9-12-2014

Socioeconomic Status and Cognitive Outcomes: Mediating Role of the Home Environment

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THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Masters of Science

Psychology

The University of New Mexico

Albuquerque, New Mexico

July, 2014

ACKNOWLEDGEMENTS

I warmly acknowledge Sarah J. Erickson, my graduate advisor and thesis chair, for providing invaluable support both instrumental and emotional throughout the last three years of completing this project. Her guidance and mentorship have indelibly impacted my career and professional identity.

I also thank my committee members, Drs. Jean Lowe and Ron Yeo, for their many worthwhile suggestions and much assistance throughout the process. I offer additional thanks to Dr. Jean Lowe for welcoming me into her research group at the Mind Research Network and making it possible for me to contribute to an existing study.

To my undergraduate research assistants, Bronwyn Bedrick, Deborah Ramirez, Danielle Chavez, Vanessa Radoslovich, Yvonne Duarte, and Angela Matthew: thank you for helping to make the home visits a gratifying experience for families and for me, and for your help with managing data. Thank you very much to Joy Van Meter, the study coordinator for the CEREBRO Study, for providing invaluable help throughout this project in recruitment and data management.

Thank you to my family, friends, and colleagues, for your unwavering support.

SOCIOECONOMIC STATUS AND COGNITIVE DEVELOPMENT IN TODDLERS: THE MEDIATING ROLE OF THE HOME ENVIRONMENT

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ABSTRACT

Low socioeconomic status (SES) in early childhood is associated with increased risk for deficits in cognitive development. Early home environment quality has been shown to mediate between SES and cognition in toddlers from low-income families. This study explored the mediation of home environment quality between SES and cognition in socioeconomically diverse toddlers. 26 families completed a HOME interview (Home Observation for Measurement of the Environment). Child cognitive ability was assessed using the Bayley Scales of Infant Development. The Monte Carlo method for testing indirect effects was used to test for mediation of HOME standardized total scores between SES and developmental measures. Data demonstrated a significant mediation of home environment quality between family SES and toddlers' cognition. This study replicated past findings of significant mediation of home environment quality between SES and cognition. Findings uniquely extend previous evidence of this relationship in socioeconomically diverse and typically developing toddlers ages 18-40 months.

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CHAPTER 1: INTRODUCTION

Socioeconomic Status and Early Cognitive Development

Socioeconomic disadvantage in early childhood presents risks not only for physical health problems, higher rates of morbidity and mortality, loss of opportunity, and poor nervous system development, but also for failing to develop to one's full cognitive potential (Lipina & Colombo, 2009). Thus, impoverished children face myriad disadvantages, including reduced economic resources and opportunities in addition to risk for impairment in health, mental health, and cognition. Indeed, 65% of children with parents in the bottom fifth of the economic distribution remain in the bottom two-fifths into adulthood (Fass, Dinan, & Aratani, 2009). Reports of the detrimental impact of poverty on early cognitive development cite poorer scores on developmental quotients, standardized tests, verbal and achievement IQs, and school readiness, as well as a higher incidence of learning disorders and school absences, fewer years of school completion and more behavioral disorders (Bradley & Corwyn, 2002; McLoyd, 1998; Duncan, Brooks-Gunn, & Klebanov, 1994). For example, cognitive development was assessed in low- and middle-income preschoolers using the Woodcock-Johnson Achievement Test, the Peabody Individual Achievement Test, and the McCarthy Scales of Children's Abilities (Stipek & Ryan, 1997). Children from low-income families showed significantly lower scores than middle-income children on all indices. Motivation scores did not differ between groups, suggesting that group differences were not likely attributable to differences in effort.

The severity of poverty's impact on child development varies in relation to duration, timing, and developmental context. Stronger effects on IQ and behavioral disorders have been shown with longer duration of exposure rather than occasional incidents of poverty (Duncan, Brooks-Gunn, & Klebanov, 1994). Longitudinal studies have demonstrated that environmental deprivation effects associated with socioeconomic disadvantage vary in relation to both the amount and timing of deprivation as well as quality of individual developmental contexts (NICHD, 2003; 2005). Poverty during the preschool and early school years predicts lower rates of school completion than do experience of poverty only in later childhood and adolescence (Brooks-Gunn & Duncan, 1997).

Although no uniform method exists for operationally defining child poverty, it is most commonly measured using specific income levels (Minujin, Dealmonica, Davidziuk, & Gonzalez, 2006). Research has demonstrated that income impacts child development independently of parental education level (Duncan et al., 1994), suggesting that this index may be a valid individual predictor of developmental outcomes. However, research in recent years has demonstrated a significant relationship between other indices of SES and neurocognitive measures of development in early childhood. For example, neurocognitive assessments of children from diverse SES backgrounds that demonstrate SES-related disparities in cognitive measures (Noble, McCandliss, & Farah, 2007; Noble, Farah, & McCandliss, 2006, Noble, Norman, & Farah, 2005) have operationally defined poverty as a composite score that includes parental education, parental occupation, and parental income in terms of the income-to-needs ratio criteria (Hackman & Farah, 2008; Lipina & Colombo, 2009). Current conceptual definitions of poverty utilized by economists, sociologists, and developmental psychologists reference a set of psychological, physical and cultural needs, with a normative level of need satisfaction defining the level of disadvantage. Thus the definition of poverty results from a comparison between personal or family circumstances and a set of universal or absolute and specific needs and satisfiers. For example, an income-to-needs ratio is sometimes calculated from dividing the total family income by the federal poverty threshold based on family size (Roosa, Deng, Nair, Burrell, & Lockhart, 2005).

Some have argued for equal consideration of specific environmental factors impacting development in addition to income, such as low cognitive stimulation levels in the home, punitive parenting styles, and overcrowded living conditions, and other risk and protective factors present at home, at school, and in community institutions and organizations (Walker, Wachs, Grantham-McGregor, et al., 2011). Others have cited the importance of the amount of environmental privation and enrichment available during critical stages of brain development (Lipina & Colombo, 2009). Finally, some have advocated for the value of measuring subjective experiences of poverty, in order to characterize the effects of poverty on the psychological well-being of adults (Roosa, et al., 2005). Evidence also supports consideration of early home environment variables in predicting cognitive outcomes. For example, one study demonstrates a positive association between the number of years living in poverty, defined by income level, and the quality of the home environment, as defined by physical environment quality, parental emotional support, and opportunities for experiences away from the home (Garrett, Ng'andu, & Ferron, 1994). Researchers have also found that improvements in family income have strong effects on the quality of the home environment for children, particularly for those with the longest duration of time spent living in poverty (Garrett et al., 1994).

Effects of Poverty on Brain Development

In a review of the effects of poverty on brain development, Lipina and Colombo (2009) emphasize that material and social deprivation that is associated with poverty occurring in the earliest developmental stages can critically jeopardize brain structure and function, but also that early social and material stimulation can help mitigate these effects. Thus, within the sensitive periods for brain organization, a child's physical and social world may significantly influence neurocognitive outcomes. The peak of both synaptic overproduction and pruning vary according to cortical areas, and such differences in timing across different regions thus moderate the effects of environmental stimulation on neurocognitive development. For example, in the visual cortex synapse formation peaks between four and six postnatal months, followed by a gradual reduction toward adult ability levels between four and six years of age. In contrast, the rate of synapse formation in the prefrontal cortex and middle frontal gyrus is reached at about 12 postnatal months, and adult levels of development are not obtained until mid to late adolescence (Nelson, 2002).

Structural and functional organization of the cerebral cortex is also influenced by critical and sensitive periods. Critical periods refer to specific times during which either a brain structure or function develops quickly. During such periods specific stimuli are needed in order for the brain to progress through developmental stages; after critical periods end, acquisition of specific functions are much more difficult. Sensitive periods are times when the brain is particularly sensitive to specific kinds of external stimuli. During these periods the brain is especially receptive to experiences that influence brain organization, and after this window closes neural organization is irreversible (Thomas & Johnson, 2008). The influence of experiences on neural organization during early development is strongly related to molecular and cellular mechanisms that mediate neural plasticity during sensitive periods and that enable neural circuits to change in architecture, chemistry and gene expression (Knudsen, 2004). Changes during these sensitive periods tend to reinforce initial configurations as well as to limit the subsequent formation of different connectivity patterns. In such a way early experience is especially influential on the formation of neural circuits due to limited interference from preexisting connectivity patterns (Knudsen, 2004). Such findings, in conjunction with the existence of critical and sensitive periods, suggest that early childhood environments play a critical role in influencing neurocognitive development. As will be described in a later section, behavioral genetic investigations of cognition in early childhood suggest that SES may moderate the relationship between environmental nurturance or deprivation and early cognition (Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman, 2003), offering a more nuanced understanding of environmental influences on early brain development.

Developmental cognitive neuroscience research suggests that the effects of poverty on different domains of cognitive development vary according to maturation patterns of different neural networks. For example, both language and cognitive control or executive functioning systems are more susceptible to environmental influences than other cognitive systems (Lipina & Colombo, 2009). Some researchers have speculated that language and executive systems show the strongest SES-related disparities of all cognitive systems because both undergo a longer course of maturation than do other neural areas (Noble et al., 2005), suggesting a pronounced susceptibility of these systems to environmental influence. Thus, such systems may offer a potential window through which SES-related disparities in early development may be mitigated.

SES and Neuropsychological Test Performance

Noble, Farah, McCandliss, and colleagues have assessed neurocognitive systems in children from preschool through preadolescent ages in order to identify socioeconomic contributions to both performance on neuropsychological tests and patterns of neural activation (Farah, Shera, Savage, et al., 2006; Hackman & Farah, 2008; Noble et al., 2007; Noble et al., 2006; Noble et al., 2005; Noble, Wolmetz, Ochs, Farah, & McCandliss, 2006b). These studies demonstrated that socioeconomic disadvantage is associated with poorer performance on measures of language and executive functioning across all of childhood, with relatively fewer SES-related disparities indicated in visual cognition, visuospatial skills, memory, or spatial ability. SES has also been shown to modulate children's brain activity while reading, speaking and listening. Functional magnetic resonance imaging (fMRI) studies have revealed an interaction between SES and phonological awareness and activation of the left fusiform brain area, a region associated with reading skill, in first to third-grade children (Noble et al., 2006b). Specifically, the relationship between phonological language skill and activation of this region is attenuated as SES increases, suggesting that SES can influence the relationship between standardized measures of phonological awareness and reading-related brain activity. One possible interpretation of such a finding is that environments with higher levels of literacy support resources may reduce the influence of individual differences in activation patterns and phonological abilities. Finally, SES has also been shown to interact with phonological awareness in predicting decoding ability (Noble et al., 2007, Noble et al., 2006).

SES, Language, and Executive Functioning

Executive functioning refers to a system including both basic cognitive processes like memory and attention, and the ability to plan and execute goal-directed behavior (Blair, 2002), and has been described as the cognitive system that controls and manages all cognitions and behaviors (Carlson, 2005). Executive functioning skills include planning, working memory, attention, problem solving, verbal reasoning, inhibition, mental flexibility, and goal-directed behaviors. Several core categories of executive functioning in early child development have been explored in relation to socioeconomic risk, and include (a) working memory: "the ability to hold and manipulate complex information in the mind" (pg. 120), (b) inhibitory control: the ability to delay a well-learned response in favor of a more appropriate behavior, and (c) cognitive flexibility: the ability to adapt behavior appropriately across changing situations (Sarsour et al., 2011). SES significantly predicts all of these executive functioning abilities as measured by behavioral tests. For example, children from higher SES families have demonstrated significantly greater improvements in accuracy on a measure of cognitive control in response to alerting cues, in comparison to low-SES children, while low-SES children consistently perform less proficiently under all conditions (Mezzacappa, 2004). Other studies have demonstrated similar findings of SES-modulated performance on measures of working memory and inhibitory control (Diamond, 1985).

Research suggests that many language abilities are detrimentally impacted by poverty status. For example, two to three year-old children from lower SES backgrounds have been shown to build their vocabularies at slower rates than children from higher SES homes (Hoff, 2006). SES has also been shown to predict spontaneous speech ability, as measured by the Peabody Picture Vocabulary Test (Qi, Kaiser, Milan, & Hancock, 2006), as well as to modulate performance on measures of grammatical development, communicative styles and skills, and arithmetic word problems (Hoff, 2006). In a low-income sample of three year-old children, Stanton-Chapman, Chapman, Kaiser, and Hancock (2004) found that for each social and family risk factor present at birth, girls' language scores on measures of receptive and expressive language decreased by 2.3 points on a 48-point scale, while boys' scores decreased by 1.1 points.

Language, executive functioning, and overall cognitive development in early childhood have all been shown to predict important life outcomes from childhood into adulthood. Language ability is a critical precursor for development of both language and non-language academic skills, including mathematics, reading, and overall school readiness (Dieterich, Assel, Swank, Smith, & Landry, 2006). Early executive functioning abilities and language development, such as working memory, cognitive flexibility, and phonological processing, are fundamentally tied to many critical cognitive abilities throughout the lifespan (Lipina & Colombo, 2009). For example, both language and executive functioning are significant determinants of school readiness (Blair, 2002) while superior executive functioning and self-regulatory abilities have been cited as critical factors in predicting positive life outcomes in the presence of socioeconomic disadvantage (Buckner, Mezzacappa, & Beardslee, 2003). Furthermore, delayed development of executive functioning in early childhood has been shown to predict developmental psychopathology, physical aggression, and cortisol reactivity (Sarsour et al., 2011). Blair and Razza (2007) found that in low-income three to five year-old children, inhibitory control, effortful control and false belief, or the understanding that individuals may believe and act upon false beliefs, and attention-shifting aspects of executive function, each accounted for unique variance in arithmetical and literacy measurements, independently of general intelligence measures. Inhibitory control was also a significant correlate of both early math and reading ability. An exploration of long-term cognitive outcomes as predicted by early environmental risk factors such as home conditions and parental divorce found that differences in adult cognitive ability were mostly explained by the effects of early risk on early childhood cognitive ability (Richards & Wadsworth, 2004). Thus, socioeconomic disadvantage may increase the risk of underdevelopment of skills necessary for literacy, academic performance, and lifetime achievement.

Relationship Between Executive Functioning and Language Development

Researchers have speculated that language skills may mediate the relationship between SES and executive functioning development (Noble et al., 2005, 2007). For example, neurocognitive studies of Kindergarten children found that while both SES and language abilities predicted executive functioning abilities, SES did not account for any variance in executive functioning ability over and above that predicted by language ability (Noble et al., 2006). Landry, Miller-Loncar, Smith, & Swank (2002) found that mothers' verbal instruction at three years of age indirectly influenced working memory, cognitive flexibility, and goal-directed behavior at six years by directly influencing children's language and nonverbal problem solving skills at four years of age, further suggesting a mediating role of language ability in the relationship between SES-related disparities in environmental stimulation and executive functioning. However, at least one exploration of this mediational relationship using measures of expressive language skills in school-aged children failed to validate this model (Sarsour et al., 2011). The current study explores the mediating role of language in this relationship in toddlers ages 18 to 40 months.

SES and the Importance of the Early Environment

Behavioral genetic research suggests that the early environment may be of particular significance for children in low SES environments in influencing early cognitive development. Studies of IQ in monozygotic and dizygotic twins between the ages of 10 months and 7 years raised together and apart (Turkheimer et al., 2003) found that in impoverished families the shared environment accounts for 60% of the variance in IQ, while the contribution of genes to this variance is negligible; the opposite profile of results was found in high-SES children. Results suggest that environmental factors are significant determinants of early cognitive development particularly for children in low-socioeconomic status families, and also that genetic potential for learning may be more fully realized when children are provided with sufficient resources (Noble et al., 2005). These SES-related differences in the heritability of IQ have been shown to emerge at two years of age, suggesting a possible increase in the importance of environmental variables in influencing cognitive outcomes starting at this age (Tucker-Drob, Rhemtulla, Harden, Turkheimer, & Fask, 2011).

Pathways and Mediators Between SES and Cognitive Outcomes

A number of pathways have been explored in determining how SES impacts cognitive outcomes in childhood. The main categories of mediators that have received research support include pre and perinatal health and nutrition, exposure to environmental toxins, malnutrition, housing quality, physical home environment, cognitive stimulation in the home environment, parenting behaviors and parenting stress, and neighborhood factors (Bradley & Corwyn, 2002; Guo & Harris, 2000; Lipina & Colombo, 2009). Of course, the constructs of poverty and child development are multifactorial, dynamic, and highly complex, which complicates explorations of their relationship (Hoff, Laursen, & Tardif, 2002). Furthermore, accurate determination of potential mediating constructs is also complicated because SES necessarily co-occurs with other environmental conditions that are likely to impact child cognitive development, such as ethnic minority status and living in a single-parent home (Lipina & Colombo, 2009). As previously described, behavioral genetic research offers one perspective for partitioning variance in developmental outcomes into influence from genes and influence from environment, and demonstrating a pathway from family SES to early cognition (Turkheimer et al., 2003). From this perspective, genetic mutations and heritable characteristics on one hand and environmental factors such as SES on the other individually and interactively contribute to early cognition.

Despite the aforementioned complications in studying SES and child development, low SES in early childhood has consistently been found to be associated with mediating variables that predict poor cognitive outcomes (Bradley &

Corwyn, 2002). For example, low SES predicts increased risk for premature birth, birth defects, perinatal complications, and postbirth infections, all of which negatively impact cognitive and academic performance (Bradley & Corwyn, 2002). Children in low income homes are more likely to be exposed to toxic agents such as lead (Hubbs-Tait, Nation, Krebs, & Bellinger, 2005), which in turn has been associated with poor executive functioning abilities (Canfield, Kreher, Cornwall, & Henderson, 2003). Economic disadvantage is also strongly associated with underweight status that in turn predicts poorer cognitive outcomes that are likely to endure throughout both childhood and adolescence (Brooks-Gunn & Duncan, 1997; McLoyd, 1998). Poor nutrition for pregnant mothers can affect prenatal brain growth and thus contribute to poor school achievement in childhood (Brooks-Gunn & Duncan, 1997). Institutional resources such as schools, child care, medical services, and employment opportunities have also been proposed as mediators between SES and child cognitive outcomes (Leventhal & Brooks-Gunn, 2000). For example, poorer children are more likely to attend schools that lack resources, fail to expect or encourage high achievement from their students, and have poor classroom behavior standards (Bradley & Corwyn, 2002; Brooks-Gunn & Duncan, 1997).

Socioeconomic disadvantage has been shown to increase the prevalence of stressors that parents face, which in turn produces psychological distress for parents that reduces their ability to provide sensitive and responsive care, and increases their chances of utilizing punitive and coercive parenting styles (Bradley & Corwyn, 2002; McLoyd, 1998). Specifically, poverty is associated with parental experiences of threats, exposure to environmental dangers, family and community violence and abuse, family dissolution, moving, unemployment, employment uncertainty, and persistent economic privation (Bradley & Corwyn, 2002), which are all associated with socioemotional and self-regulatory dysfunction in both adults and their children (Brooks-Gunn & Duncan, 1997; McLoyd, 1998). Chronic exposure to stress as well as decreased social support may result in allostatic loading, or the constant activation and deactivation of physiologic responses to stressful events, which in turn may lead to long-term health and mental health consequences such as persistent high blood pressure (Bradley & Corwyn, 2002). Furthermore, increased negative emotionality that is associated with stress such as anxiety, depression, and anger could in turn impact interactions among family members and lead to negative parenting strategies, more negligence, and less sensitivity to children's needs (McLoyd, 1998). Daily strains of economic pressure can also lead directly to low levels of parental nurturance, and reliance on uninvolved, inconsistent, and harsh parenting (Conger & Donnellan, 2007).

Physical and social aspects of the home environment have also been implicated in predicting and impacting cognitive outcomes. The HOME inventory (Bradley, 1994) has been utilized in studies of cognitive development in Africa, Asia, Australia, Europe, Latin America, the Caribbean, and the United States, to identify significant relationships between home environment conditions and cognitive outcomes in infancy through adolescence. Across diverse cultures, measurements of parental stimulation, including availability of learning materials, parental involvement, and responsiveness, all significantly predict children's cognitive development (Bradley & Corwyn, 2005; Bradley, Corwyn, & Whiteside-Mansell, 1996; Farah, Betancourt, Shera, et al., 2008), and have shown significant relationships with such demographic variables as the amount of crowding in the home and birth order (Bradley & Caldwell, 1984). In a review of outcomes of children from the Early Childhood Longitudinal Study (ECLS-K), a nationally representative sample of 21,260 children enrolled in 944 Kindergarten programs during the 1998-1999 school year, researchers demonstrated support for a model that showed unique parent-mediated paths from income to cognitive skills in math, reading, and overall academic achievement (Gershoff, Aber, Raver, & Lennon, 2007). Specifically, parental provision of cognitively stimulating materials in the home and opportunities for activities outside of the home, as measured by the HOME scale, extracurricular activities, and parental involvement in school, all uniquely predicted cognitive abilities after controlling for income.

The early environment has also been demonstrated to significantly mediate between SES and cognitive outcomes in teenagers. For example, Guo & Harris (2000) explored the roles of various early environmental factors in mediating the effects of poverty on children's intellectual development at ages 14 to 21 years. Their results indicated that cognitive stimulation in the home is the strongest intervening mechanism for this relationship, though parenting style, physical home environment, and poor child health at birth, also demonstrated a significant mediating role. The mediating roles of cognitive stimulation and emotional support within the home environment in the relationship between poverty and achievement in mathematics and reading has also been demonstrated for adolescents age twelve to fourteen years (Eamon, 2002). Additionally, in a large ethnically diverse sample of toddlers born low-birth-weight and premature, families' provision of stimulating experiences in the home as measured by the HOME scale mediated between family income and child cognitive ability at ages 3 and 5 (Linver, Brooks-Gunn, & Kohen, 2002). The consistency of these findings from early childhood through adolescence suggests the importance of these early home environment factors in mediating risk across all of childhood.

Of note, none of the above studies assessing home environment quality employed a design that allowed for determining the individual or interactive causal effects of SES or home environment quality on child development. In particular, none of the studies addressed the potential issue of gene-environment covariation. For example, it is possible that higher SES parents who provide genetic material fostering optimal cognitive development also provide high quality home environments, without the home environment playing a causal role in cognitive development. The present study's design similarly precluded an exploration of causal relationships, but attempted to replicate previous findings of home environment quality mediating between SES and early cognition, specifically in toddlers ages 18-40 months.

Parenting Behaviors, Language and Executive Functioning

Among environmental mediators that lead to SES-related disparities in cognitive outcomes, some research has emphasized that low SES is associated with parenting behaviors lacking in stimulation for the development of language and executive functioning. For example, a recent review of SES and parenting behaviors (Hoff, et al., 2002) found that higher SES parents across diverse cultures converse more with their children and more frequently elicit pleasant conversation, while lower SES mothers do not often engage in conversation with their children, instead speaking to them mostly with the sole purpose of directing behavior. Furthermore, parents in higher SES homes also engage in richer verbal conversations with their children in terms of linguistic content, sensitive answers, and involvement (Hoff et al., 2002), while their teaching and support of their children's learning relies on a more supportive style as well as more complex verbal strategies for communication (Bradley & Corwyn, 2002). An investigation of SES-related differences in expressive vocabulary development in two year-olds showed that high-SES children gained more than mid-SES children in the size of their productive vocabularies over a period of ten weeks, and that such differences were accounted for by maternal patterns of speech in regards to the number of words and word types produced (Hoff, 2003). Other cross-cultural studies have demonstrated that parents from higher SES homes utilize more verbal communication with their children as well as provide more learning opportunities both inside and outside the home (Bradley, Corwyn, Burchinal, McAdoo, & Coll, 2001). Mezzacappa et al. (2004) have demonstrated that low-SES children receive little parental instruction that is associated with the development of executive functioning abilities; children from low-SES homes show lower performance on measures of working memory, inhibitory control, and cognitive flexibility. Landry, Miller-Loncar, Smith, & Swank (2002) found that mothers' scaffolding, or verbal input that provides children with information about associations between objects, concepts and actions, at three years of age predicted both the executive functioning components of working memory, cognitive flexibility, and goal-directed behavior, as well as language and nonverbal problem solving skills at age six.

The Early Home Environment, Language, and Executive Functioning

In addition to mediating overall cognitive development indices, the quality of the home environment as measured by the HOME scale has been shown to mediate between socioeconomic disadvantage and language in the first three years of life (Rodriguez, Tamis-LeMonda, Spellmann, et al., 2009) and socioeconomic disadvantage and executive functioning in 8 to 12 year-old children (Sarsour et al., 2011). Studies by the National Institute of Child Health and Human Development (NICHD) and Early Child Care Research Network (2003, 2005) have shown that the quality of the home environment, as defined by the availability of stimulating learning materials and toys, behavioral provision of learning stimulation by parents, and parental responsivity and sensitivity, predict children's abilities in inhibitory control, planning, and sustaining attention, suggesting that such variables may be significant mediators of the relationship between SES and cognitive outcomes. Furthermore, such home environment factors have been shown to predict cognitive outcomes more strongly than either child care or school qualities. A study of the long-term effects of early risk demonstrated that material home conditions, maternal care, and the experience of parental divorce strongly predicted lower cognitive ability in terms of verbal ability, memory, processing speed and concentration in childhood, adolescence, and midlife (Richards & Wadsworth, 2004). Such findings attest to the long-term consequences on critical cognitive abilities of early risk factors associated with economic disadvantage.

Present Study and Hypotheses

A primary goal of this study was to test the mediating role of the early physical and social home environment in the relationship between SES and cognitive outcomes for typically developing and medically healthy toddlers ages 18 and 40 months. Specifically, we hypothesized that 1) HOME total score would significantly mediate between SES and all cognitive outcome measures: cognitive score, language composite score, and executive functioning measures. 2) We predicted that the HOME score would more strongly mediate between SES and all cognitive outcomes for low SES families versus high SES families. 3) We also hypothesized that language ability would mediate the relationship between SES and executive functioning. 4) Finally, we predicted that parenting stress would significantly mediate the relationship between SES and all cognitive outcomes.

CHAPTER 2: METHOD

Sample and Participant Selection

Participants included children between the ages of 18 and 40 months and their primary caregivers. Children were born between 2009 and 2011. They were recruited from a community sample of 60 families who participated in a longitudinal study in which their toddlers had been previously assessed on cognitive development and had participated in an fMRI scan at 4, and 9 months; some had also already completed a scan at 18 months at the time of the home visit. Data about the home environment and parenting stress were collected through a home visit and several questionnaires completed by the child's caregiver. Neuropsychological evaluations of the child were conducted either during the home visit or at a separate appointment conducted at the MIND Research Network in Albuquerque, NM. Children within the study sample were 37.5% White, 33.3% Hispanic, 12.5% Native American, 0% African American, 0% Asian, and 16.7% of two or more minority races (including combinations of Hispanic, African American, Asian, and Native American races). Approximately 29.2% of families were at or below the national poverty level based on family size, while approximately 25% of families were at or above three times the national poverty level, with 45.8% of families in the study having an intermediate income level (USDHHS). Mothers' mean age at the time of the child's birth was 29.8 (SD=7.0), with a range of 17 to 44, and the mean number of people in the household was 4 (SD=1.29) with a range of 2 to 8. Demographics are summarized in Table 1.

Measures

Sociodemographic Variables

Demographic variable data collected included family income, maternal education, child and caregiver ethnicity and parental occupation. Caregivers indicated yearly income by selecting one of seven choices: 1) from $0 to $10,000, 2) between $10,001 and $20,000, 3) between $20,0001 and $30,000, 4) between $30,001 and $40,000, 5) between $40,001 and $50,000, 6) between $50,001 and $60,000, and 7) greater than $60,000. Maternal and paternal education were indicated by caregiver self-report as one of seven different choices: 1) less than 12th grade, 2) high school graduate, 3) 1 year of college, 4) an Associate's degree, 5) a B.A., 6) some graduate school, or 7) Masters degree or higher. Caregivers were asked to indicate both parents' ethnicity, selecting as many as they saw fit from among 1) Caucasian, 2) African American, 3) Hispanic/Latino, 4) Asian American, 5) Native American, or 6) Other, with a blank space provided. Caregivers were also asked to indicate their current occupations. After data were collected, all occupations that were provided were given a numerical code on a scale from 1-9, with higher numbers indicating higher levels of occupational social status (Hollingshead, 1975): 1) farm laborers, menial service workers, students, housewives, dependent on welfare, or no regular occupation, 2) unskilled workers, 3) machine operators and semi-skilled workers, 4) smaller business owners, 5) clerical and sales workers, small farm and business owners (business valued at $25,000-50,000, 6) technicians, semi-professionals, small farm and business owners (business valued at $50,000-$75,000, 7) medium size business owners, farm owners, managers, minor professionals, 8) administrators, lesser professionals, proprietors of medium-sized businesses, 9) higher executive, proprietors of large businesses, major professionals.

Home Environment

The Infant/Toddler Home Observation for the Measurement of the Environment inventory (HOME) was used as a measure of home environment quality for toddlers ages 18-36 months, while the Early Childhood HOME inventory was used to assess home environment quality for toddlers ages 36-40 months. The HOME scale was administered via a semi-structured interview at family homes by trained doctoral students in clinical psychology and trained undergraduate research assistants. The HOME scale is intended to measure both the quality and frequency of cognitive stimulation and emotional support provided to a child in his or her home environment. The Infant/Toddler HOME Inventory contains 45 binary items clustered into six categories: parental responsivity, parental acceptance, organization of the home environment, learning materials, parental involvement, and variety of experiences. The Early Childhood HOME Inventory contains 55 binary items clustered into eight categories: learning materials, language stimulation, physical environment, parental responsivity, academic stimulation, parental modeling of behaviors, variety of experiences, and parental acceptance.

These subscales were validated using data from six large national longitudinal data sets, including the Infant Health and Development Program (IHDP), the National Longitudinal Study of Youth-Child Supplement (NLSY-CS), the NICHD Study of Early Child Care (NICHD-SECC), the Early Head Start Research and Evaluation Project (EHS), the Panel Study of Income Dynamics—Child Development

Supplement (PSID-CDS), and the Project on Human Development in Chicago Neighborhoods (PHDCN) (Linver, Brooks-Gunn, & Cabrera, 2004). Such databases were selected due to their representation of diverse populations and generalizability to the U.S. population. In 2004, new HOME subscales were created using three steps: 1) items were together based on theoretical relatedness rather than factor analyses, 2) items with item-to-subscale correlations lower than .25 were eliminated, and 3) subscales with alpha levels below .50 were also eliminated. These changes were intended to address a previous lack of consistency of items within each subscale, and an inability of scores to discriminate among families. In assessments of the predictive validity of new subscales on the Infant-Toddler and Early Childhood HOME scale, each was found to correlate significantly with select cognitive and behavioral outcomes in each of the six national longitudinal data sets using both zero-order and partial correlations, with the latter being utilized to control for family sociodemographic characteristics (Linver, Martin, & Brooks-Gunn, 2004).

Child Neurocognitive Abilities

All participants were assessed on overall cognitive development, receptive and expressive language, and the executive functioning components of behavioral inhibition and cognitive flexibility.

Overall Cognitive Score. The Bayley Scales of Infant Development-III (BSID-III; Fernandez & Zaccario, 2007) were used to assess cognitive development, with the overall cognitive score used as a proxy for this index. The Bayley-III is widely used to measure cognitive and language abilities of children and has well-developed norms. The Bayley Mental Developmental Index (MDI), from which the

Bayley-III was derived, has demonstrated test-retest reliability and correlates with other measures of child cognitive abilities (Bayley, 1993).

Language Ability. The BSID-III Receptive and Expressive Language scores were used as measures of language ability.

Cognitive flexibility. The Bear/Dragon test was used to assess children's ability to alternate between different tasks in response to changing stimuli (Reed, Pien, & Rothbart, 1984). This test requires children to respond differently to the commands of two different puppets. Specifically, they are instructed to obey all requests given by the Bear, and ignore all commands made by the Dragon. The dependent variable of interest is the number of correct responses the child produces before four consecutive errors are made (Carlson, Moses, & Claxton, 2004).

Inhibitory control. The Gift Delay task was used to measure children's abilities to inhibit prepotent responses (Kochanska, Murray, & Harlan, 2000). In this test, children are told that they will be receiving a present shortly but that they need to turn around and face the wall while the experimenter wraps it. The measures of interest in this test are the amount of time the child can wait before turning around and viewing, touching, or trying to open the present.

Parenting Stress

The Parenting Stress Index – Short Form (PSI –SF) was used to assess parenting stress. The PSI is designed to assess the level of stress that parents experience in relation to parenting. It includes three components with twelve items each: parental distress, parent-child dysfunctional interaction, and difficult child (McKelvey, Whiteside-Mansell, Faldowski, et al., 2009). The PSI-SF has been shown to be both a reliable and valid measure of parenting stress in parents of typically developing children (Abidin, 1995). Abidin (1995) has reported internal reliability coefficients as measured by Cronbach's alpha between .80 and .87 for the three subscales.

CHAPTER 3: RESULTS

A total of twenty-eight families agreed to participate in a HOME interview, and 24 completed the study. Of those not included in analyses, two completed the interview more than a year after their most recent Bayley developmental assessment and declined to complete a subsequent evaluation. Additionally, one participant was observed to engage in many behaviors consistent with a diagnosis of Autism Spectrum Disorder. Another child was known to have been abused by her father and had been recently separated from both parents due to her father being incarcerated and her mother losing child custody. Thus, the HOME interview did not likely represent the home environment in which the child had grown up, as she was living with her grandmother and uncle at the time of the interview. The intent of this study was to explore relationships between environmental risk and developmental outcomes in typically developing children in relatively stable home environments. Thus, these latter two participants were not included in analyses.

In order to test the strength of the mediation, or indirect effect of independent variables through mediating variables on outcomes of interest, the Monte Carlo method was used (Preacher & Selig, 2012). This method generates a sampling distribution of the indirect effect by using point estimates of component statistics, "along with the asymptotic covariance matrix of these estimates and assumptions about how the component statistics are distributed (Preacher & Selig, 2012, pp. 82-83)." These components include the unstandardized regression coefficients for the relationships between the independent variable and the mediator and between the mediator and dependent variable, as well as the standard errors for each. A confidence interval is then determined on the basis of the sampling distribution generated, which can then be used as evidence for or against the null hypothesis. Such a method has demonstrated several advantages over other methods of testing indirect effects in ease and greater feasibility of use for a wider range of data sets, while producing comparable results (Preacher & Selig, 2012). Importantly, this method does not require that the independent variable have a significant effect on the dependent variable independently of the mediating variable, thus allowing for testing of mediation across a wider range of data sets (Hayes, 2009). Because of this, mediation analyses for this study were guided by evidence of a significant relationship between the independent variable and the mediator and between the mediator and dependent variable, regardless of whether the independent variable significantly influenced the dependent variable. In the present analyses, SES represents the independent variable, home environment quality the mediator, and developmental measures the dependent variables.

Due to the small sample size, exploratory correlations were sometimes conducted as preliminary guides to mediation analyses. Of particular note, all results must be interpreted with caution due to the small sample size; lack of support for hypotheses may not necessarily indicate a lack of expected relationships between variables, but may have resulted from low power.

Preliminary Analyses

Variable distributions were examined for independent variables (SES composite, family income level, parental occupation levels, and parental education levels), dependent variables (Bayley cognitive and language composites, Gift Delay, Bear Dragon, and Snack Delay), and the mediating variable (HOME total standardized score).

Departures from normality were checked using indices of skewness and kurtosis. One dependent variable, seconds until opening the gift on the Gift Delay, had a kurtosis value of 19.00, indicating very minimal variance, and thus this variable was not included in analyses. Other non-normal variables were adjusted using log transformations. For example, seconds until touching on the Gift Delay had a kurtosis value of 3.628, which is above the cutoff of 3 to indicate an acceptable level of variance (Field, 2009), and thus this variable was transformed. Subsequent analyses were conducted using both transformed and non-transformed data to verify results.

Home Environment Quality as Mediator Between SES and Cognitive Development

The primary hypothesis of this study was to explore whether the quality of the home environment, as measured by the HOME scale, would mediate between SES and cognitive outcomes. The Monte Carlo method for testing indirect effects was used to test a mediation of HOME standardized total scores between SES composite and Bayley cognitive composite (Preacher & Selig, 2012). SES accounted for 22% of variance in HOME standardized total scores (R^2=.220, $F(1,23)$= 4.869, $p < .05$) for a small effect size of .28. (With the sample size of 24 and at a power level of .8, a medium effect size of .36 was possible for all analyses that included the whole sample). HOME scores explained 27% of variance in cognitive composites (R^2=.267, $F(1,23)$= 8.000, $p < .05$) for a medium effect size of .36. Results indicate that the indirect effect of SES on Bayley cognitive score through HOME standardized score was not zero by a 95% confidence interval based on 20,000 repetitions (.3322 to 6.22). Thus, data support mediation of the effects of family SES on toddlers' cognition by quality of home environment. In other words, results indicate a significant indirect effect of income on toddlers' cognition as mediated by the quality of the home environment.

Additionally, Pearson correlation coefficients were calculated to investigate the relationship between SES and HOME measures (see Table 2), and between HOME measures and Bayley cognitive composite (see Table 3). SES measures that made up the SES composite included family income, parental occupation levels, and parental education levels. Income level was found to correlate significantly with HOME total standardized score ($r(24)=.426$, $p<.05$), which was found to account for a significant amount of variance in cognitive composite. Thus, The Monte Carlo method was used to test a mediation of HOME standardized total scores between income level and Bayley cognitive composites. Income accounted for 18% of variance in HOME standardized total scores ($R^2=.181$, $F(1,23)= 4.869$, $p < .05$), with a small effect size of .22. Again, HOME scores explained 27% of variance in cognitive composites ($R^2=.267$, $F(1,23)= 8.000$, $p < .05$), with a medium effect size of .36. Results indicated that the indirect effect of income on Bayley cognitive score through HOME standardized score was not zero by a 95% confidence interval based on 20,000 repetitions (0.04141 to 1.857). Thus, data supported mediation of the effects of family income on toddlers' cognition by quality of home environment.

Paternal education level was also found to correlate significantly with HOME total standardized score ($r(24)=.560$, $p<.005$). Paternal education level accounted for 31% of variance in HOME standardized total scores ($R^2=.314$, $F(1,23)= 10.058$, $p < .005$), with a medium effect size of .45. This exceeded the minimum possible effect from this sample size at a preselected power level of .8, which lends further support to this finding that paternal education significantly influenced home environment quality. The indirect effect of paternal education level on Bayley cognitive score through HOME standardized score was not zero by a 95% confidence interval based on 20000 repetitions (.3251 to 3.097). Thus, data support mediation of the effects of paternal education on toddlers' cognition by quality of home environment.

Five of the families in the study received the Early Childhood HOME interview for children over 36 months, which includes additional subcomponents of the HOME scale that are not included in the Infant Toddler HOME interview for families with children under 36 months. Some of these subcomponents were found to significantly correlate with some SES measures (see Table 3). However, because only five families were administered interview items from these additional components, mediation analyses were not conducted using these data.

Home Environment Quality as Mediator Between SES and Language

The Monte Carlo method was used to test the mediation of HOME standardized total scores between SES composite and Bayley language composite (Preacher & Selig, 2012). As stated previously, SES accounted for 22% of the variance in HOME standardized total score (R^2=.220, $F(1,23)$= 6.208, $p < .05$) with a small effect size of .28. HOME scores explained 9% of variance in language composites (R^2=.094, $F(1,22)$= 2.187, $p = .154$), with a small effect size of .11. The indirect effect of SES on language composite through HOME total standardized score was shown to be nonsignificant by a 95% confidence interval based on 20,000 repetitions (-.7513 to 7.602) and mediation of home environment quality between SES and language ability was not supported.

Correlation coefficients were also calculated between all measures of language (receptive language scaled score, expressive language scaled score, and language composite) and all standardized scores for subcomponents of the HOME scale, as well as with the total standardized score. Language measures did not correlate significantly with any HOME standardized scores (see Table 3).

Home Environment as Mediator Between SES and Executive Functioning

Participants who most recently completed a developmental evaluation and HOME interview between ages 18 and 22 months were administered, at the time of testing, the Snack Delay task as a measure of executive functioning, while those who most recently completed a developmental evaluation at ages 30 to 34 months were administered the Bear Dragon and Gift Delay tasks. Because only four out of twenty-four individuals completed developmental evaluations at ages 18-22 months, they were omitted, and only those twenty participants who completed their most recent developmental evaluation at 30-34 months, including Bear Dragon and Gift Delay, were included in analyses involving executive functioning. Due to extremely low variance in seconds until gift open, with only one participant actually opening the present before the two minutes were up, this measure was neither transformed nor included in analyses, as stated previously.

The Monte Carlo method was used to test the mediation of HOME standardized scores between SES and executive functioning (EF) measures. The indirect effect of SES composite on executive functioning as mediated by HOME total standardized score was not significant for gift peek, gift touch, or Bear Dragon total score (see Tables 4 and 5).

Pearson correlations were also performed to investigate the relationship between each measure of SES and each measure of executive functioning (see Table 6), in order to explore whether additional indirect effects of SES on EF by HOME should be conducted.

The only significant relationships found were a negative correlation between maternal education level and seconds until peeking at the gift during the Gift Delay, and a negative relationship between paternal occupation level and the number of seconds until touching the gift during Gift Delay. Thus, contrary to expectations, higher maternal education and paternal occupation predicted poorer behavioral inhibition in this sample, in the context of obeying instructions to not look at or touch a gift they were about to be given during a two-minute delay.

Because maternal education was significantly correlated with seconds until peeking, regression analyses were conducted to assess whether this socioeconomic variable had a significant effect on the HOME score, and whether the HOME scale significantly impacted seconds until peeking. Maternal education level accounted for 14% of the variance in HOME standardized total score (R^2=.139, F(1,23)= 3.540, *p* =.073), with a small effect size of .16. HOME standardized scores explained 2% of variance in seconds until peeking at the gift (R^2=.015, F(1,18)= .259, *p* = .618) indicating no effect. Because both regression coefficients were not significant, a test for mediation was not justified. Thus, if higher maternal education is associated with poorer behavioral inhibition, current data suggests that it is not likely to be mediated by home environment quality as measured by the HOME scale.

Because paternal occupation was significantly correlated with seconds until touching the gift, regression analyses were conducted to assess whether paternal occupation significantly influenced the HOME score, and whether the HOME score significantly impacted seconds until touching the gift. Paternal occupation level accounted for .8% of variance in HOME standardized total score (R^2=.008, F(1,20)=

.145, *p* =.707) and HOME standardized scores explained 7% of variance in seconds until touching the gift (R^2=.069, F(1,18)= 1.254, *p* = .278), with neither regression coefficients showing an effect. Because both regression coefficients were not significant, a test for mediation was not justified. Data thus suggest that if higher paternal occupation is associated with poorer behavioral inhibition, this relationship is not likely to be mediated by home environment quality.

Additional Testing of Primary Hypothesis using HOME Subcomponents

Pearson correlations were conducted to explore relationships between subcomponents of the HOME (parental responsivity, parental acceptance, home organization, learning materials in the home, parental involvement, and variety of experiences) and all SES measures (see Table 2) and between subcomponents of the HOME and all cognitive outcomes (see Table 3), with the purpose of exploring whether individual subcomponents of the HOME scale would be better suited then the overall HOME standardized score for mediation analyses of home environment quality between SES and developmental outcomes. Responsivity was significantly correlated with cognitive composite (r(24)=.516, *p*<.01), but was not significantly related to any SES measure, thus, testing of a mediation of Responsivity between SES and Bayley cognitive composite was not justified.

Learning Materials standardized score was found to correlate significantly with seconds until touching the gift (r(19)=.479, *p*<.05) (see Table 3**)** and with the following SES measures (see Table 2): SES composite (r(24)=.532, *p*<.01), income level (r(24)=.537, *p*<.01), maternal education level (r(24)=.443, *p*<.05), and paternal education (r(24)=.539, *p*<.01). Thus, the Monte Carlo method was used to test the mediation of

Learning Materials standardized score between each component of SES with which it was associated, and with seconds until touching the gift (see Tables 7-9**)**.

Using the nontransformed variable of gift touch, the indirect effect of SES on gift touch was found to be nonzero by a 95% confidence interval based on 20,000 repetitions for several SES measures as mediated by Learning Materials (see Table 9): SES composite (1.065 to 29.66), maternal education (.09677 to 10.71) and paternal education (.5065 to 13.44). However, a repetition of these same analyses using log transformations of both Learning Materials and gift touch, both of which had non-normal distributions, indicated that that the indirect effect as mediated by Learning Materials was zero (see Table 9). Thus, when altering the data so that the assumption of normality, that is implicit in regression analyses, was satisfied, a significant indirect effect was no longer found. In other words, the significant mediation by Learning Materials of SES on gift touch was not robust and likely inaccurate.

Secondary Hypotheses

A secondary hypothesis (hypothesis 3) concerned whether language ability mediated between SES and executive functioning. First, correlation coefficients were calculated between all measures of SES and all language ability measures (see Table 3). Language composite was found to significantly correlate with both SES composite ($r(23)=.504$, $p<.05$) and income level ($r(23)=.575$, $p<.005$), but with no other SES measures. Receptive language correlated significantly with SES composite ($r(22)=.518$, $p<.05$), income level ($r(22)=.547$, $p<.01$), and maternal occupation level ($r(16)=.523$, $p<.05$). Similarly, expressive language was also significantly correlated with SES composite ($r(22)=.526$, $p<.05$) and income level ($r(22)=.561$, $p<.01$). Pearson correlations were also conducted to assess relationships between language measures and executive functioning measures (see Table 10) and no relationships were significant. Due to the lack of a relationship between language and executive functioning, testing of the mediation of language between SES and executive functioning was not justified.

Another secondary hypothesis (hypothesis 4) included in analyses was whether parental stress mediated between SES and cognitive outcomes. First, Pearson correlation coefficients were calculated between each measure of parental stress (Personal Resources Questionnaire (PRQ), the State-Trait Anxiety Inventory (STAI) and the Parenting Stress Inventory-Short Form (PSI-SF)) and each measure of SES (see Table 11), and no relationships were significant. Nine caregiver responders were below the cutoff on Defensive Responding on the PSI-SF, indicating significant levels of defensiveness; thus, additional correlations were calculated with these families excluded (see Table 12). Again, with the remaining 11 families, no relationships between SES and parent stress were found to be significant. Furthermore, no measure of parenting stress was found to significantly correlate with any developmental measure (see Table 12) even when defensive responders were excluded (see Table 13). Thus, testing of a mediation of parent stress between SES and cognitive outcomes was not justified.

A final secondary hypothesis (hypothesis 2) proposed that SES moderated the mediation of HOME between SES and cognitive outcomes. Because a moderated mediation analysis requires a larger sample size (at least 100 participants) than was available in this study, a moderated mediation analysis was not possible.

CHAPTER 4: DISCUSSION

General Discussion

The present study's primary aim was testing whether home environment quality mediated between SES and cognitive development in several domains: overall cognitive ability, language ability, and executive functioning in the areas of behavioral inhibition and cognitive flexibility. Results demonstrated that the quality of the home environment significantly accounted for the relationship between socioeconomic status and overall cognitive ability in a socioeconomically diverse sample of toddlers between ages 18 and 40 months. The indirect effect of SES on cognitive ability as mediated by home environment quality was significant when utilizing the composite SES measure that included parental occupation and education and family income, as well as using income and paternal education as individual measures of SES. In this sample, family income and paternal education were the only subcomponents of SES to significantly influence home environment quality and to indirectly influence cognitive ability through the mediation of home environment quality. These findings uniquely suggest the importance of early home environment quality in supporting development of overall cognitive ability in toddlers in this specific age group, and in understanding the effects of SES on cognitive development. Results suggest that it is largely through the quality of the home environment that family socioeconomic status impacts cognitive ability in this age group. The other central study questions of whether home environment quality mediated between SES and language, and SES and executive functioning, were either not supported by data or not possible to address in this sample.

Current findings support previous research demonstrating the unique impacts of

SES and home environment quality on cognitive ability in early childhood (Lipina & Colombo, 2009) and of home environment quality on cognitive ability (Bradley & Corwyn, 2005). Present results also extend previous research demonstrating the role of home environment quality, as measured by the HOME scale, in relation to both SES and developmental outcomes. For example, a large multi-site study of Kindergarten children demonstrated that parental provision of cognitive stimulation in the home uniquely predicted academic achievement in all areas, including math and reading, after controlling for family income (Gershoff et al., 2007). Similarly, in a sample of disadvantaged families, parenting quality mediated the effects of family resources (using a combined index of mother's reading frequency, mother's education level, parent living arrangements, and family income) on children's cognitive ability as measured by the Bayley, at ages 14, 24, and 36 months. Extending these past findings, present results uniquely implicate the overall home environment in driving the effects of SES (as measured by parental income, education, and occupation) on cognitive ability in the specific toddler age group of 18-40 months in a socioeconomically diverse sample, using the home total score, rather than a HOME subscale as used in previous studies.

Of note, the analysis approach used for testing mediation relationships, the Monte Carlo method, allows for testing of mediation even in the absence of a significant effect of the independent variable on the dependent variable. In this sample, regression results indicate that the SES composite variable did not significantly influence cognitive ability. However, SES did have a significant indirect effect on cognitive ability when mediated by HOME total score. Similarly, paternal education did not significantly influence cognitive ability except as mediated through home environment quality. Thus, overall family SES and paternal education may impact toddlers' cognitive ability, but only through impacting the quality of the home environment.

Contrary to expectations, the quality of the home environment was not significantly related to language outcomes, thus precluding the testing of a mediation of home environment quality between SES and language ability. In previous research, it was found that parents' verbal scaffolding at child age 3 indirectly influenced executive functioning at age 6 by directly influencing language ability and nonverbal problem-solving at age 4 (Landry et al., 2002). Previous research has also demonstrated that family SES predicted the quality of language stimulation that parents provided for their children (Hoff et al., 2002, Bradley & Corwyn, 2002) and that children from lower SES families were more likely to show language deficiencies (Hackman et al., 2010). While present results did not demonstrate an influence of home environment quality on child language, they did demonstrate the impact of SES on toddler language ability. Perhaps parenting factors such as parental verbal stimulation, which in previous research has been shown to relate to SES and to child language ability, are not measured the HOME scale. Indeed, the subcomponents of the HOME that are common to all age groups in the present sample did not include any items specifically assessing parental verbal stimulation.

The present study's results regarding executive functioning are inconclusive. Several of our measures of behavioral inhibition on the Gift Delay had extremely low variability, disallowing tests of a mediation of home environment quality between SES and this domain. Additionally, this measure has yet to be confirmed as having an acceptable level of reliability or validity for measuring this construct in toddlers ages 30-

34 months (Carlson, 2005). Our measure of cognitive flexibility, the Bear Dragon, was not significantly influenced by the home environment quality; thus, a test of the mediation of home environment quality between SES and this domain was not justified. Although the Bear Dragon had an acceptable level of variability in this sample, it too has yet to demonstrate reliability and validity in measuring cognitive flexibility in toddlers under the age of 40 months (Carlson, 2005, Reed et al., 1984).

As stated previously, in this sample, SES directly impacts language ability but affects cognitive ability only when mediated by the home environment. Such findings may implicate the ability of HOME scale to capture primary intervening variables related to cognitive ability but not to language development. If such results were to be replicated in a larger and more nationally representative sample and with a design that allows for causal inferences to be drawn, it could offer potential differentiated targets for interventions geared towards improving cognitive ability versus language ability. For example, supporting language development for at-risk children may be more effective by teaching parents verbal scaffolding techniques (Landry et al., 2002), while improving child cognitive ability may be better accomplished by providing a greater variety of learning materials and cognitive stimulating experiences in the home, whether verbal or nonverbal, as suggested by the findings of Bradley & Corwyn (2005).

Results regarding predictors of executive functioning largely contrasted with previous research. For example, in this study there was a lack of influence of home environment quality on executive functioning measures. Large-scale studies by the NICHD Early Child Care Research Network have shown that HOME scores predict children's inhibitory control, planning, and sustained attention (NICHD, 2003; 2005).

The present study's executive functioning measures, Gift Delay and Bear Dragon, were intended to measure inhibitory control and behavioral flexibility, respectively; neither variable was influenced by home environment quality. Effect sizes for these nonsignificant relationships were small; the sample size for these analyses with a preset power level of .8 had a possible medium effect size of .36. Because it was possible to obtain a higher effect size with this sample size, the acquired effect size combined with the fact that the relationship is not significant suggests that HOME total standardized scores did not significantly influence language composite, rather than suggesting that the nonsignificant finding resulted from a small sample size.

Other unusual findings included negative correlations between maternal education level and seconds until peeking, and between paternal occupation level and the number of seconds until touching the gift during Gift Delay. In other words, higher maternal education and paternal occupation predicted poorer behavioral inhibition in this sample, in the context of obeying instructions to not look at or touch a gift they were about to be given during a two-minute delay. This contrasts with previous research citing a positive relationship between socioeconomic status as defined by family income and parental occupation and education, and executive functioning as measured by tasks of spatial working memory and inhibitory control (Noble et al., 2005). Unexpected findings may have resulted from being acquired from a small, unrepresentative sample. On the other hand, if such results were to be replicated in another sample, it could indicate that children with higher educated mothers and fathers with higher prestige occupations may not be able to exercise behavioral inhibition in the context of waiting for a present. Additional analyses exploring these unexpected relationships between parent SES and executive functioning indicated that they could not have been mediated by home environment quality, as neither paternal occupation nor maternal education significantly impacted home environment quality.

Secondary hypotheses regarding pathways between SES and cognitive outcomes were not supported, either due to insignificant results or to lack of feasibility for testing using present data. Furthermore, due to the very small sample size, insignificant results may not necessarily reflect an absence of hypothesized relationships between variables. Specifically, present findings offer limited insight into the following hypothesized pathways between SES and cognitive development: 1) that the strength of the mediation of home environment quality would be greater for children from low SES homes than for children from high SES homes, 2) that language mediates between SES and executive functioning, and 3) that parental stress levels mediate between SES and cognitive development. The first of these hypotheses was not possible to address with this sample size. Regarding the second of these hypotheses, language ability was found to significantly relate to both income and overall SES, but was not related to any executive functioning measure, so this mediation hypothesis could not be tested. This contrasts with previous research demonstrating that child language ability at 4 years drove the relationship between parental scaffolding at 3 years and executive functioning ability at 3 years (Landry et al., 2002). This previous study assessed language ability using the Clinical Evaluation of Language Fundamentals, which includes subtests assessing receptive language in the areas of sentence structure, concepts and directions, and word classes and expressive language in the areas of word structure, formulated sentences, and recalling sentences. Conversely, the present study assessed language using the Bayley language scales that measure overall expressive and receptive language only.

Present results did not demonstrate any relationship between home environment quality and executive functioning measures. Executive functioning measures used in the Landry (2002) study, which guided the present study hypothesis of home environment quality mediating between SES and EF, were administered at age 6 years and involved more complicated tests of cognitive flexibility, and measured a higher-order executive functioning area of goal-directed play behavior. Thus, discrepancies between findings from this past research and the present study may have resulted from different measures used across the studies, and thus the measurement of slightly different constructs. Additionally, present findings call into question whether behavioral inhibition may be validly measured at age 30-34 months in toddlers using the Gift Delay tasks. Kurtosis values for gift touch and gift open revealed nearly nonexistent variability. While evidence to date suggests that behavioral inhibition is a distinct component of executive functioning that may be measured in children beginning at age 8 months (Garon, Bryson, & Smith, 2008), reliability has yet to be demonstrated for these specific tasks at ages 30-34 months (Carlson, 2005).

Another secondary hypothesis was that parental stress mediated between SES and stress levels. No measure of SES was related to any of the present measures of parental stress, including self-reported stress from lack of interpersonal resources, mood or anxiety problems, dysfunctional parental-child interactions, or having a difficult child. (Thus, the test of a mediation of parental stress between SES and cognitive development was not possible). This finding conflicts with previous research showing a strong relationship between SES and parents' self-reported stress, but in different domains than those measured in the present study: environmental dangers, family dissolution, unemployment, and economic privation, all measured using different scales than those in the present study (Bradley & Corwyn, 2002). Present results may thus indicate that different kinds of stressors are more strongly related to SES than others, or may simply reflect a small or unrepresentative sample. Of note, 11 out of 24 total parents who completed the PSI were above the cutoff on defensive responding, which is well above the average of defensive responders in normative samples (McKelvey et al., 2009). Parent questionnaires were administered right after home interviews ended. The experience of answering questions about their parenting and the kind of homes they were providing for their children may have led to higher than average defensive responding in study participants. Even after removing defensive responders from analyses involving any parental stress measures, however, no parent stress measures were related to any SES measures with this very small sample size of 24.

Limitations and Future Research

The nonexperimental design of this study precludes any conclusions of causality. Like previous similar studies, the possibility of a gene-environment covariation may not be ruled out by this data. For example, parents may be providing home environments that are influenced by their own heritable characteristics, such as cognitive ability, without the home environment playing a causal role their children's cognitive development. Though the present results are suggestive of hypothesized relationships, the causal impact of SES and home environment quality on cognitive outcomes cannot be assessed in this study, nor can the indirect causal effect of SES on cognition as mediated by HOME environment quality.

Although present data preclude drawing causal conclusions, intervention research has implicated the causal role of both SES and home environment quality in influencing developmental outcomes for disadvantaged children. For example, short-term parenting interventions targeting parental responsivity and involvement in child play, both of which are measured by the HOME, have been shown to lead to significant improvements in child development outcomes, in the absence of improved socioeconomic circumstances of families (Olds, 2006). Experimental welfare programs that increased family income through earnings supplements and employment produced positive effects on school achievement in elementary school-aged children, across multiple studies (Morris, Huston, Duncan, Crosby, & Bos, 2001; Zaslow, Moore, & Brooks, et al., 2002). Another study designed to improve developmental outcomes of infants born prematurely and low birthweight provided education and support services for mothers and educational day care and health services for children. In addition to preceding increases in child IQ scores up to five years after the end of the intervention in comparison to a control group (Hill, Brooks-Gunn, & Waldfogel, 2003), the program also significantly increased families' HOME scores over a period of two years in comparison to controls (Bradley, Whiteside, & Mundfrom, et al., 1994). Intervention effects on IQ in this program may have been significantly mediated by improvements in home environment quality, but this question was not addressed. Together with such compelling findings, present results suggest that such a possibility may be worth exploring in future intervention studies, to better inform how best to support cognitive development in children from low-income families. A recent study of the long-term effects of environmental enrichment provided for disadvantaged children through the Carolina Abecedarian Project (ABC) demonstrated that treatment predicted significantly lower risk for cardiovascular and metabolic diseases into the mid-30s (Campbell, Conti, & Heckman, et al., 2014). Such results indicate that providing a stimulating early home environment may even improve long-term health outcomes of disadvantaged children. Future research may benefit from exploring whether improving home environment quality is what drives the effectiveness of early interventions.

Additionally, present analyses were run on a sample of only between 19 and 24 families from a single US metropolitan area in the only minority-majority state. Clearly, these nonexperimental results should be interpreted with caution in terms of extrapolating to other samples. Furthermore, families recruited for this study were already participating in another study requiring multiple visits to a research facility over the course of several years. Each visit involved either several hours of developmental testing and completing questionnaires, and/or a nighttime MRI scan that could take between 2 and 4 hours. It is unclear whether families willing to commit this amount of time and effort to a research study for compensation represent the full range of families with toddlers in this age group. Finally, several study hypotheses could not be addressed with present data due to sample size or lack of significance in simple regression relationships.

Summary and Implications

Results from this small study offer exciting areas of inquiry for mapping pathways between SES and cognitive development for children across all socioeconomic levels. Of primary interest in the present study is the finding that home environment quality mediated the significant influence of SES on cognitive ability in toddlers. Other findings conflicted with previous research. Contrary to expectations, home environment quality did not impact language ability. Although strong psychometric properties of the HOME scale and of the Bayley language scale may suggest that the sample was too small or unrepresentative, acquired effect sizes compared with those possible with this sample size do suggest a lack of a relationship. Replication of such results in a design that allows for causal conclusions to be drawn, such as a large-scale study of twins raised together and apart, could suggest that factors measured by the HOME scale would not be optimal targets in intervention for increasing language ability in toddlers. The lack of variability in executive functioning in the present data suggests that more nuanced measures of executive functioning may be more appropriate for assessing this set of abilities in toddlers between the ages of 18 and 40 months, and calls into question the validity of present executive functioning measures for assessing this construct in this age group. In contrast with previous research, higher maternal education and paternal occupation level were associated with poorer behavioral inhibition on the Gift Delay task. Such results may have been due to a small or unrepresentative sample. Present executive functioning measures that had an appropriate level of variability were not significantly influenced by home environment quality, precluding the testing of a mediation of home environment quality between SES and executive functioning.

In line with previous research, SES significantly impacted HOME scores, which in turn significantly influenced cognitive ability. A review of items on the HOME scale suggests that many factors may be modified without increasing parental income or education. Items on the HOME scale also measure developmental appropriateness of learning materials in the home, parental attitudes of acceptance towards their children, and the variety of experiences provided both inside and out of the home. Present findings suggest potential targets for early intervention to lessen the impact of socioeconomic risk on cognitive ability in toddlers. Future research to inform such interventions would likely benefit from attempting to replicate present findings with a larger and more nationally representative sample, using a study design that allows for causal conclusions to be drawn. As described previously, theoretically informed early interventions have improved developmental outcomes through targeting parental responsivity and involvement (Olds, 2006), have resulted in significant improvements in home environment quality (Bradley et al., 1994), and also have potential to reduce long-term health inequities through providing a stimulating early childhood environment (Campbell et al., 2014). Such compelling findings across multiple intervention studies support the importance of exploring these pathways from disadvantage to early development.

References

Abidin, R. R. (1995). *Parenting Stress Index: Professional Manual (3rd ed.).* Odessa, Fl: Psychological Assessment Resources, Inc.

Bayley, N. (1993). *Bayley Scales of Infant Development (*2nd ed.). San Antonio, TX: Psychological Corporation.

Blair, C. (2002). School readiness: integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist*, *57*(2), 111-127.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in Kindergarten. *Child Development*, *78*(2), 647-663.

Bradley, R. H. (1994). The home inventory: Review and reflections. *Advances in Child Development*, *25*, 241-288.

Bradley, R. H., & Caldwell, B. M. (1984). The HOME Inventory and family demographics. *Developmental Psychology, 20*(2), 315-320.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic Status and Child Development. *Annual Review of Psychology, 53,* 371-99.

Bradley, R. H., & Corwyn, R. F. (2005). Caring for children around the world: A view from HOME. *Journal of Behavioral Development, 29*(6), 468-478.

Bradley, R. H., Corwyn, R. F., Burchinal, M., McAdoo, H. P. & Coll, C. G. (2001). The home environments of children in the United States Part I: Variations by age, ethnicity, and poverty status. *Child Development, 72*(6), 1844-1867.

Bradley, R. H., Corwyn, R. F., & Whiteside-Mansell, L. (1996). Life at home: same time, different places-an examination of the HOME inventory in different cultures. *Early Development and Parenting*, *5*(4), 251-269.

Bradley, R. H., Whiteside, L., Mundfrom, D. J., Casey, P. H., Caldwell, B. M., & Barrett., K. (1994). Impact of the Infant Health and Development Program (IHDP) on the home environments of infants born prematurely and with low birthweight. *Journal of Educational Psychology*, *86*(4), 531-541.

Brooks-Gunn, J., & Duncan, G. J. (1997). The effects of poverty on children. *The Future Of Children*, *7*(2), 55-71.

Buckner, J. C., Mezzacappa, E., & Beardslee, W. R. (2003). Characteristics of resilient youths living poverty: The role of self-regulatory processes. *Development and Psychopathology*, *15*, 139-162.

Campbell, F. Conti, G., Heckman, J. J., Moon, S. H., Pinto, R., Pungello, E., et al. (2014). *Science*, *343*, 1478-1485.

Canfield, R. L., Kreher, D. A., Cornwell, C., & Henderson, Jr., C. R. (2003). Low-level lead exposure, executive functioning, and learning in early childhood. *Child Neuropsychology*, *9*(1), 35-53.

Carlson, S. M. (2005). Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropscyhology*, *28*(2), 595-616.

Carlson, S. M., Moses, L. J., & Claxton, L. J. (2004). Individual differences in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology, 87,* 299-319.

Confer, R. D., & Donnellan, M. B. (2007). An interactionist perspective on the socioeconomic context of human development. *Annual Review of Psychology, 58*, 175-99.

Conger, R. D., & Donnellan, M. B. (2007). *Annual Review of Psychology, 58*, 175-179.

Diamond, A. (1985). Development of the ability to use recall to guide action, as indicated by infants' performance on AB. *Child Development*, *56*, 868-883.

Dieterich, S. E., Assel, M. A., Swank, P., Smith, K. E., & Landry, S. H. (2006). The impact of early maternal verbal scaffolding and child language abilities on later decoding and reading comprehension skills. *Journal of School Psychology, 43*, 481-494.

Duncan, G. J., Brooks-Gunn, J., & Klebanov, P. (1994). Economic deprivation and early childhood development. *Child Development*, *65*(2), 296-318.

Eamon, M. K. (2002). Effects of poverty on mathematics and reading achievement of young adolescents. *22*(1), 49-74.

Farah, M. J., Betancourt, L., Shera, D. M., Savage, J. H., Giannetta, J. M., Brodsky, N. L., et al. (2008). *Developmental Science*, *11*(5), 793-801.

Farah, M. J., Shera, D. M., Savage, J. H., Betancourt, L., Giannetta, J. M., Brodsky, N. L., et al. (2006). Childhood poverty: Specific associations with neurocognitive development. *Brain Research*, *1110*, 166-174.

Fass, S., Dinan, K. A., & Aratani, Y. (2009). Child Poverty and Intergenerational Mobility. National Center for Children in Poverty, Mailman School of Public Health, Columbia University.

Fernandez, M., & Zaccario, M. (2007). Bayley III: A preliminary overview. *Journal of Early Childhood and Infant Psychology, 3*.

Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed.). London: Sage Publications.

Fiscella, K., & Kitzman, H. (2009). Disparities in Academic Achievement and Health: Intersection of Child Education and Health Policy. *Pediatrics,123(*3), 1073-1080.

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134*(1), 31-60.

Garrett, P., Ng'andu, N., & Ferron, J. (1994). Poverty experiences of young children and the quality of their home environments. *Child Development*, *65*(2), 331-345.

Gershoff, E. T., Aber, J. L., Raver, C. C., & Lennon, M. C. (2007). Income is not enough: Incorporating material hardship into models of income associations with parenting and child development. *Child Development, 78*(1), 70-95.

Guo, G., & Harris, K. M. (2000). The mechanisms mediating the effects of poverty on children's intellectual development. *Demography, 37*(4), 431-447.

Hackman, D. A., & Farah, M. J. (2008). Socioeconomic status and the developing brain. *Trends in Cognitive Science*, *13*(2), 65-73.

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical meditational analysis in the new millennium. *Communication Monographs, 76*(4), 408-420.

Hill, J. L., Brooks-Gunn, J., & Waldfogel, J. (2003). Sustained effects of high participation in an early intervention for low birth-weight premature infants. *Developmental Psychology, 39*(4), 730-744.

Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review, 26*, 55-88.

Hoff, E., Laursen., B., & Tardif, T. (2002). Socioeconomic status and parenting. In M. H. Borstein (Ed.), *Handbook of parenting (2nd ed.): Vol. 2. Biology and ecology of* *parenting* (pp. 231-252). Mahwah, NJ: Erlbaum.

Hollingshead, A. A. (1975). Four-factor index of social status. Unpublished manuscript, Yale University, New Haven, CT.

Hubbs-Tait, L., Nation, J. R., Krebs, N. F. & Bellinger, D. C. (2005). *Psychological Science in the Public Interest, 6*(3), 57-121.

Knudsen, E. I., Heckman, J. J., Cameron, J. L., & Shonkoff, J. P. (2006). Economic, neurobiological, and behavioral perspectives on building America's future workforce. *Proceedings of the National Academy of Sciences USA, 103,* 10155-10162.

Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology, 36*, 220-232.

Landry, S. H., Miller-Loncar, C. L., Smith, K. E., & Swank, P. R. (2002). The role of early parenting in children's development of executive processes. *Developmental Neuropsychology, 21*(1), 15-41.

Leventhal, T., & Brooks-Gunn, J. (2000). The neighborhoods they live in: The effects of neighborhood residence on child and adolescent outcomes. *Psychological Bulletin, 126*(2), 309-337.

Linver, M. R., Brooks-Gunn, J., & Cabrera, N. (2004). The Home Observation for Measurement of the Environment (HOME) Inventory: The derivation of conceptually designed subscales. *Parenting: Science and Practice, 4*(2-3), 99-114.

Linver, M. R., Brooks-Gunn, J., & Kohen, D. E. (2002). Family processes as pathways from income to young children's development. *Developmental Psychology, 38*(5), 7190734.

Linver, M. R., Martin, A., & Brooks-Gunn, J. (2004). Measuring infants' home environment: The IT-HOME for infants between birth and 12 months in four national data sets. *Parenting: Science and Practice. 4*(2-3), 115-137.

Lipina, S. J., & Colombo, J. A. (2009). Effects of poverty on development II: Cognitive neuroscience perspectives. In S. J. Lipina & J. A. Colombo (Eds.) *Poverty and Brain Development During Childhood: An Approach From Cognitive Psychology and Neuroscience*, Washington, DC: American Psychological Association.

Lugo-Gil, J., & Tamis-LeMonda, C. S. (2008). Resources and parenting quality: Links to children's cognitive development across the first 3 years. *Child Development, 79,* 1065-1085.

McKelvey, L. M., Whiteside-Mansell, L., Faldowski, R. A., Shears, J., Ayoub, C., & Hart, A. (2009). Validity of the Short Form of the Parenting Stress Index for fathers of toddlers. *Journal of Child and Family Studies, 18,* 102-111.

McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *American Psychologist*, *53*(2), 185-204.

Mezzacappa, E. (2004). Alerting, orienting, and executive attention: Developmental properties and sociodemographic correlates in an epidemiological sample of young, urban children. *Child Development*, *75*(5), 1373-1386.

Minujin, A., Delamonica, E., Davidziuk, A., & Gonzalez, E. D. (2006). The definition of child poverty: A discussion of concepts and measurements. *Environment and Urbanization, 18* ,481-500.

Morris, P., Huston, A., Duncan, G., Crosby, D., & Bos, H. (2001). *How Welfare and Work Policies Affect Children: A Synthesis of Research.* New York: MDRC.

National Institute of Child Health and Human Development & the Early Child Care Research Network. (2003). Do children's attention processes mediate the link between family predictors and school readiness? *Developmental Psychology, 39*(3), 581-593.

National Institute of Child Health and Human Development & the Early Child Care Research Network (2005). Predicting Individual Differences in Attention, Memory, and Planning in First Graders From Experiences at Home, Child Care, and School. *Developmental Psychology*, *41*(1), 99-114.

Nelson, C. A. (2002). Neurobehavioral development in the context of biocultural co-constructivism. In P. Bates (Ed.), *Lifespan development and the brain: The perspectives of biocultural co-constructivism* (pp. 61-81). West Nyack, NY: Cambridge University Press.

Noble, K. G., Farah, M. J., & McCandliss, B. D. (2006). Socioeconomic background modulates cognition-achievement relationships in reading.*Cognitive Development*, *21*(3), 349-368.

Noble, K. G., McCandliss, B. D., & Farah, M. J. (2007). Socioeconomic gradients predict individual differences in neurocognitive abilities. *Developmental Science*, *10*(4), 464-480.

Noble, K. G., Norman, M. F., & Farah, M. J. (2005). Neurocognitive correlates of socioeconomic status in kindergarten children. *Developmental Science, 8*(1), 74-87.

Noble, K. G., Wolmetz, M. E., Ochs, L. G., Farah, M. J., & McCandliss, B. D. (2006). Brain-behavior relationships in reading acquisition are modulated by socioeconomic factors. *Developmental Science, 9*(6), 642-654.

Olds, D. L. (2006). The Nurse-Family Partnership: An evidence-based preventive intervention. *Infant Mental Health Journal, 27*(1), 5-25.

Preacher, K. J., & Selig, J. P. (2012). Advantages of Monte Carlo confidence intervals for indirect effects.

Qi, C. H., Kaiser, A. P., Milan, S., & Hancock, T. (2006). Language performance of low-income African American and European American preschool children on the PPVT-III. *Language, Speech, and Hearing Services in Schools, 37*, 5-16.

Reed, M. A., Pien, D. L., & Rothbart, M. K. (1984). Inhibitory Self-Control in Preschool Children. *Merrill-Palmer Quarterly (1982), 30*(2), 131-147.

Richards, M., & Wadsworth, M. E. J. (2004). Long term effects of early adversity on cognitive function. *Archives of Disease in Childhood, 89*, 922-927.

Rodriguez, E. T., Tamis-LeMonda, C. S., Spellmann, M. E., Pan, B. A., Raikes, H., Lugo-Gil, J., Luze, G. (2009). The formative role of home literacy experiences across the first three years of life in children from low-income families. *Journal of Applied Developmental Psychology, 30*, 677-694.

Roosa, M. W., Deng, S., Nair, R. L., & Burrell, G. (2005). Measures for studying poverty in family and child research. *Journal Of Marriage And Family*, *67*(4), 971-988.

Sarsour, K., Sheridan, M., Jutte, D., Nuru-Jeter, A., Hinshaw, S., & Boyce, W. T. (2011). Family Socioeconomic Status and Child Executive Functions: The Roles of

Language, Home Environment, and Single Parenthood.

Stanton-Chapman, T. L., Chapman, D. A., Kaiser, A. P., & Hancock, T. B. (2004). Cumulative risk and low-income children's language development. *Topics in Early Childhood Special Education, 24*(4), 227-237.

Stipek, D. J., & Ryan, R. H. (1997). Economically disadvantaged preschoolers: Ready to learn but further to go. *Developmental Psychology*, *33*(4), 711-723.

Thomas, M. S. C., & Johnson, M. H. (2008). New advances in understanding sensitive periods in brain development. *Current Directions in Psychological Sciences, 17*, 1-5.

Tucker-Drob, E. M., Rhemtulla, M., Harden, K. P., Turkheimer, E., & Fask, D. (2010). Emergence of a gene x socioeconomic status interaction on infant mental ability between 10 months and 2 years. *Psychological Science, 22*(1), 125-133.

Turkheimer, E., Haley, A., Waldron, M., D'Onofrio, B., & Gottesman, I. I. (2003). Socioeconomic Status modifies heritability of IQ in young children. *Psychological Science*, *14*(6), 623-628.

United States Department of Health and Human Services (USDHHS). (2014). *2014 Poverty Guidelines.* Retrieved from http://aspe.hhs.gov/poverty/14poverty.cfm

Walker, S. P., Wachs, T. D., Grantham-McGregor, S., Black, M. M., Nelson, C. A., Huffman, S. L., & ... Richter, L. (2011). Inequality in early childhood: Risk and protective factors for early child development. *The Lancet*, *378*(9799), 1325-1338.

Zaslow, M. J., Moore, K. A., Brooks, J. L. Morris, P. A., Tout, K., Redd, Z.A., et al. (2002). *The Future of Children, 12*(1), 78-95.

APPENDICES

Appendix A. Tables

Table 1. Demographics

Table 1

Demographics

Variable (range)	Mean (SD)
Child Age in months (21.93 to 42.03)	31.09(5.72)
SES composite z-score (-1.32 to 1.10)	.0238(.78)
Income level	3.79(2.52)
Maternal Education	3.38(1.93)
Paternal Education	2.63(1.74)
Maternal Occupation level	5.35(2.26)
Paternal Occupation level	4.95(1.99)
	Number (%)
Gender	
Male	12 (50%)
Female	12 (50%)
Ethnicity	
Caucasian	9 (37.5%)
Hispanic	8 (33.3%)
Native American	3 (12.5%)
African American	0 (0%)
Asian	0 (0%)
Two or more minority races	4 (16.7%)
Income level	
0-$10,000	5 (20.8%)
$10,001-$20,000	1 (4.2%)

$20,001-$30,000	1 (4.2%)
$30,001-$40,000	2 (8.3%)
$40,001-$50,000	4 (16.7%)
$50,001-$60,000	4 (16.7%)
$60,001-$70,000	3 (12.5%)
above $70,000	4 (16.7%)

Note: n=24

Table 2. Correlations Between Socioeconomic Status and HOME Scale Components

Table 2

Correlations Between SES and HOME

HOME Variable	SES Composite	Mom Education	Dad Education	Mom Occupation	Dad Occupation
Total	.469*/24	.372(.073)/24	.560**/24	.072(.772)/17	.087(.707)/21
Responsivity (IT/EC)	.279(.186)/24	.159(.458)/24	.343(.101)/24	.007(.978)/17	.127(.583)/21
Acceptance (IT/EC)	.291(.168)/24	.273(.196)/24	.247(.244)/24	(-).010(.969)/17	(-).200 (.385)/21
Organization (IT)	(-).224 (.357)/19	(-).144 (.557)/19	.012 (.960)/19	(-).252 (.384)/14	.027(.918)/17
Learning Materials (IT/EC)	.532**/24	.443*/24	.539**/24	.124(.635)/17	.091(.696)/21
Involvement (IT)	.072(.770)/19	(-).002 (.994)/19	.310(.197)/19	(-).119 (.685)/14	(-).130 (.619)/17
Variety (IT/EC)	(-).051 (.813)/24	(-).026 (.905)/24	(-).131 (.543)/17	.079(.763)/17	(-).177 (.443)/21
Language Stimulation (EC)	.933*/5	.980**/5	.954*/5	incalculable	.333(.667)/4
Physical Environment (EC)	.527(.361)/5	.505 (.385)/5	.547(.340)/5	incalculable	(-)1.000***/4

Academic Stimulation (EC)	.917*/5	.942*/5	.942*/5	incalculable	(-).577 (.423)/4
Modeling (EC)	.782(.118)/5	.722 (.168)/5	.739(.153)/5	incalculable	.577(.423)/4

Notes. Format: r value(p-value)/n

IT=Infant Toddler HOME; EC=Early Childhood HOME

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

Table 3. HOME Standardized Score Correlations with cognitive outcomes

Table 3

HOME Standardized Score Correlations with cognitive outcomes

HOME	Cognitive Composite	Receptive language	Expressive Language	Bear Dragon score	seconds until peek	seconds until touch	seconds until open
Home Total	.516*/24	.249(.263)/22	.314(.154)/22	(-).265(.360)/14	(-).122(.618)/19	.262(.278)/19	.508*/19
Responsivity (IT/EC)	.516*/24	.300(.174)/22	.267(.229)/22	(-).147(.615)/14	.613(.505)/19	.436(.062)/19	.664**/19
Acceptance (IT/EC)	.327(.119)/24	.184(.412)/22	.293(.185)/22	(-).029(.923)/14	(-).242(.318)/19	.033(.892)/19	.018(.940)/19
Organization (IT)	(-).210(.387)/19	(-).395(.116)/17	(-).355(.162)/17	.111(.761)/10	.104(.711)/15	incalculable/15	incalculable/15
Learning Materials (IT/EC)	.220(.301)/24	.312(.157)/22	.339(.122)/22	(-).159(.587)/14	(-).080(.744)/19	.479*/19	.705**/19
Involvement (IT)	.313(.192)/19	(-).173(.507)/17	.021(.937)/17	(-).221(.539)/10	(-).192(.492)/15	incalculable/15	incalculable/15
Variety (IT/EC)	.362(.082)/24	.072(.750)/22	(-).022(.922)/22	(-).307(.285)/14	.087(.724)/19	.223(.360)/19	.123(.615)/19
Langua	.377(.53	.606(.27	.358(.55	(-	.973*/4	.627(.373	1.000***

ge Stimulation (EC)	1)/5	8)/5	4)/5	).161(.839)/4		)/4	/4
Physical Environment (EC)	.704(.184)/5	.660(.226)/5	.800(.104)/5	(-).221(.779)/4	.702(.298)/4	.638(.362)/4	.477(.423)/4
Academic Stimulation (EC)	.591(.294)/5	.738(.155)/5	.619(.265)/5	(-).187(.813)/4	.975*4	.704(.296)/4	.943(.057)/4
Modeling (EC)	.467(.427)/5	.644(.241)/5	.389(.517)/5	(-).754(.246)/4	.619(.318)/4	.764(.236)/4	.778(.222)/4

Notes. Format: r value(p-value)/n

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

Table 4. Regression Results for Components of Mediation of HOME Between Socioeconomic Status and Executive Functioning

Table 4

Regression components of HOME mediation between SES and EF

Regression components	HOME regressed on SES composite	gift peek regressed on HOME	gift touch regressed on HOME	gift touch_LN regressed on HOME
R^2	0.22	0.015	0.069	0.037
F	6.208*	0.259	1.254	0.652
p	0.021	0.618	0.278	0.431
β (unst.)	0.379	-4.147	14.014	-0.496
Standard Err.	0.152	8.154	12.516	0.614

Notes. Analyses included only those who completed Gift Delay (n=19)

Format: r value(p-value)/n

Table 5. Confidence Intervals for the Indirect Effect of Socioeconomic Status Executive Functioning as Mediated by HOME

Table 5

Indirect Effect of SES on EF mediated by HOME

Mediation Components	Bear Dragon	Gift touch	Gift Touch_LN
Lower Limit	-4.892	-3.921	-0.7675
Upper Limit	1.434	18.01	0.2759
Non-Zero?	No	No	No

Notes: Analyses included only those who completed Gift Delay (n=19) or Bear Dragon (n=14)

Confidence Intervals obtained at confidence level 95% with 20,000 repetitions

Table 6. Correlations Between Socioeconomic Status and Executive Functioning

Table 6

Correlations between SES and EF Measures

SES measure	Bear Dragon Score out of 33	Seconds until touch	Seconds until Open
SES Composite	(-).198(.497)/14	.031(.900)/19	.440(.060)/19
Income Level	(-).158(.606)/14	.234(.335)/19	.426(.069)/19
Maternal Education	(-).111(.706)/14	(-).037(.880)/19	.311(.195)/19
Paternal Education	.022(.940)/14	(-).072(.771)/19	.366(.123)/19
Maternal Occupation	(-).117(.731)/11	(-).283(.307)/15	incalculable/15
Paternal Occupation	.108(.726)/13	(-).514*/17	incalculable/17

Notes. Analyses included only those who completed Gift Delay (n=19)

Format: r value(p-value)/n

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$

Table 7. Regression Results for Mediation Components of Learning Materials Between Socioeconomic Status and Seconds until Touching Gift

Table 7

Regressions for Mediation of Learning Materials Between SES and Gift Touch

Regression components	Learning Materials (LM) regressed on SES composite	LM on mom educ	LM on dad educ	sec until touch on LM
R^2	0.283	0.196	0.29	0.23
F	8.676**	5.36*	9.004**	5.064*
p	0.007	0.03	0.007	0.038
β (unst.)	0.422	0.143	0.192	30.397
Standard Err.	0.143	0.062	0.064	13.508

Notes. Analyses included only those who completed Gift Delay (n=19)

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

Table 8. Regression Results for Mediation Components of Learning Materials (LN Adjusted) Between Socioeconomic Status and Seconds Until Touching Gift

Table 8

Regressions for Mediation of Learning Materials (LN adjusted) between SES and Gift Touch

Regression components	Learning Materials (LM)-LN regressed on SES composite	LM-LN on mom educ	LM-LN on dad educ	sec until touch_LN on LM-LN	sec until touch_LN on LM	gift touch on LM-LN
R^2	0.24	0.174	0.283	0.129	0.157	0.977
F	6.935	4.636	8.67	2.514	3.175	723.726
p	0.015	0.043	0.007	0.131	0.093	.000
β (unst.)	-0.206	-0.071	-0.101	2.084	-1.214	-20.494
Standard Err.	0.078	0.033	0.034	1.315	0.681	0.762

Notes. Analyses included only those who completed Gift Delay (n=19)

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

Table 9. Confidence Intervals for Mediation Of Learning Materials Between Socioeconomic Status and Executive Functioning

Table 9

Confidence Intervals for Mediation of Learning Materials between SES and EF

SES measure	LM mediating between SES and seconds until touch	LM-LN mediating between SES and seconds until touch	LM-LN mediating between SES and seconds until touch_LN
SES composite	.9857 to 29.67	1.083 to 7.335	(-)1.194 to 0.09947
Income Level	.3018 to 9.303	.3472 to 2.308	(-).3722 to 0.02768

Maternal Education	.09677 to 10.71	.1253 to 2.793	(-).4338 to 0.04005
Paternal Education	.07047 to 10.96	.6957 to 3.455	(-).5661 to 0.04355

Note: Analyses included only those who completed Gift Delay (n=19)

Table 10. Correlations Between Language and Executive Functioning

Table 10

Correlations Between Language and EF

Executive Functioning Measure	Language Composite	Expressive Language
Bear Dragon Score out of 33	(-).271(.349)/14	(-).011(.972)/13
Seconds Until Peek	(-).049(.842)/19	.000(.999)/18
Seconds Until Touch	.315(.188)/19	.293(.238)/18
Seconds Until Open	.311(.196)/19	.219(.382)/18

Note: Analyses included only those who completed Gift Delay (n=19) or Bear Dragon (n=14)

Table 11. Correlations Between Parenting Stress and Socioeconomic Status

Table 11

Correlations Between Parenting Stress and SES Measures

SES measure	PSI total_percentage	PRQ z-score
SES Composite	.081(.706)/24	.125(.559)/24
Income Level	.086(.688)/24	.161(.451)/24
Maternal Education	.040(.853)/24	.176(.410)/17
Paternal Education	(-).078(.718)/24	(-).024(.910)/21
Maternal Occupation	.015(.954)/17	(-).034(.896)/24

Paternal Occupation	.003(.991)/21	.027(.908)/24

Notes. Format: r value(p-value)/n

Not all participants provided occupation and education info

Table 12. Correlations Between Parenting Stress and Socioeconomic Status, Excluding Defensive Responders

Table 12

Correlations between parenting stress and SES measures

SES measure	PSI total_percentage	PRQ z-score
SES Composite	(-).036(.908)/13	.289(.338)/13
Income Level	.151(.622)/13	.290(.336)/13
Maternal Education	(-).284(.347)/13	.445(.127)/13
Paternal Education	(-).475(.101)/13	.098(.751)/13
Maternal Occupation	.029(.940)/9	(-).017(.966)/9
Paternal Occupation	(-).138(.686)/11	.106(.756)/11

Notes. Excludes defensive responders

Analyses included only those who completed all necessary measures.

Format: r value(p-value)/n

Table 13. Correlations Between Parenting Stress and Developmental Measures

Table 13

Correlations between parenting stress and developmental measures

Developmental Measure	PSI total_percentage	PRQ z-score
Cognitive Composite	(-).097(.652)/24	.075(.726)/24
Language Composite	.175(.461)/20	.045(.849)/20

Receptive Language	.041(.856)/22	(-).129(.566)/22
Expressive Language	.164(.465)/22	(-).154(.295)/22
Bear Dragon Total	(-).142(.629)/14	.102(.728)/14
Seconds Until Peek	.404(.086)/19	(-).256(.289)/19
Seconds Until Touch	.350(.142)/19	(-).169(.488)/19
Seconds Until Open	.250(.303)/19	(-).096(.696)/19

Notes. Analyses included only those who completed all necessary measures

Format: r value(p-value)/n

Table 14. Correlations Between Parenting Stress and Developmental Measures, Excluding Defensive Responders

Table 14

Correlations between parenting stress and developmental measures

Developmental Measure	PSI total_percentage	PRQ z-score
B	(-).312(.299)/13	.232(.445)/13
Language Composite	(-).031(.927)/11	.273(.416)/11
Receptive Language	(-).268(.400)/12	.004(.990)/12
Expressive Language	(-).099(.760)/12	.120(.709)/12
Bear Dragon Total	.000(1.000)/7	.043(.927)/7
Seconds Until Peek	.594(.070)/10	(-).396(.257)/10
Seconds Until Touch	.379(.381)/10	(-).134(.711)/10
Seconds Until Open	incalculable/10	incalculable/10

Notes: Excludes defensive responders

Analyses included only those who completed all necessary measures.

Format: r value(p-value)/n