ph.D)
Duties: Completed comprehensive assessments including review of records, classroom observations, structured and unstructured assessments for students with a range of disabilities/diagnoses (including cognitive, emotional, and developmental), assisted in the planning and coordination of interventions, and made recommendations for IDEA classification and DSM diagnosis.

Practica, *Psychological and Educational Evaluation and Research Psychological Services*, 2004-2005 (Supervisor: Dr. Hedwig Teglasi, Ph.D)
Duties: Completed comprehensive assessments for students referred to University School Psychology Clinic, assisted in the planning and coordination of interventions, and provided individual feedback for parents and if appropriate the client.

Practica, *Howard County Schools,* 2004-2005 (Supervisor: Mary Nelpa, Eds)
Duties: Provided instructional consultation for teachers around the instructional needs of students and provided consultation for the administrative team around systematic concerns about the current character education program. Completed curriculum-based assessments and assisted in the development and measurement behavioral assessments and interventions.

Provision of Supervision

Supervisor, *University Parent Consultation & Child Evaluation Service/University Counseling Center*, 2005-2006
Duties: Provided individual supervision for 2 University of Maryland school psychology practicum students. Oversaw the administration, scoring, interpretation, writing, and feedback of cognitive and achievement assessments.

Reviewer

Reviewer, *Current Issues in Education,* 2005-2006

Research Experiences

2004-Current The development of executive functioning and joint play: Secondary analysis of longitudinal data. William Strein, Ph.D (dissertation chair) University of Maryland.

2004-2006 Achieving Accurate Results for Diverse Learner. Rebecca Kopriva. Ph.D. (center director) University of Maryland.

2003-2006 Valid Assessment of English Language Learners. Rebecca Kopriva Ph.D (center director) University of Maryland.

2003-2005 Meta Analysis. Social Skills Training. William Strein, Ph.D (advisor) University of Maryland.

2003-2005 The Taxonomy of English Language Learners. Rebecca Kopriva Ph.D (center director) University of Maryland.

2002-2003 Investigating formal operational reasoning as a predictor of performance on the Tower of Hanoi-Revised. Marilyn Welsh Ph.D (advisor) University of Northern Colorado.

2002-2003 Investigating nursing student's attitudes towards ageism. Nancy Karlin Ph.D and Elizabeth Mehls, FNP University of Northern Colorado.

2002 Individual differences in self-efficacy and tower task performance. Marilyn Welsh Ph.D (advisor) University of Northern Colorado.

2001-2002 Validation of sexual attitudes and behaviors survey. Jennie Bruner Psy.D (supervisor) University of Northern Colorado.

2001-2003 Development of sexual assault prevention program based on social norms theory and previous research. Jennie Bruner Psy.D (supervisor) University of Northern Colorado.

2002 Investigating male attitudes toward social norm messages. Teresa Wroe (supervisor) Colorado Coalition Against Sexual Assault.

2000-2001 Investigating the effect of contour deletion on Biederman's theory of object perception by preschool children. Robert Haaf Ph.D (advisor) University of Toledo.

2001 Investigating the effect of various therapies on children of substance abusers: National Longitudinal Study. Christie Berger Ph.D (supervisor) University of Toledo.

2000-2001 Investigating influence of naming objects on infant's ability to form concepts of those objects. Anne Fulkerson Ph.D. (supervisor) University of Toledo.

2000-2001 Investigating the effect of parsing on object recognition of preschoolers. Robert Haaf Ph.D (supervisor) University of Toledo.

Grants and Contracts

2006 Contract ($500) with Psychological Corporation for the national standardization of the *PALS-II*.

2005-2006 Contract ($500) with the Riverside Publishing Company for the try-out of the *Cognitive Assessment System-Revised* (CAS-R).

2004-2006 Contract ($700) with Riverside Publishing Company, per training, for providing private trainings regionally and nationally on the *Battelle Developmental Inventory 2nd Edition (*BDI-2).

2004-2006 Contract ($3000) with grant program Assisting Young Mothers for assessments using the *Battelle Developmental Inventory 2nd Edition* to measure participant's growth and assess programmatic performance.

2005 Contract ($200) with The Psychological Corporation for the national standardization of the *Differential Abilities Scale 2nd Edition* (DAS-II).

2004 Contract ($200) with The Psychological Corporation for the national standardization of the *Bayley Scales of Infant Development 3rd Edition* (BSID-III)

2002-2003 Contract ($1500) with Riverside Publishing Company for national standardization (validity and stability) and field test (palm software) of the *Battelle Developmental Inventory 2nd Edition (*BDI-2).

2002 Contract ($2000) with Riverside Publishing Company for national standardization (convergent validity and stability) of the *Stanford-Binet Intelligence Scale Fifth Edition.*

Trainings Attended

Cognitive Assessment System- Revised, *December, 2005,* Itasca, IL
Training: 12 hour training on the administration, scoring and interpretation of the *Cognitive Assessment System- Revised.*

American Psychological Association, *June 2005*, Chapel Hill, NC
Training: 40 hour Advanced Training Institute in Using Large-Scale Databases: The NICHD's Study of Early Child Care sponsored by American Psychological Association and Research Triangle Institute.

Battelle Developmental Inventory Train-the-Trainer Event, *August 2004,* Itasca, IL
Training: 16 hour training on the administration of the *Battelle Developmental Inventory 2nd Edition* and training on the presenting the assessment sponsored by Riverside Publishing Company.

Ending Violence against Women Training, *January 2003,* Greeley, CO
Training: 8 hour training on campus dating violence sponsored by the Department of Justice.

Battelle Developmental Inventory Training, *December 2002,* Little Rock, AK
Training: 12 hour training in administration of the *Battelle Developmental Inventory 2nd Edition* sponsored by Riverside Publishing Company.

Therapeutic Crisis Intervention Training, *July 2002,* Loveland, CO
Training: 30 hour training in therapeutic crisis intervention, behavioral techniques, and childhood restraint sponsored by Namaqua Residential Treatment Center.

PASS Theory and the Cognitive Assessment System, *May 2002*, Greeley, CO
Training: 8 hour training in theory and administration of the CAS system sponsored by Riverside Publishing Company.

Sexual Assault Prevention Training, *May 2002*, Montrose, CO
Training: 30 hour training in sexual assault prevention education and program evaluation sponsored by the Department of Justice.

Stanford-Binet Intelligence Scale Fifth Edition, *February 2002,* Denver, CO
Training: 8 hour training in administration of the *Stanford-Binet Intelligence Scale Fifth Edition* sponsored by Riverside Publishing Company.

Sexual Assault Advocate Training/Trainer, *January 2002,* Greeley, CO
Training: 30 hour training in sexual assault advocacy sponsored by University of Northern Colorado. Certified as a confidential sexual assault advocate and trained other advocate.