THE INFLUENCE OF PARENTING ON COGNITIVE AND SOCIAL-EMOTIONAL DEVELOPMENT ASSOCIATED WITH PRETERM BIRTH: A MULTIPLE-GROUP COMPARISON USING STRUCTURAL EQUATION MODELING

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ABSTRACT

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Children born prematurely are a high-risk group for whom cognitive, academic, and behavioral deficits are common. The consequences of these deficits often worsen once the onset of schooling occurs. The period of early childhood provides an important point of intervention. Parenting behavior during this time can potentially prevent or lessen adverse outcomes associated with preterm birth. The purpose of the proposed study was to examine the relations between birth status, parenting behavior, cognitive and social-emotional development in a sample of children born preterm and full term. Primary analyses employed multi-sample Structural Equation Modeling (SEM) to evaluate whether parenting behavior differentially predicted outcomes in children born preterm when compared to children born full term. Data was drawn from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B), which sampled approximately 11,000 children born in the year 2001 from birth through kindergarten entry. For children born in the year 2001, results revealed that birth status significantly predicted cognitive development and parenting behavior at 24-months, and parenting behavior significantly predicted cognitive development and social-emotional outcomes at kindergarten entry. In addition, cognitive development predicted social-emotional outcomes. All of these paths were significant even after controlling for race, gender, socioeconomic status, birth plurality and type of delivery. Multi-sample analyses revealed differential relations between parenting, cognitive development, and social-emotional outcomes across children born at varying degrees of biologic risk, defined via gestational age criteria. Findings highlight that underlying cognitive deficits including mental, motor, and attentional processes might hinder the acquisition of higher-order processes that enable social-emotional development that emerges during kindergarten entry. Further, findings point to the importance of parenting behavior during early childhood to promote optimal cognitive development at 24-months for children born preterm and full term.

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CHAPTER 1
INTRODUCTION

Advances in medical technologies have contributed to increasingly greater numbers of survivors of preterm birth, before 37 weeks gestation. Today, approximately 13% of all births in the United States are considered preterm (Behrman & Butler, 2007). The decrease in mortality of premature infants has paralleled an increase in associated neurodevelopmental, academic, behavioral, and social-emotional disabilities (Bhutta, Cleves, Casey, Cradcok, & Anand, 2002), placing a significant toll on economic, health care, education, and mental health systems (Behrman & Butler, 2007). Severe neurological sequelae among preterm infants include cerebral palsy, hydrocephalus, blindness, deafness and seizure disorders (Bhutta et al., 2002; Marlow, Wolke, Bracewell, Samara, & EPICure Study Group, 2005), all of which are likely to remain stable over the course of development, and are often identified at birth. Although these severe medical conditions have profound effects on subsequent development, the majority of extremely premature (EP; < 28 weeks gestation), very premature (VP; < 32 weeks gestation), and preterm (< 37 weeks gestation) infants who survive will avoid having a severe disability (Colvin, McGuire, & Fowlie, 2004; Lorenz, 2001). Instead, they have a higher incidence of subtle disorders of the central nervous system, including mild cognitive impairments, learning disabilities, attention deficits, behavioral problems and social-emotional difficulties, all of which are typically detected later in life and adversely affect academic performance (Behrman & Butler, 2007; Bhutta et al., 2002). It is these subtle disorders that have received increased attention recently.

Despite initial optimism that children born preterm will catch up with their same-age, full term peers, considerable research has argued against this. Learning and/or behavioral problems often persist into adolescence and adulthood (Cooke, 2004; Gardner et al., 2004). The rate of

Attention Deficit/Hyperactivity Disorder (ADHD) seen in children born preterm is substantially higher than what is seen for the entire population (Shum, Neulinger, O'Callaghan, & Mohay, 2008). By middle childhood, children born preterm are three times more likely to meet diagnostic criteria for ADHD (Bhutta et al., 2002; Johnson et al., 2010), and are at elevated risk for other social-emotional problems including depression, withdrawal, anxiety, subtle attention deficits, social deficits, and externalizing behavioral problems compared to same-age, full term peers (Bhutta et al., 2002; Clark, Woodward, Horwood, & Moor, 2008). In addition, preterm birth has consistently been associated with lower cognitive abilities (Anderson & Doyle, 2003). With the noted impairments in intellectual and social-emotional functioning, it is not surprising that high rates of educational problems are also reported among this population (Anderson & Doyle, 2007). Such deficits often become evident as children reach kindergarten (Rose, Feldman, Jankowski, & Van Rossem, 2008), however, may go undetected until early elementary school or later. These subtle deficits likely have their roots in infancy, contributing to continued difficulties across development.

As children progress academically and developmentally and are faced with increasingly complex cognitive, social, and academic demands, early subtle deficits often worsen and become more pronounced (Taylor, 2010). Thus, intervening early in development to promote success has become increasingly important. During the early childhood years, the neural systems underlying social, emotional and cognitive development undergo rapid reorganization and are especially susceptible to environmental influences (National Research Council and Institute of Medicine, 2000). The parental role during this critical time is one important variable to consider and may have the potential to alter developmental trajectories in high-risk infants to promote optimal success. In typically developing children, the quality of the parent-child interaction is considered to lay the foundation for cognitive and social-emotional development (Sumner & Spietz, 1994; Tronick, Ricks, & Cohn, 1982). However, whether early parenting behavior operates similarly for children who are biologically at-risk for adverse outcomes is relatively unknown (Tully, Arseneault, Caspi, Moffitt, & Morgan, 2004).

The purpose of the current study was to test a hypothesized longitudinal model to examine the relations between birth status, parenting behavior, cognitive development, and social-emotional outcomes in a sample of children born preterm and full term across the first five years of life. Using gestational age criteria, this study sought to evaluate whether parenting behavior during years one and two differentially predicted outcomes in children of varying degrees of biological risk when compared to children born full term. Utilizing a large, representative sample of children born preterm, this study addressed previous methodological flaws in extant literature from which sufficient samples and comparisons groups were missing and sought to guide the development of further inquiry and future models that account for the influence of preterm birth on development.

CHAPTER 2
LITERATURE REVIEW

The following chapter reviews research literature emphasizing neurodevelopmental outcomes related to preterm birth and the neuropathology of preterm birth. Subtle deficits associated with preterm birth are discussed within a neurobiological framework, specifically the hierarchical-vertical integrative model (Geva & Feldman, 2008). A broad overview of cognitive and social-emotional outcomes associated with preterm birth follows, with an emphasis on early childhood outcomes. Parenting behavior related to cognitive and social-emotional outcomes in children, regardless of premature birth is briefly discussed. Next, parenting behavior in the context of preterm birth as a potential protective factor to mitigate risks associated with preterm birth is reviewed. The chapter concludes with the purpose of the present study, pulling together the literature to inform the study's research questions.

Introduction to Preterm Birth

The length of a child's gestation is one of the most important predictors of subsequent health and development (Behrman & Butler, 2007; Fogel, 2009). Advances in medical technologies have contributed to increased survival rates of infants born preterm over the past few decades. In the 1980s, progressive obstetrical and delivery room care was applied to the smallest and most immature infants, rescuing neonates born as early as 23 weeks gestation (Fanaroff, Hack, & Walsh, 2003). While infants are afforded opportunities to live, subsequent costs of care, length of hospitalization, and neonatal morbidity have been exceptionally high as compared to those of bigger, more mature neonates (Fanaroff et al., 2003). Today, preterm birth contributes disproportionately to neonatal mortality and morbidity and, to subsequent physical and neurodevelopmental disabilities (Colvin et al., 2004).

Prevalence and Incidence

Infants born preterm, before 37 weeks gestation, accounted for 12.5% of all United States (US) live births in the year 2004 (Behrman & Butler, 2007). The following year, preterm births remained relatively stable with 12.7% of all live US births meeting criteria for preterm birth (Hamilton, Martin, & Ventura, 2006). Today, this percentage has remained steady. This percentage represents an increase of 20% since 1990 and has risen steadily over the past two decades (Behrman & Butler, 2007; Hamilton et al., 2006). Similarly, the number of infants born with low birthweights, less than 2,500 grams, has increased 20% since the mid-1980s, accounting for approximately 8% of all live US births in 2004 (Martin et al., 2006). Late preterm infants, born between 34 and 36 weeks gestation, account for approximately 9% of all live US births and make up the greatest number of preterm births. Infants born between 32 and 33 weeks gestation account for approximately 1.6% of all live US births and infants born before 32 weeks gestation currently represent approximately 2% of all live US births. Thus, the upward trends of preterm birth can be mostly attributed to increases in late preterm births (Martin et al., 2006), and changes in survival in infants born extremely and very preterm.

Significant advances in neonatal care have influenced declines in mortality rates in infants born at the lowest limits of vitality, and have also influenced the increase in the number of late-preterm infants, born between 33 and 36 weeks gestation. Late preterm infants are physiologically and metabolically immature, contributing to increased medical complications that could result in higher rates of mortality and morbidity during birth hospitalization when compared to their full term peers (Engle, Tomashek, & Wallman, 2007). Clinical reports have also found increased rates of cerebral palsy, neurodevelopmental disorders, behavioral difficulties, and social difficulties in late preterm populations, likely due to the immaturity of their nervous systems resulting from being born too early (Engle, Tomashek, & Wallman, 2007). Thus, there is an increased demand for, and cost of care provided to these high-risk infants, born before 37 weeks gestation, during the neonatal period and long-term (Petrou, 2003), placing a significant toll on societal systems.

Economic Consequences of Preterm Birth

The financial and personal cost of preterm birth is substantial, leading Congress to pass the PREEMIE act in 2006, which provides federal support for increased research on prematurity. It is estimated that the annual economic burden of outcomes associated with preterm birth in the United States in 2005 was approximately 26.2 billion dollars, or 51,600 dollars per infant born preterm (Behrman & Butler, 2007). These costs are significantly higher than monetary costs expended for full term births. Medical care alone is estimated to cost 16.9 billion dollars annually. It is evident that an inverse relationship exists between gestational age and hospital service costs during the neonatal period (Petrou, 2003). Following discharge from the hospital, infants born preterm disproportionally rely on and utilize hospital and community health services at greater rates than their full term peers.

The long-term economic costs associated with survival of preterm infants are not isolated and restricted to the health care sector (Petrou, 2003). In terms of long-term expenditures, early intervention services cost 611 million dollars, whereas special education services cost around 1.1 billion dollars annually (Behrman & Butler, 2007). Preterm birth, before 37 weeks gestation, as identified through birth certificate data, has been found to be associated with increased odds for special education referral (Delgado & Scott, 2006) and children who weigh less than 2,500 grams at birth are 50% more likely to be enrolled in some type of special education program (Chaikind & Corman, 1991), are more likely to repeat a grade, and are less likely to receive schooling in a mainstream general education classroom when compared to children born full term with normal birthweights (Saigal, Hoult, Streiner, Stoskopf, & Rosenbaum, 2000). By adolescence, there is an eight- to ten-fold increase in the use of remedial special education services in extremely preterm and very low birthweight children when compared to control groups (Aylward, 2002a; Saigal et al., 2000; Taylor, Klein, Minich, & Hack, 2000). Indirect costs are also associated with preterm birth and represent indirect consumption of resources that result from disabilities or health difficulties associated with preterm birth. Associated disabilities contribute to overall lost household and labor market productivity, indirectly costing society 5.7 billion dollars annually (Behrman & Butler, 2007). High rates of morbidity resulting from preterm birth and low birthweight impose immense burden on health, education, social services, and mental health systems and produce substantial emotional costs to families and communities (Mattison, Damus, Fiore, Petrini, & Alter, 2001).

Approximately 80% of preterm births are spontaneous and 60% of preterm births continue to go undetected (Behrman & Butler, 2007; Goldenberg, & Rouse, 1998; Taylor, 2010; Tiedje, 2003). Research on preterm birth is overwhelming, extensive, and two-fold. The challenge remains for researchers and practitioners to identify ways to prevent the occurrence of preterm birth and/or delay the gestational period, while reducing the mortality and morbidity of the infant and the mother (Goldenberg & Rouse, 1998). Second, once preterm birth occurs, it is critical to identify ways to optimize health and development through the identification of early interventions that ameliorate associated neurodevelopmental adversities and reduce the incidence of long-term disabilities in the most effective, comprehensive manner that reduces long-term costs. Preterm birth does not automatically predict a specific life course trajectory or contribute to one fixed outcome. Thus, neurological health risks range from severe to mild and tend to correspond with biologic immaturity due to decreased gestational periods. For this reason, classification systems are currently utilized in practice and research to define preterm birth, describe potential associated outcomes, and to guide treatment planning.

Defining Preterm Birth

The World Health Organization (WHO) and March of Dimes define preterm birth as delivery prior to 37 weeks gestation. Gestational age is reported as the number of completed weeks from conception until birth, or duration of pregnancy (Fogel, 2009) and is based on menstrual history, early pregnancy examination, laboratory data and/or ultrasonographic examination (Lorenz, 2001). Full term birth is defined when infants are born anywhere between 37 and 42 weeks gestation. Infants are considered preterm if birth occurs before 37 weeks, very preterm (VP) if born before 32 weeks, and extremely preterm (EP) if born before 28 weeks gestation. Historically, birthweight was utilized as an indicator of preterm birth due to difficulties obtaining accurate estimates of time of conception. Due to the widely acceptable use of birthweight as an indicator of preterm status, much of the literature report outcomes of preterm birth based on birthweight criteria, rather than gestational age. Studies often examine the effects of being born at a weight that is lower than what would be expected given an infant's gestational age, a condition known as smallness for gestational age or intrauterine growth retardation (IUGR; Taylor, 2010). Thus, infants who weigh more than 2,500 grams, or 5 pounds, 8 ounces, at birth (e.g. 37 weeks) are considered normal birthweight. Infants who weigh between 1,500 and 2,500 grams are considered low birthweight (LBW). Infants are considered very low birthweight (VLBW) if they weigh less than 1,500 grams or 3 pounds, 5 ounces and extremely low birthweight (ELBW) if they weigh less than 1,000 grams or 2 pounds, 3 ounces at birth.

Birthweight tends to parallel gestational age and although can be a good indicator of adequacy of fetal growth, it often fails to identify all infants born preterm. Further, relying solely on birthweight may result in an overrepresentation of children with intrauterine growth restriction for whom the consequences differ for those of immaturity (Delobel-Ayoub et al., 2006). Thus, it is recommended that outcomes of preterm birth be reported by gestational age categories (Behrman & Butler, 2007; Delobel-Ayoub et al.). Few studies rely solely on gestational age, however, to report outcomes of preterm birth (Behrman & Butler; Lorenz, 2001). More recently, advances in prenatal technologies have enabled medical providers to obtain more accurate estimations of gestational age by evaluating fetal growth and development using ultrasound techniques. Both birthweight and gestational age are used interchangeably throughout the literature making it difficult to summarize and draw consistent conclusions on outcomes. Moreover, preterm birth is often associated with low birthweight, making it difficult to completely separate these two indicators. It is clear, however, that lower gestational ages are associated with increased severity and substantial neurological risks.

Neurological Risks Associated with Preterm Birth

Approximately 75% of perinatal deaths occur among preterm infants (Slatterly & Morrison, 2002). At 26 weeks gestation, reported infant survival ranges from 75% to 93%. There is a significant corresponding increase in survival with each week increase in gestation, with high rates of complications occurring at the lower limits of viability (Behrman & Butler, 2007; Colvin et al., 2004). Because the period between 20 and 32 weeks gestation is one of rapid brain growth and development, the most substantial neurological impairments occur in infants born before 32 weeks gestation (Behrman & Butler, 2007; Colvin et al., 2004). However, infants born between 32 and 36 weeks gestation, who make up the greatest number of preterm births, are at higher risk for health and developmental problems when compared to their full term peers (Behrman & Butler, 2007; Johnson & Marlow, 2006).

Outcomes of preterm birth are highly variable and neurological risks associated with preterm birth range from severe to mild. Severe disabilities often require additional assistance for children to perform daily activities, are typically identified at birth, more likely to remain stable over the course of development, and are less amenable to change through environmental resources. Common forms of severe early childhood neurodevelopmental disabilities include cerebral palsy, blindness, deafness, seizure disorders, or significant cognitive impairment (Colvin et al., 2004; Marlow et al., 2005; Wood, Marlow, Costeloe, Gibson, & Wilkinson, 2000). Severe medical conditions have profound effects on later development, although the majority of infants born preterm who survive will avoid having a severe disability (Colvin et al., 2004; Lorenz, 2001). Infants born preterm who escape severe neurological impairment have a higher incidence of subtle disorders of central nervous system (CNS), including mild cognitive impairments, learning disabilities, attention deficits, neuro-motor dysfunction, developmental coordination disorder, behavioral problems and social-emotional difficulties, all of which are typically detected later in life and adversely affect academic performance (Behrman & Butler, 2007; Bhutta et al., 2002). This noted variability in outcomes is associated with the extent of prematurity and medical complications experienced at birth (Taylor, 2010). There are numerous ways in which an immature brain can be injured by premature delivery resulting in mild to severe neurological sequelae.

Neuropathology of Preterm Birth

Early brain development involves a complex, temporal sequence of events including the production of neurons, their migration and maturation, apoptosis (i.e. programmed cell death), development of interneuronal connections, and synaptic pruning (Jacobson, 1991, as cited in Allin et al., 2004; Taylor, 2010). Being born too early can substantially disrupt the normal process of brain development and subsequently contribute to adverse developmental outcomes, including cerebral palsy, mental retardation, and subtle late effects (Hoon, 1995). The primary processes responsible for significant brain damage during this period are hypoxic-ischemia, or deprivation of oxygen that causes damage to cells in the CNS, exposure to fetal and maternal infection (e.g. sepsis), and under-nutrition (Hoon, 1995; Inder & Volpe, 2000). In addition to other medical complications preterm babies may experience, including respiratory and cardiovascular distress, preterm birth places infants at-risk for hemorrhaging due to the neurological and vascular immaturity of the preterm neonate. Increased ventricular pressure, which occurs with hemorrhaging, damages immature brain cells and contributes to long-term deficits commonly seen in children born preterm. Several types of acquired lesions of the CNS are associated with hypoxic-ischemia and include, a) germinal matrix-intraventricular hemorrhage (GM-IVH), especially with periventricular hemorrhagic infarction of white matter; b) periventricular hemorrhage (PVH); c) periventricular leukomalacia (PVL) with accompanying neuronal/axonal abnormalities; and d) posthemorrhagic hydrocephalus. These are the most common and critical complications experienced in extremely preterm neonates (Volpe, 1998; 2003).

The germinal matrix, which supports the development of cortical neuronal and glial cells that migrate to the cortical layers (Behrman & Butler, 2007), is the site of origin for PVH-IVH (Annibale & Hill, 2008). GM-IVH can cause damage to the neural precursor cells residing in the germinal matrix, which contribute not only to immediate damage, but can inhibit appropriate functioning of neural cells derived from the germinal matrix (Raz et al., 1994). Most PVH-IVH occur quickly after birth (within 72 hours) and severe IVH leads to disabilities that are stable over time, such as cerebral palsy, hydrocephalus and seizure disorders (Colvin et al., 2004). Less severe forms of PVH-IVH contribute to little to moderate effects on long-term cognitive and neuromotor development (Gardner, 2005). More severe grades of IVH are less common and documented in only a minority of preterm infants; the likelihood of these severe incidences increases with the degree of prematurity (Inder & Volpe, 2000). Neuroimaging studies indicate that PVL, in its various forms, is more common in preterm neonates (Volpe, 2009).

PVL refers to injury to cerebral white matter and is characterized by severe focal and less severe diffuse cerebral white matter injury, including destruction of neurons in the periventricular white matter, diffuse destruction of oligodendrocytes (i.e. myelin precursors), impaired myelination, and decreased total cerebral white matter (Volpe, 2001). PVL is often associated with neuronal/axonal damage, which is often termed “encephalopathy of prematurity” (Volpe, 2009). Of significant concern is the downstream effect of such disruptions, where early disturbances build upon one another and primary injuries result in subsequent, maturational impairments, specifically impairments in myelination and cortical and thalamic development (Volpe, 2009). Because PVL causes the death of axons, it leads to subsequent incomplete or delayed myelination (Volpe, 1998). Additionally, neurons undergoing mitosis or migration are especially vulnerable and may be adversely, and diffusely affected (Johnston, 1998). Such neurologic insult can profoundly and subtly affect children’s developmental trajectories and functioning over time (Gardner, 2005).

Magnetic Resonance Imaging (MRI) capabilities have identified structural abnormalities in school-age children, adolescents and adults who were born preterm. Variations observed include an excess of ventricular dilation, thinning of the corpus callosum and white matter deficits (Allin et al., 2004; Fearon et al., 2004; Nosarti et al., 2002), providing evidence that early disruptions persist into adolescence and adulthood. Nosarti and colleagues (2002) used structural MRI to examine whole brain, white matter, grey matter and bilateral hippocampal volumes, and ventricular size in a cohort of adolescents (14 to 15 years) born before 33 weeks gestation, and an aged-matched full term comparison group. A 12% reduction in grey matter was found in adolescents born very preterm, which they concluded likely resulted from early disruptions in normal cortical development. Since grey matter volume triples during the last trimester, preterm infants are especially vulnerable to disruptions in this area. A significant difference between ventricular volumes was found between the two groups in which the adolescents born preterm displayed more frequent occurrences of ventricular enlargement, confirming previous findings (Maalouf et al., 1999). Moreover, reduction in grey matter often corresponds with smaller volumes for the whole brain, decreased white matter, and smaller volumes for cortical and subcortical grey matter and the cerebellum (Limperopoulos et al., 2005; Nosarti et al., 2002; Peterson et al., 2003; Srinivasan et al., 2007). Additionally, identified reductions in region-specific areas have been documented in children born very preterm/very low birthweight when compared to full term controls. Reductions have been observed in the temporal, parietal, and occipital lobes, basal ganglia, corpus callosum, amygdala, hippocampus, thalamus, cerebellum, and circuits connecting subcortical structures to the frontal lobes (Allin et al., 2001; Isaacs et al., 2000; Nosarti et al., 2004; Srinivasan et al., 2007; Taylor, 2010). Reduced white matter density has also been found in individuals with very low birthweights.

Over the past 25 years the medical field has seen an upsurge in the number of research articles that have documented neurological complications that contribute to severe outcomes in very premature infants' medical, physical, and behavioral health (Msall & Park, 2008). This upsurge is likely due to the fact that severe disabilities are easier to detect than more subtle ones. However, the majority of extremely premature, very premature, and premature infants who survive will escape severe neurological insult (Colvin et al., 2004; Lorenz, 2001). Instead, a large percentage of children born preterm will display late effects, resulting from subtle injury to the CNS (Behrman & Butler, 2007; Msall & Park, 2008; Volpe, 2009). Children at age 12, who were born preterm, continued to show deficits in intellectual functioning, even after excluding those with severe brain injuries (Luu, Ment, Schneider, Katz, Allan, & Vohr, 2009). It is likely that children born preterm, who avoid severe, identified neurological insult at birth, experience unrecognized neonatal cerebral insults that lay the foundation for subtle, later emerging deficits. It is these subtle disabilities that have received increased attention recently. Health care providers and researchers have shifted their perspective to evaluate behavioral, academic, and psychological outcomes in children who are born preterm. Less research has focused exclusively on preterm infants, born between 33 and 37 weeks gestation because they often appear similar to full term infants and consequently, are treated as such (Darnall, Ariagno, & Kinney, 2006). In reality, however, these late-term premature infants experience subtle deficits consistent with very preterm and extremely preterm infants (Behrman & Butler, 2007; Engle, Tomashek, & Wallman, 2007; March of Dimes, 2010). These subtle deficits, though not obvious at birth, span social, academic and cognitive domains.

Considerable research has found that cognitive, academic, social, and behavioral deficits in children born preterm remain stable or worsen once the onset of schooling occurs (Taylor, 2010). In many instances, deficits worsen with age as children born preterm face increasingly difficult cognitive and social demands (Hille et al., 1994). These difficulties likely have their roots in infancy, as cognitive, attention, and behavioral delays are evident shortly after birth and within the first years of life in preterm infants (Anderson & Doyle, 2007; Stoelhorst et al., 2005; Taylor, 2010). Less research has documented how subtle, late effects, which emerge during school entry and beyond, evolve in children born preterm from a developmental perspective (Geva & Feldman, 2008). Recently, a developmental, hierarchical vertical-integrative neurobiological model was introduced as a means to explain the early mechanisms that likely contribute to adverse outcomes in cognitive, attention, behavioral, and executive functions (e.g. inhibition, planning, effortful control) seen in children born preterm. The theoretical foundation of the current study rests on Geva and Feldman's (2008) neurobiological model and examines the relative influence of the environment during early childhood in contributing to associated developmental outcomes in children born preterm.

Neurobiological Model of Subtle Late Effects

The developmental, hierarchical vertical-integrative model (Geva & Feldman, 2008) has recently been introduced to explain neurobiological abnormalities responsible for attention and behavior deficits seen in preterm infants. The vertical-integrative model offers a unique perspective in which to conceptualize the effects of neonatal brainstem dysfunction on the development of behavioral and emotion regulation capacities, and the role of the environment in shaping these developmental outcomes (Geva & Feldman, 2008). The current study aligns with aspects of this theory to examine the relative influence of early social interactions on the development of cognitive, social and emotional capabilities during early childhood and the period of school entry in children born preterm.

It is conceptualized that regulatory functions are processed along three core brain systems, the brainstem, limbic, and cortical systems (Geva & Feldman, 2008). These three core brain systems organize behavioral output (Tucker, Derryberry, & Luu, 2000; Feldman, 2009) and are integrated into the vertical-integrative hierarchical system (Geva & Feldman, 2008). This developing system draws upon brainstem-related homeostatic systems that provide a physiological foundation (e.g. regulation of internal states, such as hunger and satiety, regulation of sleep-wake cycles, circadian regulation of arousal, and cardio-respiratory regulation) for which the regulation and development of arousal, attention, and emotional reactivity rely (Geva & Feldman, 2008). In turn, the development of arousal, attention, and emotional reactivity drive higher-order social and emotional regulatory capacities, including effortful control, and socio-cognitive processes, which emerge during preschool and kindergarten entry (Geva & Feldman, 2008). Thus, lower-level physiological systems lay the foundation and influence the development of higher-level mechanisms of cognitive control, including the development of attention, emotions, and self-regulation (Feldman, 2009), deficits typically identified in children born preterm and examined in the current study.

Because brainstem-related systems undergo rapid developmental maturation during the last trimester of gestation (33 to 38 weeks gestation; Darnall, Ariagno, & Kinney, 2006), infants born preterm are at-risk for specific developmental disruptions to this system (Geva & Feldman, 2008). Early disruptions to brainstem-related functions have been documented in preterm neonates using auditory brainstem evoked responses (ABR). ABR anomalies are substantially greater in large samples of preterm infants with neurological impairments, including brain insults and hypoxic-ischemia (Galambos, Hicks, & Wilson, 1982; Karmel, Gardner, Zappulla, Magnano, & Brown, 1988; Murray, 1988; Salamy & Eldredge, 1994) and in preterm infants without hypoxic-ischemic encephalopathy (Jiang, Xiu, Brosi, Shao, & Wilkinson, 2007). Consistent with previous research (Volpe, 2001), these early anomalies reflect poor myelination of early-maturing brainstem systems adversely, which consequently affect the integration of high-order systems (Geva & Feldman, 2008).

A *developmental,* hierarchical-integrative approach highlights this sequential development of regulatory functions and includes a bottom-up component (e.g. hierarchical) where physiological, emotional, attentional, and self-regulatory capacities develop on top of one another (Edelman, 2004), and an integrative component, in which the brain stem, limbic system, and cortical systems all synchronize to achieve a targeted goal (Feldman, 2009; Tucker et al., 2000). Higher order regulatory capacities are enabled via the development and maturation of new skills. Processes at each new level integrate and incorporate functioning at lower levels. Even minor, undetectable disruptions at lower levels can inhibit or lead to dysfunctions in higher systems (Feldman, 2009), and may explain why subtle effects seemingly emerge over time.

As higher-order regulatory processes emerge, they serve different purposes depending on the child's age. In the neonatal period, or the month following birth, the infant's regulatory goal is to maintain physiological homeostasis (Feldman, 2009) such as regulating sleep, hunger, and arousal. As these processes become more automatic and the child enters the first year of life, regulatory processes shift to manage external/internal stress and regulate emotional input received from the environment. As the child moves into the toddler stage, regulatory goals include attention processes where the child initiates on-task focus and performs goal-directed behavior. The regulatory goals during this stage are enabled by developmental milestones including social, linguistic, and increased motor capacities (Feldman, 2009; Fogel, 2009). As the child enters the preschool stage and begins to develop a sense of self, regulatory processes draw on these skills and allow the child to internalize cultural values and norms, execute more complex actions (e.g. memory capacities), and develop self-regulatory capabilities. The developmental hierarchical-integrative model emphasizes that functioning at each level incorporates lower level processes and thus, minor disruptions at lower levels implicate and contribute to dysfunctions seen at higher-levels (Feldman, 2009). This developmental trajectory is of particular importance to children born preterm because preterm infants have greater likelihoods of encountering specific developmental disruptions to this system (Geva & Feldman, 2008).

Empirical Support. During the late fetal and early neonatal periods, the physiological regulatory systems are said to undergo significant developmental changes; the early primitive brain composed of the brainstem and cerebellum is involved with vital physiological functions including respiration, homeostasis and movement (Darnall, Ariagno, & Kinney, 2006). When infants are exposed to perinatal or neonatal risks during these developmental changes, these risk factors affect the brainstem functions and adversely affect regulation of state, hunger, heart, and lung responses (Darnall et al., 2006). Recently, Feldman (2009), found a significant main effect for physiological risk in preterm infants with a mean gestational age of 31 weeks (range = 25 to 35 weeks gestation). Physiological regulation at 32 and 37 weeks was measured via time-series of sleep-wake states and cardiac vagal tone, which measured the effects of respiration on heart-rate variability. Additionally, CRIB (International Neonatal Network, 1993), a quantitative measure of neonatal risk for preterm infants that evaluates birthweight, gestational age, congenital malformations, and oxygen intake, was utilized to created a total CRIB score, whereby higher scores indicated higher risk. Infants born with higher risks had lower cardiac vagal tone (Vna) at both 32 and 37 weeks gestation, and demonstrated less organized sleep-wake cycles at 37 weeks. Executive functions at age five were uniquely predicted by physiological regulation measures, and by emotion regulation at one-year of age, and attention regulation at two-years of age. Further, behavioral problems and self-restraint at school entry (age five) were predicted by vagal tone and early emotion regulation and attention regulation across years one and two. Previously, neonatal vagal tone has been shown to predict regulatory outcomes later in life including cognitive development (Doussard-Roosevelt, Porges, Scanlon, Alemi, & Scanlon, 1997), regulation of negative emotions (Huffman et al., 1998) and behavioral problems displayed by children at age six (Doussard-Roosevelt, McClenny, & Porges, 2001). Consequently, infants' difficulties in regulating basic physiological functions such as sleep, feeding, or self-soothing during the neonatal stage likely disrupts the management of negative emotions or the development of inhibitory control (Geva & Feldman, 2008), which may contribute to long-term attention deficits, or hyperactive symptoms.

During the first year of life, infants' regulatory processes shift to manage external/internal stress and regulate emotional input received from the environment (Fogel, 2009). Infants learn how to detect, and express emotions and begin to employ behavioral strategies to help modulate arousal and/or excitement (Haley & Stansbury, 2003). Infants born preterm with high biological risk express more negative emotions and demonstrate fewer regulatory behaviors when presented with aversive tasks. Early physiological systems have been found to influence emotional regulatory behavior. Specifically, intact early physiological systems (e.g. organized sleep-wake cyclicity) have been found to predict behavior organization and emotional regulation, in the first months of life (Feldman, Weller, Sirota, & Eidelman, 2002) and cognitive development and attention outcomes up until 4 years of life (Anders, Keener & Kraemer, 1985; Beckwith & Parmalee, 1986) in both preterm and full term infants.

A higher regulatory capacity that undergoes significant re-organization during the second year of life is the attention system. During years two and three, toddlers acquire the ability to focus attention on one task while inhibiting other distractions, allocate attention to different sources, and categorize and hold tasks in memory (Feldman, 2009). Thus, toddlers become capable of actively sustaining attention to one task (Feldman, 2009), supporting early cognitive processes. This re-organization results from the integration of the core brain systems, specifically the maturation of the prefrontal cortex that enables focused attention, effortful control, and inhibitory or delayed responses (Diamond, 2002), and promotes the emergence of the executive attention system during the preschool stage (Davis, Bruce, & Gunnar, 2002). Abnormal medical and neurological status, low gestational age, low birthweight, and higher neonatal risk at 18- and 30-months have been associated with lower attention capabilities at age 4 (McGrath et al., 2005). Research has demonstrated that frontal areas have been activated by tasks requiring shifts in attention, or cognitive shift-switching deficits that are commonly observed in children born preterm (Harvey, O'Callaghan, & Mohay, 1999). Impaired attention capabilities during years four and five may act as precursors to a later diagnosis of Attention Deficit/Hyperactivity Disorder (ADHD), as inattentive symptoms become more apparent during school age (McGrath et al., 2005). Regardless of later diagnoses, difficulties in attention during years two and three likely hinder the development of self-regulatory capacities that begin to develop during years four and five and contribute to deficits in behavioral regulation as evidenced by internalizing and externalizing symptoms displayed during early school years (Clark, Woodward, Horwood, & Moor, 2008). Finally, internalizing and externalizing symptoms, which emerge during school entry, have been associated with early physiological deficits, specifically cardiac vagal tone in the neonatal period (Doussard-Roosevelt et al., 2001).

Parental Influence on System. Environmental factors cannot be ignored when examining the development of regulatory capacities from a neurological perspective. Regulatory capacities do not occur in isolation. The ongoing interaction that occurs between the child and the social environment in shaping and contributing to developmental and behavioral outcomes is critical (Cicchetti & Cohen, 1995; Geva & Feldman, 2008). Because preterm infants are vulnerable to neurologic insult and disruptions to their developmental systems, specific physiological risk factors may be more disruptive to the infant's social environment and certain environments may be more or less ready to meet the needs of a medically involved infant (Geva & Feldman, 2008) ultimately shaping specific developmental trajectories (Sameroff & Rosenblum, 2006). For example, a child with more regulated physiological systems (e.g. sleep-wake cyclicity or hunger) will likely demonstrate increased positive affect and elicit more positive parenting behavior, which in turn, will lead to improved emotional regulation, and set the foundation for the subsequent developmental processes (Geva & Feldman, 2008). Thus, children born full term, with no neurological risk will likely present with more regulated dispositions contributing to optimal parental responses and consequently, optimal cognitive and behavioral development.

Developmental Outcomes Associated with Preterm Birth

Despite initial optimism that premature babies may "catch up" with their same-age peers, considerable research has documented that this is not the case. Cognitive, learning and/or behavioral problems likely persist well into adolescence (Cook, 2004; Gardner et al., 2004; Saigal et al., 2000) and adulthood (Moster, Lie, & Markestad, 2008). Children born preterm and with low birthweights are at-risk for lower general intelligence (Anderson & Doyle, 2008; Bhutta et al., 2003), specific cognitive deficits (e.g. attention deficits; Anderson, 2002; Anderson & Doyle, 2004; Taylor, Hack, & Klein, 1998a), motor deficits, and behavioral and emotional problems (Botting, Powls, Cooke, & Marlow, 1997), all of which can contribute to, or are associated with academic and learning difficulties (Bhutta et al., 2002; Volpe, 1995; 1997).

Cognitive Outcomes

Impairments in cognitive functioning have been well documented in children born preterm, born between 32 and 37 weeks gestation, as well as children born very preterm, extremely preterm, and with low birthweights. In an attempt to examine the etiology of mental retardation (MR), Stromme & Hagberg (2000) found that children born with low gestational age (< 32 weeks) and low birthweight (< 2,500 grams) were significantly overrepresented in a sample of children, ages 8 to 13 years, who had severe and mild mental retardation. Although preterm birth is associated with increased risk for experiencing a significant cognitive impairment, children born preterm composed only 4% of the total sample of children with mental retardation. It is more likely that children born preterm will experience more subtle cognitive delays that become evident at school age, even in those children who are free of severe intellectual disabilities (Allen, 2002; Aylward, 2002a; Bhutta et al., 2002; Johnson, 2007).

Intelligence is often positively correlated with gestational age and/or birthweight. Children born with greater gestational ages and birthweights have been found to exhibit higher scores on standardized tests (Bhutta et al., 2002; Saigal et al., 2000). Specifically, in very preterm children, mean IQ score appears to decrease by 1.7 points with every week decrease in gestational age (Bhutta et al., 2002; Johnson, 2007). Significant cognitive impairments have been reported in the EPICure cohort (n = 241), a cohort of extremely preterm children (< 26 weeks gestation) born in the United Kingdom and Ireland in the year 1995, when children were 6-years-old (Marlow et al., 2005). Specifically, the mean difference in scores for overall cognitive ability, as measured by the Kaufman Assessment Battery for Children (K-ABC; Kaufman &

Kaufman, 1983), between children born extremely preterm and a group of comparison children was 24 points; children born extremely preterm performed lower on all subscales compared to full term peers. Twenty one percent of the extremely preterm children were classified as having a moderate to severe cognitive impairment, whereas no one in the standardized comparison group was considered cognitively impaired. Forty one percent of children born extremely preterm scored two standard deviations below the mean, when compared to only two percent of classroom peers.

The degree of intellectual impairment seen in the EPICure study was significantly greater than what has been reported in other studies documenting cognitive outcomes in extremely preterm children; however, the consistency with which cognitive deficits have been reported in the literature is overwhelming. For example, Whitfield, Grunau, and Holsti (1997) reported a mean IQ of one standard deviation below the mean in a low birthweight sample compared to term born controls. Similarly, a Finnish study of extremely preterm children reported a mean IQ of 94 using the Wechsler Preschool and Primary Scales of Intelligence (WPPSI, Wechsler, 2002), however, neglected to compare these scores to a control group (Mikkola et al., 2005). An early meta-analysis conducted in 1989 documented that children (n = 4,000) born with low birthweights (< 2,500 grams) had an overall mean IQ that was five to seven points lower when compared to full term controls (Aylward, Pfeiffer, Wright, & Verhulst, 1989). Recently, Bhutta and colleagues (2002) conducted a meta-analysis of 15 case-control studies, which included 1,556 children born preterm and 1,720 controls, where children ranged from five-years to fourteen-years of age. Significantly lower cognitive scores were reported for the 1,556 children born preterm when compared to full term peers, with a weighted mean difference of 10.9 (95% CI 9.2 – 12.5). Cognitive scores were lower in children born preterm even in studies that excluded children with severe disabilities who could not be administered tests of cognition. Although it is clear that children born extremely preterm tend to perform lower on standardized intelligence tests when compared to same-age children born full term, great variability exists in terms of intellectual severity and reported IQ scores, which have ranged from severely impaired (IQ < 55; Stromme & Hagberg, 2000) to average (IQ > 90; Mikkola et al., 2005). Mean cognitive test scores, however, appear to be significantly correlated with birthweight and gestational age with below average or low average scores consistently reported in children born preterm (Bhutta et al., 2002).

Hack and colleagues (1994) conducted a longitudinal neuropsychological study in which they investigated cognitive and educational outcomes in a sample of extremely low birthweight children (< 750 grams; n = 68) born between the years 1982 and 1986, and two matched comparison groups, which included a group of children with low birthweights (between 750 and 1,499 grams; n = 65) and children with normal birthweights born full term (n = 61). The mean Mental Processing Composite (MPC) obtained from the K-ABC (Kaufman & Kaufman, 1983) when study children were 6 to 7 years old, was 87, 93, and 100, for extremely low birthweight, low birthweight, and term children, respectively. Half of the extremely low birthweight group had intellectual impairments, with approximately 21% exhibiting a severe impairment, in comparison to only 28% in the low-birthweight group and 16% in the full term group demonstrating intellectual impairments. Differences in measures of cognition and psychomotor functioning remained significant even when comparisons were further restricted to children who were both neurologically intact and of normal intelligence (Hack et al., 1994), providing additional evidence for subtle cognitive deficits seen within high-risk infants. When re-assessed during middle school (11 years), the extremely low birthweight group showed continued declines in IQ scores when tested using the Wechsler Intelligence Scale for Children, 3rd Edition (WISC-III; Wechsler, 1991), whereby the mean IQ was 78, 89, and 99 for the extremely low birthweight, low birthweight and full term children, respectively (Taylor et al., 2000). The percentage of students with a severe impairment increased from 21% during early childhood to 37% during middle school, confirming that children born with low birthweights continue to fall further behind their same-age peers as they progress academically and are exposed to increasingly complex instruction in the classroom and are required to demonstrate the acquisition of higher-order cognitive processes (Anderson & Doyle, 2007; Hille et al., 1994; Taylor et al., 2000).

Researchers have documented that adolescents and young adults who were born preterm continue to demonstrate lower IQ scores compared to same-age peers born full term (Saigal et al., 2000; Hack et al., 2002). Most longitudinal studies have failed to provide evidence that children born preterm eventually catch-up with same-age full term peers (Schneider, Wolke, Schlagmuller, & Meyer, 2004; Taylor, Minich, Klein, & Hack, 2004c). Moreover, some children demonstrate a decline in cognitive performance across time (Botting, Powls, Cooke, & Marlow, 1998; Taylor et al., 2000), even in children without severe developmental handicaps (Taylor, 2010). Because subtle cognitive deficits are often not identified until school entry, they are harder to remediate when difficulties arise. Cognitive delays during early childhood may act to prevent the acquisition of higher-order skills and could be indicative of later deficits.

Early childhood cognitive outcomes. Cognitive deficits in preterm children can be identified as early as toddlerhood. Stoelhorst and colleagues (2003) evaluated the developmental outcomes of toddlers born very preterm in an attempt to identify a developmental profile for high-risk infants. Mental and psychomotor development of 266 infants, born before 32 weeks gestation, were assessed using the Bayley Scales of Infant Development (BSID-I; Bayley 1969) at 18-months and 24-months. Consistent with findings reported in school-age children, mental development indices (MDI) and performance development indices (PDI) in preterm infants were significantly lower than 100 at both ages and the percentage of children identified as moderately and severely delayed in motor and cognitive domains differed significantly from the reference population. The difference in cognitive development between children born preterm and their full term peers appeared to gradually become clearer over the first two years of development and then stabilized or worsened over time (van Baar, Ultee, Gunning, Soepatmi, & de Leeuw, 2006; Taylor, 2010). Similarly, the EPICure cohort of extremely preterm infants were assessed using the Bayley Scales of Infant Development-Second Edition (BSID-II; Bayley, 1993), at 30-months of age (Wood et al., 2000). Mean MDI and PDI scores for children born preterm were 84 and 87, respectively. Over one-half of the children in the EPICure study had a developmental delay or disability at 30-months, with one quarter meeting criteria for a severe developmental disability.

Similar cognitive delays have been documented during preschool (Kilbride, Thorstad, & Daily, 2004) and at age 6 (Marlow et al., 2005). Eighty four percent of children born with extremely low birthweights in preschool had lower IQ scores when compared to full term siblings, even after adjusting their age for prematurity (Kilbride et al., 2004). The Victorian Infant Collaborative Study Group (VICS; 1997) also reported high rates of developmental disability and developmental delay in a sample of toddlers born extremely preterm from two different cohorts born in Victoria, Australia in the 1990s. More recently, the National Institute of Health and Human Development (NICHD) Neonatal Research Center (Hintz Kendrick, Vohr, Poole, & Higgins, 2005) reported short-term outcomes for toddlers born extremely preterm in the years 1993 to 1996 and 1996 to 1999. Only 21% of the children tested using the BSID-II at 18-

and 22-months, age adjusted for prematurity, were classified as typically developing in both cohorts with a median MDI of 75 and 72 and median PDI of 81 and 82 in cohort one and two, respectively.

A greater number of children born preterm, when compared to full term peers, experience developmental delays in more than one domain (van Baar, van Wassenaer-Leemhuis, Briet, Dekker & Kok, 2005). Thus, a global IQ score or single mental development index score may not accurately describe the range of cognitive dysfunctions seen within children born preterm. For example, attention requires receptive engagement, orienting behaviors, and sustained focus, and is considered a fundamental cognitive process that underlies memory, learning, and socialization (Lawson & Ruff, 2004). Mental, motor, and attention deficits have been identified as areas of cognitive processes that are weaker in preterm infants when compared to full term infants (Taylor, 2010) and consequently, should be assessed during early childhood (Johnson & Marlow, 2006). Thus, in the current study, mental development index, performance development index and sustained attention were used as separate indicators of cognitive development (Kline, 2005) and were hypothesized to influence social-emotional outcomes at school entry.

In a recent longitudinal study, van Baar and colleagues (2006) found significant differences between children born preterm and full term at age 10 in the areas of somatic, neuro-motor, cognitive, and social-emotional development. Specifically, more than half of the preterm population had difficulties at school as indicated by participation in special education, grade retention, classroom difficulties, and mental health diagnoses (e.g. ADHD). A retrospective analysis of participants' developmental trajectory revealed cognitive differences between the preterm and full term groups at 12-months of age, with clearly divergent trajectories beginning in year two. Within the preterm group, two subgroups were identified, children with and without school problems at age 10. The subgroup without significant school problems at age 10, demonstrated a developmental pattern comparable to the full term group, although they displayed consistently, slightly lower cognitive scores across time. The children born preterm with school difficulties at age 10 displayed increasingly greater cognitive and motor delays across the first three years of life, in which the delays stabilized thereafter. Results of this study are weakened by the small sample size of 38 preterm infants, and whether environmental factors contributed to differences in school success at age 10 is relatively unknown. It is likely that these early developmental delays serve as underlying precursors to neuropsychological deficits that contribute to adverse social-emotional deficits, including attention, hyperactivity, internalizing and externalizing difficulties seen during school entry and beyond. These deficits occur even in low-risk children born preterm without global cognitive impairments or when IQ is controlled for (Edgin et al., 2008; Espy et al., 2002; Vicari, Caravale, Carlesimo, Casadei, & Allemand, 2004).

Social-Emotional Outcomes

Children born preterm are at increased risk for social and emotional problems, evident shortly after birth (Taylor, 2010), during school entry, early elementary school (Bhutta et al., 2002; Samara, Marlow, Wolke, & EPICure Study Group, 2008), and into adolescence and early adulthood (Hack et al., 2004; Indredavik et al., 2005; Indredavik et al., 2004; Saigal, Pinelli, Hoult, Kim, & Boyle, 2003b). Most consistently, children born preterm have been found to be at greater risk for developing internalizing behavioral problems (e.g. anxiety, withdrawal), externalizing behavioral problems (e.g. hyperactivity, inattention, aggression), and social and peer relationship problems (Anderson & Doyle, 2003; Bhutta et al., 2002; Hoff, Hansen, Munck, & Mortensen, 2004; Hoy et al., 1992; McCormick, Workman-Daniels, & Brooks-Gunn, 1996;

Sykes et al., 1997). Most often, these behavioral difficulties are elicited from parents and teachers to garner a clearer understanding of difficulties across multiple contexts. Based on the current literature, social and emotional difficulties are more common in children born preterm when compared to their full term peers.

Attention Outcomes in Preterm Infants. Studies have consistently documented attention deficits in children born preterm (Elgen, Lundervold, & Sommerfeld, 2004; Shum et al., 2008), which adversely affect school performance (Bhutta et al., 2002). Attention deficits are complex and are composed of several processes that develop throughout infancy, childhood and into adolescence (Pizzo et al., 2010). The development of attention networks in infants, toddlers and preschoolers born preterm is reviewed by van de Weijer-Bergsma, Wijnroks, and Jongmans (2008) using a cognitive neuroscience model. During the first six months of life, infants are able to orient or shift their attention to specific locations in the environment; this system becomes fully functional during the first year of life, at which point attention is governed by novelty of objects and events. Between three and six months of age, infants begin to develop capacities to disengage their attention (Colombo, 2001; 2002), and later, around seven months, they are able to sustain attention enabling exploration and manipulation of objects in the environment. Significant changes in attention systems occur between 18- and 24-months, at which point infants increase their ability to manage their attention while inhibiting potential distracting stimuli allowing them to plan and self-generate the direction of their attention (van de Weijer-Bergsma et al., 2008). During preschool, children are required to sustain attention for longer periods of time in the context of events that may be intrinsically uninteresting.

This developmental attention system appears to be compromised in children born preterm (Rose, Feldman, & Jankowski, 2001; 2002). Infants born preterm have been found to display less efficient disengagement and shifting of attention as measured through habituation and novelty preference tasks, in which longer looking durations and slower shift rates reflected less mature attention skills when infants were approximately six to seven months (Bonin, Pomerleau, & Malcuit, 1998; Landry, Leslie, Fletcher, & Francis, 1985; Rose, Feldman, McCarton, & Wolfson, 1988; Rose et al., 2001; 2002). In preschool and early school ages, executive dysfunction has been observed and reported in children born preterm where difficulties inhibiting attention to irrelevant tasks have been found (Espy et al., 2002; Woodward, Edgin, Thompson, & Inder, 2005). Schooling requires that children select what they attend to, while inhibiting their attention to irrelevant stimuli. Additionally, children are required to sustain attention in order to persist and complete required tasks, and engage in other functions including memory, planning, and switching focus from one task to another.

In terms of attention problems, earlier studies have shown that children born with low birthweights, between 1,500 and 2,500 grams, performed more poorly on selective attention tasks at 6-years of age, when compared to normal birthweight compares (Breslau, Chilcoat, DelDotto, Andreski, & Brown, 1996). Similarly, a sample of children ages 5 to 9 years who were born extremely preterm performed worse than normal birthweight controls on sustained attention and set shifting tasks (Taylor, Hack, & Klein, 1998a). These same children, at later ages, demonstrated difficulties in selective attention (Taylor, Minich, Klein, & Hack, 2004c). Deficits have also been reported in areas of initiation, inhibition, and selective attention in children born with very low birthweights at 5.5 years of age (Bohm, Katz-Salamon, Lagercrantz, & Forssberg, 2002). More recently, using gestational age as an indicator of preterm birth, Deforge and colleagues (2006) found deficits in attention efficiency processes in a sample of 8- to 10-year-olds who were born between 28 and 36 weeks gestation. Dysfunction within these attention networks, as demonstrated by decreased attention, inhibition, sustained focus, and limited effortful control, may be indicative of cardinal features of Attention-Deficit/Hyperactivity Disorder (ADHD), a common and well documented childhood psychiatric disorder characterized by symptoms of inattention, impulsivity, and hyperactivity, and is more frequently diagnosed in children born preterm (American Psychiatric Association, 2000; Aylward, 2002a; Bhutta et al., 2002; Mick, Biederman, Prince, Fischer & Faraone, 2002).

Bhutta and colleagues (2002) conducted a meta-analysis to examine the incidence of behavioral difficulties, including ADHD, in children born preterm. In examining fifteen case-control studies, ten (67%) assessed for symptoms of ADHD. Children born preterm had a significantly higher prevalence of attention problems during school age compared to peers born full term and had a 2.65-fold risk for developing ADHD. An earlier study using birthweight as an indicator of prematurity, reported that 24% of their sample of extremely low birthweight children had been diagnosed with ADHD (O'Callaghan & Harvey, 1997). Others have found that low birthweight predicted ADHD symptoms at age five (Tully et al., 2004). Increased memory deficits and symptoms of hyperactivity in children born preterm have been documented (Hack et al., 1992). Cognitive, social, and academic outcomes appear to be negatively influenced for these children as well (O'Callaghan & Harvey, 1997). The Scottish Low Birthweight Study group (1992) reported that 47% of children born with very low birthweights demonstrated poor attention spans and increased problem behavior at school age. More recently, Mick and colleagues (2002) found that birthweight status was a significant risk factor for ADHD; students with ADHD were three times more likely to have been born with low birthweights compared to the non-ADHD sample and this risk factor was not accounted for by socioeconomic status, parental history of ADHD, or prenatal risk factors.

Although ADHD is known to be familial and heritable (Willcutt, 2009), children born preterm are at an increased risk for developing ADHD, even after controlling for heritable factors (Mick et al., 2002). It is hypothesized that preterm infants' neurobiological systems are affected from early birth and their ADHD symptoms result from a different developmental trajectory than what is accounted for by heritable factors. Moreover, children born preterm are more likely to experience inattentive symptoms of ADHD, suggesting a "purer" form of ADHD (Szatmari, Saigal, Rosenbaum, & Campbell, 1993) derived from early insults to their neurological systems. Swanson and colleagues (1998) examined epidemiological and biological findings further to explain the increased prevalence of ADHD seen in preterm infants. They concluded that there was a biological basis of ADHD that is caused by maladaptive development of brain structures that serve to mediate activity, impulsivity, and attention (Swanson et al., 1998; McGrath et al., 2005). Perinatal hypoxic-ischemia, common for preterm neonates, can damage the striatal neurons, subsequently affecting the developing frontal lobe-basal ganglia pathways involved in directing attention. This is one mechanism by which preterm infants may become at-risk for the development of ADHD symptoms (McGrath et al., 2005; Volpe, 2000).

Attention difficulties are also present in children born preterm who escaped significant neurological impairment at birth and with less extreme values of low birthweight (Mick et al., 2002). Shum and colleagues (2008) recently evaluated attention problems in a sample of children born preterm who did not have documented neurological impairment or physical disabilities. Participants were ages seven to nine, were born very preterm (< 27 weeks) and extremely low birthweight (< 1,000 grams), and were educated in a general education, mainstream classroom. Behavior rating scales and psychodiagnostic tests revealed attention deficits in children born preterm. Approximately 30% of the children born preterm compared to 6% of the control children were reported to be at-risk for the inattentive subscale, but not for the hyperactive subscale. Findings suggest that children born preterm are at an increased risk for receipt of a diagnosis of ADHD, specifically the inattentive type, when compared to same-age full term peers. Moreover, this prevalence may be an underestimate of ADHD seen in preterm infants given the relatively high functioning sample.

The *Diagnostic and Statistic Manual of Mental Disorders-IV Text Revision* (DSM-IV-TR; American Psychiatric Association [APA], 2000) cites a prevalence of 3-7% of school-age children as having a diagnosis of ADHD. Thus, the rate of ADHD seen in preterm infants is substantially higher than what is seen for the entire population. Similar results have been found in children born with very low birthweights and in children born with less extreme values of low birthweight (<2500) (Mick et al., 2002). The tendency to be inattentive may be a risk factor for adverse social and emotional regulation because variations in attention contribute to individual differences in self-regulation (Lawson & Ruff, 2004). Thus, these early attention difficulties seen in children born preterm likely contribute to and/or correspond with deficits in other areas of social and emotional development, including emotional regulation, externalizing and internalizing behavioral problems that are commonly seen in children born preterm.

Behavioral Outcomes. Recently, there has been an increased interest in the broader range of social and emotional outcomes, including the behavior and social development of children born preterm (Bylund et al., 2000; Hille et al., 2001). Children born preterm with low birthweights have been found to be at an increased risk for both internalizing and externalizing behavior problems according to teacher and parent ratings (Samara et al., 2008). Compared with full term controls, children born preterm had significantly higher incidences of emotional problems, conduct problems, hyperactivity, overactivity/impulsivity, lower levels of school adaptation, poorer peer relationships, and limited pro-social behavior (Samara et al., 2008).

Lowe, Woodward, and Papile (2005) found a correlation between developmental scores and behavioral scores in young children. The majority of infants' whose cognitive scores significantly decreased between the first and second testing points also received low Emotional Regulation subset scores on the Behavior Rating Scale (BRS; Lowe et al., 2005). Scores were significantly related to family income, suggesting an environmental influence of developmental outcomes in children born preterm. Results were interpreted in light of neuroscience research suggesting that similar neural mechanisms that underlie emotional regulation capacities might also support cognitive processes, and environmental risk factors associated with poverty can negatively affect parenting and lead to subsequent risk in the presence of biological and neurological risk factors (Lowe et al., 2005).

Similar behavioral deficits have been identified in school-age children and adolescents. Specifically, Elgen, Sommerfelt, and Markestad (2002) sought to identify a behavioral profile in children born with low birthweights (<2000 grams) and to determine whether these differences were confounded by parental factors. Children born with low birthweights had significantly more abnormal scores for attention, social problems, and anxiety/depression as measured via behavior checklists. Self-report measures also indicated a significant difference between the low birthweight group and controls. Children with low birthweights reported increased difficulties with school, spare time activities, and endorsed more symptoms of aggressive behavior, and lower self-esteem. Forty percent of the low birthweight children versus seven percent of the control children received an abnormal score for the total scale on the Child Behavior Checklist (CBCL; Achenbach, 1991). Parents of low birthweight children had lower mean levels of education, higher levels of stress, demonstrated less nurturing parent practices, and were more likely to smoke during pregnancy when compared to control parents. Findings suggest that certain behavioral problems, including inattention, anxiety, withdrawal, and aggression, which were found to be more prevalent in children born with low birthweights, may act as precursors of more severe psychological difficulties that manifest later in development and have been identified in teenage populations (Gardner et al., 2004).

Although children born preterm are at increased risk for experiencing negative social and emotional outcomes, which include attention deficits (e.g. planning, organizing, problem-solving, and sustaining focus), hyperactivity, aggression, social deficits, withdrawal, anxiety, and depression (Behrman & Butler, 2007), not all children born preterm will experience social and emotional difficulties or be diagnosed with ADHD. It is difficult to discern one factor that predicts later development in this at-risk group given the known heterogeneity of preterm birth. Moreover, even less is known about the developmental precursors of subsequent difficulties and the manner in which they manifest during childhood. While it is clear that associated outcomes of preterm birth become more pronounced over time, preterm birth contributes to a variety of developmental outcomes, perhaps through different pathways (Nadeau, Boivin, Tessier, Lefebvre, & Robaey, 2001). Nadeau and colleagues (2001) found that birth status might contribute to maladaptive child outcomes indirectly through its influence on intellectual and neuro-motor development. Specifically, preterm birth can lead to delays in maturation and developmental processes, which in turn, are related to the emergence of later behavioral difficulties. Thus, birth status may not be the sole factor influencing developmental processes, but rather one factor that is critical to consider. The continuum of developmental and social-emotional difficulties likely depends on many interacting components of birth status, developmental status, and family supports (Msall & Park, 2008).

Apart from medical risk factors, social risk factors including socio-economic status and parenting behavior likely have negative or positive effects on children's subsequent development (Stoelhorst et al., 2003). Given the significant variability in outcomes associated with preterm birth, social risk or protective factors, such as parenting behavior, may be critical to examine to better understand how to support children born preterm. Although the medical field has made significant strides in improving survival, preventing adverse neurodevelopmental outcomes in early childhood for high-risk survivors remains a major challenge (Marlow, 2004; Msall, 2006).

Research points to the importance of environmental factors on cognitive and social-emotional development and highlights that outcomes associated with preterm birth and low birthweight can be improved or worsened depending on postnatal environments (Msall & Park, 2008). It is important to identify whether any environmental factors exacerbate or mitigate the consequences of preterm birth (Tully et al., 2004). One critical environmental factor to consider is parenting behavior. Nadeau and colleagues (2001) found that prematurity had an indirect effect on behavioral outcomes via intellectual and neuromotor development, however they neglected to include measures of parenting behavior, which could uniquely contribute to the subtle, but persistent consequences of preterm birth (Nadeau et al., 2001) The current study builds on previous work using Feldman's hierarchical vertical-integrative model of the development of regulatory functions and further explores the relative influence of parenting during early childhood on cognitive and social-emotional outcomes across children born preterm and full term.

Parenting and Cognitive and Social-Emotional Development

Regardless of birth status, parenting behavior has consistently and extensively been found to influence children's cognitive and social-emotional development. Specifically, the quality of interactions young children have with their primary caregivers is a critical component and determinant of subsequent developmental outcomes (Baumrind, 1978; Bradley, Caldwell, & Rock, 1988). Cognitive and social-emotional outcomes and trajectories represent two of the most widely studied aspects of child development (Feldman & Eidelman, 2009). Cognitive development undergoes significant reorganization and change during the first five years of life, with the first year of life representing the development of simple attention, and perceptual-motor integration and the second year of life representing the development of more complex cognitive skills via the maturation of the attention system (Feldman & Eidelman, 2009). As children develop basic problem-solving capabilities and begin to engage in goal-oriented behavior (Posner, 2002), they are able to acquire more complex cognitive skills, including the mastery of executive functions, which tend to emerge during preschool years and school entry.

Prior to the stabilization of, or worsening of cognitive deficits, as evident in preterm birth (Taylor, 2010), the first years of life have been found to be especially susceptible to internal and external influences on the trajectory of cognitive and social-emotional development (National Research Council and Institute of Medicine, 2000). Maternal sensitivity has been shown to provide a secure base that is internalized by the infant, and which promotes optimal social-emotional development (Bowlby, 1969). Thus, parenting during the first two years of life may be especially influential on cognitive and social-emotional outcomes and have the potential to alter developmental trajectories in high-risk infants.

In general, the quality of the parent-child relationship, as measured via parent-child interaction tasks, has repeatedly been found to promote cognitive and social-emotional development in children (Sumner & Spietz, 1994). An optimal parenting style is one that fosters independence by allowing the child some degree of control (e.g. non-intrusive behavior), while attending to the child's interests and needs through contingent, sensitive responding (Baumrind, 1966; Parpal & Maccoby, 1985; Bornstein & Tamis-LaMonda, 1989). Specifically, maternal responsiveness during infancy (e.g. six-months) has been found to be associated with IQ scores when children were six-years-old (Coates & Lewis, 1984), and frequent maternal stimulation via warm, verbal maternal-child interactions has been found to influence vocabulary development at one-year of age (Ruddy & Bornstein, 1982) and high IQ scores at two-years of age (Olson, Baytes, & Bayles, 1984).

Mother-child interactions during infancy have long lasting effects on development and have been found to be associated with outcomes in kindergarten, specifically teacher ratings of academic competence (Coates & Lewis, 1984). Similarly, maternal positive regard for the child, responsive interaction and language stimulation have been linked to optimal social-emotional development during early childhood (Maccoby & Martin, 1983) and during school entry (Landry et al., 2001; 2003). Mother-child interactions have been found to be particularly critical during early child development, as this is a period of rapid cognitive and social-emotional growth and brain organization (National Research Council and Institute of Medicine, 2000), which ultimately influences subsequent developmental outcomes. In contrast, negative parenting behavior such as punishment, restriction, threatening, intrusiveness, and detachment have been found to exert negative influence on children's cognitive and social-emotional development in children born full term (Crockenberg & Litman, 1990; Power & Chapieski, 1986; Weiss, Dodge, Bates, & Pettit, 1992).

Children born preterm are one group who likely require more specialized parenting to optimize their cognitive and social-emotional growth, given they are more susceptible to specific deficits in these areas, as compared to full term peers (Landry, Smith, Miller-Loncar, & Swank, 1997). There is a large body of research that has identified risk and protective factors for behavioral and cognitive outcomes in children (see Garmezy & Rutter, 1985; Rutter, 1987). Protective factors that are associated with resilience, or optimal development include specific aspects of parenting such as parental warmth, positive regard, and positive parent-child interactions (Masten et al., 1988; Werner, 1990). For example, parenting behavior during parent-child interactions may mediate the effects of adversity to promote optimal development in the face of biological risk (Werner & Smith, 1982; 1992). However, whether these protective factors or environmental variables operate similarly for children who are biologically at-risk of adverse subtle outcomes is relatively unknown (Tully et al., 2004). It is hypothesized that the relation of early parenting behavior to children's later outcomes may be even stronger for children born with greater degrees of biological risks because their need for specialized support via external means is even greater than what is needed for children born full term with little to no biological risks (Landry, Smith, & Swank, 2003). Given the substantial literature on adverse outcomes associated with preterm birth, it is important to identify whether any environmental factors exacerbate or mitigate the effect of preterm birth on associated outcomes. Parenting behavior during the earliest stages of development is a critical variable to consider and likely minimizes subsequent adversities.

Parenting and Preterm Birth

Previous research has provided initial evidence that parenting behavior differentially predicts outcomes in children born preterm when compared to children born full term (Landry et al., 1997; Landry et al., 2003; Laucht, Esser, & Schmidt, 2001). Specifically, increased maternal positive involvement, lower use of negative control strategies and increased cognitive and developmental stimulation (e.g. teaching episodes, verbalizations) have been related to positive outcomes in premature infants (Berlin, Brooks-Gunn, Spiker, & Zaslow, 1995; Olsen, Bates, & Kaskie, 1992; Poehlmann & Fiese, 2001). Much of the available research has examined parenting behavior in relation to cognitive outcomes in children born preterm (Smith, Landry, & Swank, 2006). Specifically, earlier studies demonstrated the relationship between the quality of the parent-infant interaction and cognitive and/or language development. Maternal behavior such as attentiveness, contingency, mutual visual regard, and face-to-face talk during mother-child interactions when children were one-month of age, have been found to correlate with IQ scores and language development at two-years, five-years, and eight-years of age (Cohen & Beckwith, 1979; Beckwith, Cohen, Kopp, Parmelee, & Marcy, 1976; Beckwith & Cohen, 1989). Children born preterm whose mothers had been consistently responsive during infancy demonstrated higher IQ scores, math scores, increased self-esteem, and lower behavioral and emotional problems reported by teachers at age twelve (Beckwith, Rodning, & Cohen, 1992). Additionally, in a four-year study of mother-child interactions in a sample of preterm infants, mother-infant interactions were among the best predictors of subsequent IQ and language performances (Bee et al., 1982).

Maternal use of interactive strategies during early childhood has also been found to promote cognitive and language stimulation in preterm infants (Smith et al., 1996). Because infants born preterm have difficulties shifting their attention, organizing environmental input and become easily overwhelmed with excess stimulation (Landry, 1995; Rose, Feldman, & Jankowski, 2001; 2002), mothers who follow their infants' cues, assist them in maintaining active involvement with toys, and decrease the demands placed on the infants' attention system, enable and facilitate early exploration and development (Landry, Garner, Swank, & Baldwin, 1996). Smith and colleagues (1996) found maternal use of attention-maintaining strategies during free play situations to be strongly related to low- and high-risk preterm infants' development of cognitive and language skills, suggesting that children born preterm with low birthweights may need more specialized support than full term infants during the first year of life to help them organize responses and acquire early attention skills. However, these results were limited to the first year of life. Additionally, maternal warmth, sensitivity, and use of directive strategies were not positively related to cognitive and language outcomes. More recently, Tully and colleagues (2004) confirmed that maternal warmth did not moderate the effect on children's IQ scores at age five (Tully et al., 2004). Specific parenting behaviors, such as positive regard, responsivity and warmth may be more closely linked to social and emotional development in preterm infants and moderate the effects of birthweight on children's inattention and hyperactive symptoms (Landry, 1995; Tully et al., 2004). Thus, while related, there is some evidence that specific parenting practices may influence social and cognitive outcomes differently.

Forcada-Guex, Pierrehumbert, Borghini, Moessinger, and Muller-Nix (2006) sought to identify dyadic patterns of mother-infant interactions and to determine the potential impact of these patterns on infants' developmental and behavioral outcomes at 18-months. Mother and infant interactional patterns were identified and coded from a 10-minute play interaction task. Maternal behaviors included sensitivity, control and unresponsiveness, and child behaviors included cooperative, compliant, difficult, and passive. Two specific dyadic patterns emerged, a cooperative pattern and a controlling pattern. Interestingly, no differences in outcomes between preterm and full term infants of cooperative pattern dyads were found. In contrast, the outcomes of preterm infants from controlling pattern dyads differed from those of full term infants, as well as from those of cooperative pattern preterm dyads, with preterm infants in the controlling dyads displaying increased levels of global behavioral difficulties (Forcarda-Guex et al., 2006). Thus, it is likely that parental responsiveness and sensitivity lessens the effect of preterm birth on associated outcomes; preterm infants who received optimal parenting had similar outcomes as full term peers. In contrast, preterm infants of controlling patterns fared worse on developmental outcomes when compared to full term peers of controlling patterns, and preterm peers of cooperative patterns. Thus, the cumulative contribution of biological and environmental risk might actually exacerbate or markedly increase preterm children's vulnerability to adverse developmental outcomes (Feldman & Eidelman, 2009; Sameroff & Fiese, 2000; Werner & Smith, 1992).

Laucht and colleagues (2001) addressed issues concerning differential development of social-emotional difficulties in children born with low birthweights. Specifically, they sought to determine the influence of early biological risk factors (low birthweight) and psychosocial risk factors (family disadvantage) on behavioral and emotional development during childhood (ages 2, 4.5, and 8) and to evaluate whether early responsive caregiving, measured via 10-minute semi-structured play task when the study children were 3-months-old, predicted differential outcomes, as measured via parent report. Two-way analyses revealed that for children with high psychosocial risk, children of responsive parents at 3-months of age exhibited significantly fewer behavioral problems later in life than children of non-responsive parents. After breaking down the externalizing problem score into separate indicators of conduct problems and ADHD symptoms, significant interactions between maternal responsivity and psychosocial risk and maternal sensitivity and birthweight were found. Children of non-responsive mothers from adverse family backgrounds or with low birthweight exhibited more ADHD symptoms, whereas no differences were found between at-risk and non-risk children of responsive mothers (Laucht et al., 2001). In terms of internalizing symptoms, findings revealed that internalizing problems of children from different birthweight groups were dependent on maternal responsivity and differences between children of non-responsive and responsive mothers increased with age in the very low birthweight group. Thus, at 8-years of age, children exposed to non-responsive parenting at 3-months of age clearly exhibited the highest levels of internalizing symptoms, suggesting that early parenting behavior may exert influence on the development and emergence of subtle deficits seen within preterm children later in life.

Responsive parenting across early childhood (birth through four years) has been found to predict more optimal cognitive and social-emotional development in all children through four-years of age and eight-years of age (Landry, Smith, Swank, Assel, & Vellet, 2001; Landry et al., 2003). Of particular interest to the current study were the differential relations between parenting, cognitive development and social-emotional outcomes across early childhood and middle childhood. Similar to previous findings, when mothers were minimally responsive, the potential negative impact was greater for the preterm children than the full term children, placing these children 12 to 14 months, on average, behind that of children parented by consistently responsive mothers (Landry et al., 2001; 2003). Children born preterm were at greater advantage if they received consistently supportive parenting. The moderating effect of parenting on preterm children's cognitive and social-emotional development is of particular importance given their slower rates of development and skill acquisition (Landry et al., 2001; 2003). Parenting during early childhood appears to play a unique role in establishing a strong foundation for later, subsequent development in children born preterm (Bradley et al., 1988; Landry et al., 2001; 2003; Smith et al., 2006; Wakschlag & Hans, 1999).

Purpose of the Present Study

There is strong evidence that children born preterm are at greater risk than their full term peers for a variety of negative short- and long-term outcomes. Even in children for whom severe medical complications, such as hemorrhaging, cerebral palsy, vision, and hearing impairments did not occur, increased susceptibility to problems with attention, peer relationships, behavior, emotional regulation, mood, and cognition have been widely documented. Although evidence related to associated outcomes of preterm birth is strong, there are some important limitations.

First, much of the work that has been accomplished with this population has relied on the use of small samples or cross-sectional data, and has included specific subpopulations of children born preterm (e.g. extremely preterm and very preterm), while excluding children born preterm at later gestational ages. Several studies have been criticized due to problems related to study design, non-representative samples, exclusion of control groups or inadequate selection of control groups, and inadequate demographic information (Bhutta et al., 2002). Thus, the reliability of the findings as well as our ability to generalize to the population is limited. In addition, much of the existing literature has involved preterm populations born in the 1990s, or earlier, when medical practices conferred more damage and may not have included the high numbers of more subtly affected survivors of preterm birth seen in greater numbers in more recent times. Third, birthweight is frequently utilized as an indicator of preterm birth. Therefore, much of the literature report outcomes of preterm birth based on birthweight criteria, rather than gestational age, which may inaccurately misrepresent outcomes associated with preterm birth. Relying solely on birthweight can lead to an over-representation of children with intrauterine growth restriction, and can exclude children born before 37 weeks gestation. Few studies have relied solely on gestational age to report outcomes of preterm birth and researchers' use of birthweight categories are often inconsistent and used interchangeably with gestational age categories, making the literature difficult to summarize and interpret (Behrman & Butler, 2007; Lorenz, 2001).

Finally, much of the extant work has used statistical methods that cannot simultaneously account for other important influences on the outcomes and may not take into account the interrelationship of subtle disabilities seen in this population, possibly inflating the results. Factors that affect change longitudinally may be different from those that predict cross-sectional outcomes (Taylor et al., 2004c; Taylor, 2010). Additional longitudinal studies are needed to better understand how outcomes of preterm birth are best explained in terms of multiple influences that include biological risks, cognitive skills, and environmental influences (Taylor, 2010).

The current study tested a longitudinal model examining the relations between birth status, parenting, cognitive development, and social-emotional outcomes in a sample of children born preterm and full term across the first five years of life. Using gestational age criteria, the current study evaluated whether parenting behavior during years one and two differentially predicts outcomes at 24-months and kindergarten entry in children of varying degrees of biological risk when compared to children born full term. Structural Equation Modeling (SEM) was used to empirically test the proposed model (see Figure 1). Primary analyses used multiple-sample SEM, which simultaneously fitted the model to the populations of interest (very preterm, preterm, and full term) to test group differences on parenting behavior and outcome variables.

Utilizing a large, representative sample of children born preterm in the year 2001, this study sought to better understand early environmental factors that are amenable to change, and which promote social-emotional and cognitive success in a high-risk population. Further, multiple-sample SEM allowed for comparison across a control group, addressing previous methodological flaws. Results of this study contributed to improved understanding of whether parenting behavior exerts a greater effect on outcomes in high-risk infants. The results are intended to inform future model development and research that informs policymakers, educational researchers, and practitioners on the development of early intervention programs to prevent adverse outcomes and reduce costs associated with preterm birth.

Research Questions

Research Question 1

What are the relations between birth status, parenting behavior, cognitive development and social-emotional outcomes across the first five years of development?

Research Question 2

Do the relations between parenting behavior, cognitive development, and social-emotional outcomes differ between preterm and full groups, defined by gestational age criteria?

Research Question 3

Does group membership (full term, preterm, very preterm, and extremely preterm) moderate the relations between parenting behavior, cognitive development, and social-emotional outcomes?

Covariates

- Gender
- Race
- Age at Assessment
- SES
- Birth Plurality
- Apgar Scores
- C-Section

Figure 1. Conceptual Model

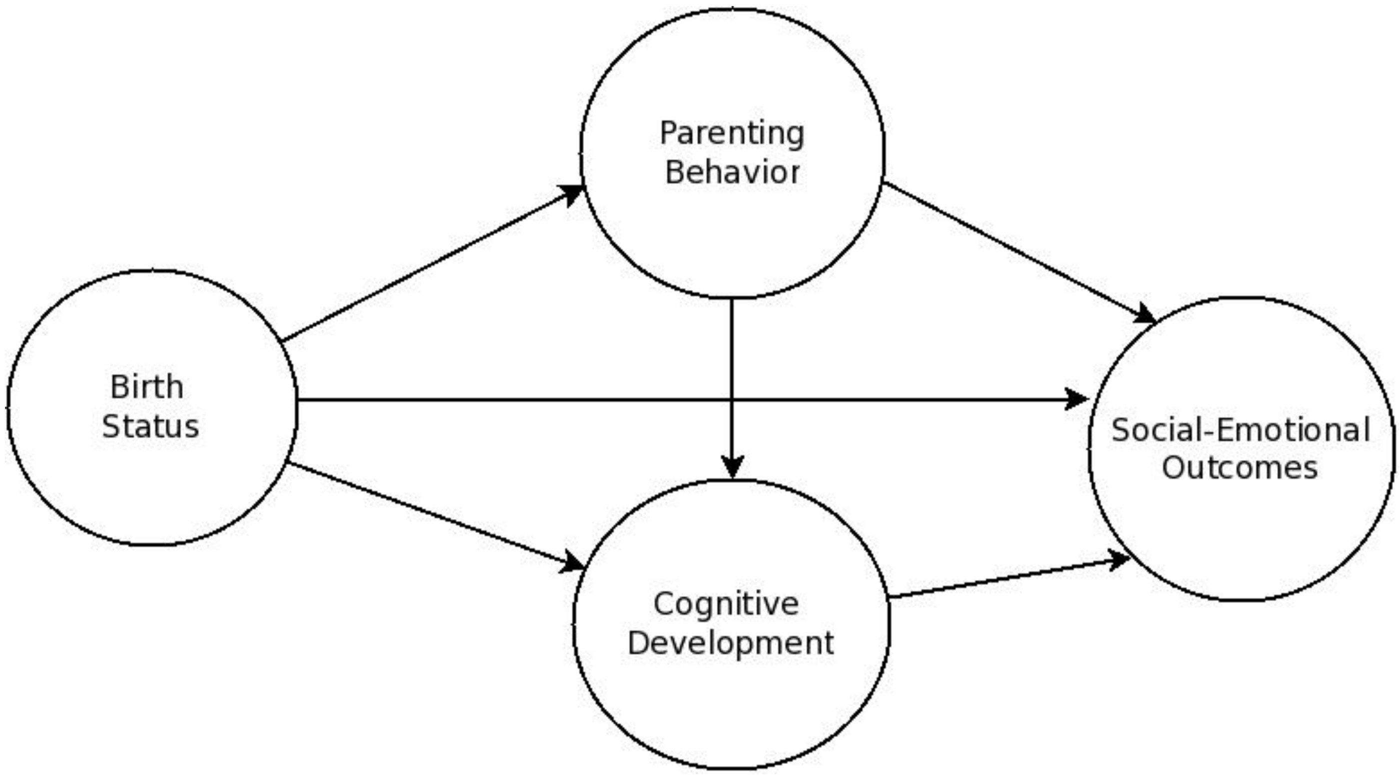


Table 1

Summary of Research Questions, Variables, and Analyses

Research Question	Analyses	Latent Variables*	Covariates
1. Model Fit	Latent Variable Structural Equation Modeling	Birth Status Parenting Behavior Cognitive Development Social-Emotional Outcome	Gender SES Age Race
2/3. Model Fit for Subsamples of Preterm Birth	Multiple-Group SEM	Parenting Behavior Cognitive Development Social-Emotional Outcome	Gender SES Age Race

**Note*. Please see Table 2 for specific indicators corresponding with latent variables.

Table 2

Summary of ECLS-B Variables Corresponding to Latent Constructs

Latent Constructs	ECLS-B Variables	ECLS-B Data Source
1. Birth Status	a. Estimated Clinical Gestation b. Birthweight (grams)	a/b. Birth Certificate
2. Parenting Behavior	a. Total Parent Score (9-months) b. Parent Supportiveness, Intrusiveness, Detachment, and Negative Regard (24-months)	a. Nursing Child Assess. Teaching Scale b. Two-Bags Play Task
3. Cognitive Development	a. Mental and Motor Scale Score b. Sustained Child Attention	a. Bayley Short Form-Research Edition b. Two-Bags Play Task
4. Social-Emotional Outcomes*	a. Parent Report (Kindergarten) b. Teacher Report (Kindergarten)	a/b. Indirect Child Socioemotional Battery
5. Additional Variables	Gender; SES; Age at Assessment; Race	

*****Note.* Confirmatory Factor Analyses was conducted on individual items to identify behavioral constructs at kindergarten entry.

CHAPTER 3
METHOD

Study Design

Data from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) developed under the sponsorship of the National Center for Education Statistics (NCES) within the Institute of Education Sciences (IES) and the US Department of Education (ED), was used to test the hypothesized model. The ECLS-B followed a nationally representative cohort of children born in 2001 from birth through kindergarten entry and over-sampled specific groups of at-risk children, including children born preterm and with low birthweights (Snow et al., 2007). Multi-informant and multi-method data collection allowed for an in-depth description of health status at birth and early childhood experiences at home and across educational settings, including kindergarten entry. Therefore, the proposed study capitalized on this large-scale data set to look at a vulnerable, high-risk population of children born preterm. The ECLS-B data allowed the current study to address previous methodological flaws in extant literature from which sufficient samples and comparison groups were missing.

The ECLS-B utilized a multistage, stratified, cluster sampling design from which the United States was separated into primary sampling units (PSU). Birth certificates were then sampled from within the PSU. Data for the ECLS-B were collected during five separate waves starting in 2001 and ending in 2007. Data were collected when study children were approximately 9-months old (wave 1; n = 10,700), 2-years-old (wave 2 in 2003; n = 9,850), preschool age (wave 3 in 2006; n = 8,750), kindergarten entry 2006 (wave 4 in 2006; n = 6,900) and kindergarten entry 2007 (wave 5 in 2007; n = 1,900). Approximately 75% of the sample entered kindergarten during the 2006 school year; the other 25% of the sample were not yet enrolled in kindergarten at this time (see Table 3). The kindergarten entry 2007 data collection included: a) children entering kindergarten for the first time, b) children from the 2006 cohort who repeated kindergarten in 2007, c) children who were not age-eligible to enter kindergarten in the year 2006 and d) children who delayed kindergarten entry (Snow et al., 2009). Approximately 4% of the children who were in kindergarten in 2006 repeated kindergarten in 2007.

The primary modes of data collection were in-person interviews with the primary caregiver and direct child assessments, which occurred during home visits. Data were collected at multiple time points from multiple informants, including children, mothers, fathers, child care providers, teachers, and schools. Multiple methods of data collection were used, including direct child assessments, videotaped child-parent interactions, audiotaped teacher and parent interviews, face-to-face and telephone interviews, and direct observations. Approximately 2,850 children sampled at 9-months were born preterm, before 37 weeks gestation. The primary investigator was granted permission to use the restricted-use ECLS-B data for this project under a restricted-data license agreement provided to her dissertation faculty chair. A waiver from the Michigan State University Institutional Review Board was obtained for completion of this project.

Table 3

Overview of Data Collection and Original ECLS-B Sample

Data Collection Wave	Sample Size	Age of Study Child		Data Collection
		Mean	SD	
9-months	*n* = 10,700	09.7 Months	*SD* = 4.4	F2001-F2002
24-months	*n* = 9,850	24.5 Months	*SD* = 1.3	F2003-F2004
Preschool	*n* = 8,750	53.0 Months	*SD* = 4.2	F2005-S2006
Kindergarten 2006	*n* = 6,900	65.1 Months	*SD* = 3.8	F2006-S2007
Kindergarten 2007	*n* = 1,900	74.4 Months	*SD* = 2.8	F2007-S2008

Note. F = Fall; S = Spring. Sample represents unweighted sample rounded to nearest 50.

ECLS-B Original Sample

The ECLS-B population is a representative sample of children born in the year 2001 who were born to mothers 15-years or older, were not adopted prior to 9-months of age, and did not die or move out of the country prior to the 9-month data collection wave. A total of 10,700 children participated in the study during the initial wave of data collection, when the study child was approximately 9-months-old, in the years 2001 and 2002. Children were followed through kindergarten during the years 2006 and 2007. ECLS-B participants who enrolled in kindergarten for the first time in 2006 or 2007 were included in the final sample. Children who repeated kindergarten in 2007 were included with the 2006 data collection period only. Children were primarily Caucasian (41%), African American (16%), Hispanic (14%), Asian (11%) and Multi-Racial (8%); 5,500 children were male (51%). According to birth certificate data, 73% (n = 7,650) of the participants were born full term (gestation age $\geq$ 37 weeks); 27% (n = 2,850) were born preterm (gestation age < 37 weeks). The majority of primary caregivers were biological mothers (99%).

Missing Data. Longitudinal research studies often have large amounts of missing data across the course of the entire study (Acock, 2005), and especially on the outcome variables (5,650 participants were missing teacher and/or parent data at kindergarten entry and/or missing complete data at earlier time points). To understand the nature of the missing data, a series of comparisons were conducted on the included sample and excluded sample and various demographic and predictor variables (see Table 4 and Table 5). No important differences were found between the included and excluded groups. No significant differences were found between the two groups on clinical gestation, gender, birthweight, motor scale score, parental detachment, intrusiveness, and negative regard. The differences that were significant were not of clinical importance. For example, the included sample obtained a mean of 125.92 compared to a mean score of 125.10 for the excluded sample, representing minimal differences between the two groups on mental development index. Rather than imputing a large amount of missing data, sample weights were applied to all analyses and accounted for non-response biases and allowed for the generalization of results. The final sample used in the longitudinal model consisted of approximately 5,050 children.

Table 4

Comparison of Demographic Information Between Included and Excluded Sample

Characteristics	Included Sample	Excluded Sample	Chi-Square (df)
Total	5,050	5,650	
Child Gender			1.04 (*1*), p=.31
Male	2,550 (50.6%)	2,900 (51.6%)	
Female	2,500 (49.4%)	2,750 (48.4%)	
Child Race/Ethnicity			51.61 (*7*), p<.001***
White/Non-Hispanic	2,150 (42.6%)	2,250 (40.3%)	
Black/African-American	700 (14.3%)	1,000 (17.3%)	
Hispanic, Race Specified	700 (14.2%)	850 (14.7%)	
Hispanic, No Race Specified	300 (5.4%)	400 (6.7%)	
Asian, Non-Hispanic	550 (11.1%)	650 (11.4%)	
Native Hawaiian or Other Pacific Islander	50 (.3%)	50 (.5%)	
American Indian or Alaska Native	150 (3.4%)	150 (2.2%)	
More than One Race	450 (8.5%)	400 (6.7%)	
Clinical Gestation			
Dichotomized			1.40 (*1*), p=.24
Full Term	3,500 (68.8%)	3,850 (68.2%)	
Preterm	1,300 (25.8%)	1,500 (27%)	

Note. Sample N rounded to the nearest 50.

Table 5

Comparison of Covariates and Predictor Variables for Included and Excluded Samples.

Variables	Included Sample Mean (*SD*)	Excluded Sample Mean (*SD*)	Independent Samples *t*-test (df)
Clinical Gestation	37.45 (*3.6)*	37.32 (*4.0)*	-1.65 (*10474),* p=.10
Birth Weight (g)	2,946 (*865.6)*	2,916 (*895.3)*	-1.75 (*10431),* p=.08
Mental Scale Score	125.92 (*10.84)*	125.10 (*11.14)*	-3.51 (*8919),* p<.001**
Motor Scale Score	80.80 (*5.28)*	80.78 (*5.47)*	-.184 (*8852),* p=.85
NCATS Total Parent	34.54 (*4.55)*	34.21 (*4.54)*	-3.41 (*8631),* p=.001**
Two Bags Parent Support	4.37 (*.87)*	4.32 (*.87)*	-.2.60 (*7690),* p=.01**
Parent Detachment	6.94 (*.37)*	6.94 *(.37)*	.07 (*7691),* p=.95
Parent Negative Regard	6.88 (*.46)*	6.86 *(.47)*	-1.56 (*7554),* p=.12
Parent Intrusiveness	6.80 *(.58)*	6.80 *(.55)*	-.24 (*7691),* p=.81
Covariates			
Time 1 SES	5.01 (*.86)*	4.88 *(.85)*	-7.81 (*10686),* p<.001***
Time 2 SES	5.02 (*.86)*	4.90 (*.85)*	-6.53 (*9833),* p<.001***
Kindergarten SES	5.02 (*.86)*	4.95 (*.85)*	-3.34 (*7020),* p<.001***
Time 1 Age at Assessment (months)	10.49 *(1.88)*	10.55 *(1.88)*	1.57 (*10228),* p=.116
Time 2 Age at Assessment	24.42 *(1.22)*	24.60 *(1.40)*	5.98 (*9833),* p<.001***
Kindergarten 2006 Age at Assessment	65.10 (*3.76)*	65.23 (*3.83)*	1.668 (*7020),* p=.10
Kindergarten 2007 Age at Assessment	74.71 (*2.77)*	74.38 *(2.95)*	2.24 (*1915),* p<.05*

Table 5 (cont'd)

Age of Mother at Birth	27.86 *(6.35)*	27.16 *(6.35)*	-5.69 (*10606),* p<.001***

Final Sample for Current Study

The current study included a sample of children from the original ECLS-B data set who had both teacher and parent reports of social-emotional outcomes at kindergarten entry. Participants who were assigned the sample weight, WK45T0, were retained for the current study. The sample weight WK45T0 was assigned to children who had parent and child data at 9-months and 24-months, and had parent and teacher data at kindergarten entry (see Table 4). The final sample consisted of 5,050 children born in the year 2001; 2,550 (51%) were male. See Table 6 for mean child age at each time point. Children were primarily Caucasian (42%), Black or African American (14%), Hispanic, Race Specified (14%), Asian (11%), Multi-Racial (9%), Hispanic, Race Unspecified (5%), and American Indian or Alaska Native (3%). The majority of the children entered kindergarten for the first time in 2006 (*n* = 3,800); approximately 1,200 children entered kindergarten for the first time in 2007. The majority of primary caregivers at all time points were biological mothers (*n* = 5,000; range: 96-99%). In terms of educational attainment, approximately 1,500 (29%) caregivers had received a high school diploma or equivalent, 1,150 (22%) had received some college, 1,500 (29%) reported having a bachelor's degree or higher, and 900 (18%) had received less than a high school diploma at the time of the child's birth. See Table 7 for child characteristics and Table 8 for parent demographic information.

Table 6

Overview of Data Collection for Final Sample

Data Collection Wave	Age of Study Child		Data Collection
	Mean	SD	
9-months	10.4 Months	*SD* = 1.8	F2001-F2002
24-months	24.4 Months	*SD* = 1.2	F2003-F2004
Kindergarten 2006	65.1 Months	*SD* = 3.8	F2006-S2007
Kindergarten 2007	74.4 Months	*SD* = 2.8	F2007-S2008

Note. F = Fall; S = Spring.

Table 7

Demographic Characteristics of Final Sample (n = 5,050)

	Sample N	Sample %	Weighted N	Weighted %
Gender				
Male	2,550	50.5	1,956,249	51.6
Female	2,500	49.5	1,837,028	48.4
Race/Ethnicity				
White/Non-Hispanic	2,150	42.6	2,039,397	53.9
Black/African-American	700	14.3	497,938	13.1
Hispanic, Race Specified	700	14.2	671,877	17.8
Hispanic, No Race Specified	250	5.4	305,287	8.0
Asian, Non-Hispanic	550	11.1	98,529	2.6
Native Hawaiian or Other Pacific Islander	50	.3	4,306	.1
American Indian or Alaska Native	150	3.4	18,818	.5
More than One Race	400	8.5	145,438	3.8
Not Ascertained	<50	.2	11,687	.3
Clinical Gestation				
Dichotomized				
Full term	3,600	72.0	3,299,535	88.2
Preterm	1,300	25.8	443,455	11.8

Table 7 (cont'd)

Categorized				
Full Term	3,600	73.6	3,299,535	88.2
Preterm	800	16.6	368,966	9.9
Very Preterm	300	6.3	55,929	1.5
Extremely Preterm	150	3.4	18,560	.5

Note. Sample N rounded to the nearest 50.
Preterm = equal to or less than 36 weeks gestation.

Table 8

Primary Caregiver's Demographic Information

Characteristic	Wave 1		Wave 2		Kindergarten	
	Sample N	Percent	Sample N	Percent	Sample N	Percent
Parent Income						
$5,000 or less	250	4.9	200	4.3	200	3.7
$5,001 to $10,000	300	6.0	300	5.3	200	4.1
$10,001 to $15,000	300	6.3	350	6.6	300	5.2
$15,001 to $20,000	350	7.2	350	6.8	300	5.8
$20,001 to $25,000	450	9.1	350	7.2	300	6.3
$25,001 to $30,000	400	7.7	400	7.5	350	6.5
$30,001 to $35,000	300	6.1	300	5.6	300	5.9
$35,001 to $40,000	300	6.5	300	6.1	300	5.9
$40,001 to $50,000	450	8.6	450	8.6	450	8.5
$50,001 to $75,000	800	15.5	850	17.1	800	16.1
$75,001 to $100,000	500	10.4	600	11.6	650	12.6
$100,001 to $200,000	500	10.1	550	10.7	800	15.7
$200,001 or more	100	1.7	100	2.4	200	3.9

Note. Sample N rounded to the nearest 50.

Preterm sample. The primary population of interest was children born preterm. For the current study, preterm birth was conceptualized as a calculated clinical gestation below 37 weeks, defined by the World Health Organization (WHO), which was obtained from participants' birth certificates. Because degree of immaturity is a significant predictor of subsequent outcomes, the current study relied on gestational age to classify preterm birth for multiple-group analyses. Relying solely on birthweight likely over-represents children with intrauterine growth restriction for whom the consequences may differ from those of immaturity (Delobel-Ayoub et al., 2006) or may fail to identify all children born preterm. Moreover, some argue that outcomes of preterm birth should be reported by gestational age categories; however, few studies have relied solely on gestational age to report outcomes of preterm birth (Behrman & Butler, 2007; Lorenz, 2001), contributing to interpretation difficulties in the extant literature. Therefore, in the current study, all children born under 37 weeks gestation were considered preterm (Behrman & Butler, 2007). Children born at or above 37 weeks gestation were considered full term and served as the comparison group. Seventy-two percent of the participants (n = 3,650) were born full term. Sixteen percent (n = 800) were born preterm (between 32 and 36 weeks gestation), six percent (n = 300) were born very preterm (less than 32 weeks gestation), and three percent (n = 150) were born extremely preterm (less than 28 weeks gestation).

Exclusion criteria. Given the interest in the relationship between birth status, parenting behavior, and subtle cognitive and behavioral abnormalities seen within children born preterm, children born with Down Syndrome were excluded from the sample (n = 50). All other children who entered kindergarten during the 2006 or 2007 school years were included in the sample. Cases where data were missing entirely across one of the four waves of data collection were excluded. No other exclusionary criteria were applied.

Sample size. The current study used a mixed sample of children born preterm and full term. Descriptive statistics include unweighted and weighted means. All unweighted samples were rounded to the nearest 50 due to restrictions set forth via the licensing agreement.

Unweighted descriptive statistics represent the final ECLS-B population where each case was counted equally. Weighted descriptive statistics represent the entire population (children born in 2001) and account for those children who were not sampled and did not provide data. Full sample weights were applied to preliminary analyses. Full sample and replicate weights were applied to structural equation analyses to adjust for differential selection probabilities, reduce bias associated with non-response, reduce standard error, and allow for analyses that represent the target population.

Variables and Measures

Measures for key variables are organized and presented below according to the hypothesized, conceptual model, which includes birth status, parenting behavior, cognitive development, social-emotional outcomes, and covariates.

Birth status. Two variables, birthweight and clinical gestation, were used as indicators of *birth status* for the longitudinal model (research question 1; see Figure 1), both obtained from the study child's birth certificate. Clinical gestation, number of weeks from conception to birth, was calculated for each participant as required by the US Standard Certificate for Live Births. Birthweight was also used as an indicator of premature status because it tends to parallel gestational age and is an important indicator of the adequacy of fetal growth (Behrman & Butler, 2007). For Multiple-Group Structural Equation Modeling, clinical gestation was used as the grouping variable. Two grouping variables were recoded from the original clinical gestation variable: dichotomized preterm birth (research question 2) and preterm type (research question 3). The dichotomized preterm birth variable classified children into one of two categories, full term (gestational age>37 weeks) and preterm (gestational age<37 weeks). The preterm type variable consisted of four categories of preterm birth including full term (>37 weeks), preterm

(32-36 weeks), very preterm (28-31 weeks), and extremely preterm (<28 weeks). Birthweight was not used as the grouping variable because of its strong relationship with intrauterine growth restriction in the current study (IUGR; r =.80), and because it is not considered an accurate measure of biologic maturity at birth. Maturity of the infant at birth, as measured via gestational age, is a major predictor of outcomes (Hack, Klein, & Taylor, 1994), and thus, was used as the grouping variable in the current study.

Parenting behavior. Observational measures of parenting behavior were obtained from videotaped semi-structured parent-child play interaction tasks during home visits when the study child was approximately 9-months and 24-months of age. Five separate indicators of parenting were used in the current study to assess both positive and negative aspects of parenting. One measure was obtained when the study child was 9-months-old, and four measures were obtained when the study child was 24-months-old. In general, the semi-structured play interaction tasks provided information on the quality and quantity of such interactive behaviors as parental emotional support, parental negative regard, parental intrusiveness, and parental cognitive stimulation of the child and measured overall interactive patterns parents had with their children during the earliest stages of development. These interactions have been found to contribute to cognitive and social-emotional outcomes in children in general (Magill-Evans, Harrison, & Burke 1999). The current study sought to examine whether these parenting behaviors operate similarly for children born with biological risk compared to full term children. High parenting scores represented a high frequency of positive, optimal parenting practices observed during the semi-structured play interaction tasks. Please see below for a description of the two semi-structured play tasks and individual parenting measures utilized from each task for the current study.

Nursing Child Assessment Teaching Scale. The Nursing Child Assessment Teaching Scale (NCATS; Sumner & Spietz, 1994) is an observation coding system and was administered when the study child was approximately 9-months-old. The NCATS has been widely used in clinical practice and in research to screen and identify mothers and infants who may be in need of individualized early intervention programs (Sumner & Spietz, 1994). The NCATS required parents to select a task that was developmentally advanced for their child's current developmental ability; they were provided appropriate materials and asked to teach their children how to complete the selected task (e.g. stringing beads). The NCATS parenting scale consists of a total of 50 binary (yes/no) items that were scored by ECLS-B staff during the home visit. Items were scored "yes" if the behavior was observed and scored "no" if the behavior was absent during the interaction task. Total Parenting, a composite score of all 50 items measuring parent's Sensitivity to Child Cues, Response to Child Distress, Cognitive Growth Fostering and Social-Emotional Growth Fostering was used (range 17 to 49). The Total Parenting score had high internal consistency, which is consistent with previous reports. Internal consistency reliability (Cronbach's alpha) of .87 and test-retest reliability of .85 has been reported (Sumner & Spietz, 1994).

The total parenting score measured parent's use of the "teaching loop," during the teaching task. The teaching loop consists of four components: 1) alerting the child to the teaching task and setting up expectations; 2) instruction, in which the parent teaches the child using a variety of teaching strategies; 3) performance, in which the child responds to the caregivers' instructions and suggestions; and 4) feedback, in which the caregiver comments on the child's attempts or completion of the task. A low total-parenting score suggested that the parent did not engage in many teaching-oriented behaviors during the interaction task and a high-score suggested that the parent engaged in a broad range of teaching-oriented behaviors and completed the "teaching loop." Example items include, "caregiver positioned the child so he/she was safely supported," and "caregiver avoids yelling at the child." Yes responses indicate positive direction and an absence of negative behavior.

Two-Bag Semi-Structured Play Task. The Two-Bag Interaction Task, administered when the child was 24-months is a simplified version of the Three-Bag Interaction Task that was used successfully in the large-scale Early Head Start Research and Evaluation Project (EHSREP), sponsored by the Administration for Children and Families, and the Study of Early Child Care, sponsored by the National Institute of Child Health and Human Development (Nord, Edwards, Andreassen, Green, & Wallner-Allen, 2006). The Two-Bag Interaction Task consisted of a 10-minute session in which the parent was provided with two bags that contained two separate sets of toys and asked to play with them how the child wished (Love et al., 2005); bag 1 contained a children's book and bag 2 contained a set of dishes. Parents were told they had ten minutes to play with their child and were instructed to play with the bags in numeric order. The parent and child were videotaped and parent behavior was coded by expert coders. Four parenting behaviors were coded on a 7-point Likert-type rating scale, which ranged from very low (1) to very high (7). For the current study: parent supportiveness, intrusiveness, negative regard, and detachment were used as indices of parenting behavior. Such parenting behavior displayed during semi-structured play interaction tasks have been identified as important to the development of social competence (Hartup, 1985; Karen, 1998), and cognitive skills such as language acquisition (Snow, 1994), and pre-literacy (Bus & Van IJzendoorn 1988), in young children, and thus, were appropriate given the current research questions and potential importance in the outcomes associated with preterm birth. High scores were indicative of optimal parenting behavior. Specific measures were reverse coded to follow this pattern. Please see below for further information on specific subscales that were used.

Parent supportiveness. The parent supportiveness scale used in the current study was a composite that was created by ECLS-B by adding the means of the three positive parenting subscales, parental sensitivity, parental cognitive stimulation, and parental positive regard, and dividing by three. The three individual scales emphasized parental sensitivity (e.g. response to child cues), parental effortful teaching, and parental expression of love, warmth, and admiration for the child during the play activity. In the EHSREP, the three positive parenting scales were highly inter-correlated; EHS created one supportiveness subscale by summing the means of the three individual scales. Parent supportiveness reflected overall positive aspects of parenting when the study child was 24-months-old. A high score on this composite represents indices of positive behavior demonstrated during the Two-Bag Interaction Task.

Parental intrusiveness. The parent intrusiveness scale represented the degree to which the parent tried to control the child during the semi-structured play activity. Intrusiveness was coded from a child perspective, and therefore, the coder attended to the child's reaction and response to intrusive parenting behavior. Extreme intrusiveness has been seen as over-controlling and tends to minimize a child's autonomy and may be seen more frequently in parents of preterm children (Muller-Nix et al., 2004). This subscale was reverse coded; a higher score represents less intrusive parenting and a low score reflects extremely intrusive parenting behaviors.

Parental negative regard. The parental negative regard scale reflects the parent's discontent with, anger toward, disapproval of, or rejection of the child during the play interaction task. This subscale was reverse coded; a higher score represents optimal parenting and less negative regard, and a low score reflects negative parenting behavior.

Parental detachment. The parental detachment scale measured parent's awareness of, and attention toward their child during the play interaction task. Detachment reflects consistently inattentive or indifferent behavior toward the child. This subscale was reverse coded; a higher score represents attentive parenting and a low score reflects extremely detached parenting behaviors.

Reliability of parenting measures. Reliability of coders was ensured and established for both the NCATS and Two-Bags Task. NCATS tapes were selected at random and sent to the University of Washington where a certified NCATS individual coded the same tape as the ECLS-B individual. Additionally, inter-lab reliability was required; ECLS-B staff were required to complete one reliability tape each week to establish coder agreement with the University of Washington. Inter-rater reliability was high (86% agreement) and exceeded the target score of 85% agreement between ECLS-B and NCATS staff (Nord et al., 2004).

Similarly, reliability for the Two-Bag Interaction Task was established. Reliability for the Two-Bags rating scales followed similar procedures established for the Three-Bags Task used in the EHSREP. Child development staff for the ECLS-B attended a three-day training led by the same trainers who trained the EHSREP staff members. At the end of the three-day training, ECLS-B staff were required to meet a standard of 90% agreement for five videotaped interactions. After the training, ECLS-B staffs were required to reliably code Early Head Start videotaped child-parent interactions and meet sustained criteria of 90% agreement. Average reliabilities (percent agreement) for subscales of the Two-Bags Interaction Task for the ECLS-B 2-year data collection were: a) 96.5% for overall parent rating scales; b) 99% for detachment; c) 98% for negative regard; d) 98% for intrusiveness; e) 97% for sensitivity; f) 93% for positive regard; and f) 94% for cognitive stimulation.

Although the NCATS and Two-Bags Task were administered at different time points during early childhood for the ECLS-B and represent slightly different measures of parenting, overall parenting constructs are similar across the two tasks and are appropriate given developmental milestones expected during each time point (9-months and 24-months). Additionally, the ECLS-B found meaningful correlations between parenting at 9-months-old and 24-months-old, which provides initial evidence that parenting practices during 9-months are predictive of parenting practices at 24-months and can be included as indicators of an early childhood parenting construct, as occurred in the current study. Specifically, strong positive correlations were found between the NCATS total parent score and Two-Bags Parent Supportiveness score ($r = .24$; $p < .05$), and significant negative correlations between the NCATS total parent score and Two-Bags Parental Intrusiveness ($r = -.09$; $p < .05$), Parental Negative Regard ($r = -.11$; $p < .05$), and Parental Detachment ($r = -.05$; $p < .05$). There are also some unique features that differentiate the NCATS assessment from the Two-Bags Interaction Task. Specifically, the NCATS parent scales include items that assess parental sensitivity and response to child distress, as well as parent fostering of child social-emotional growth and stimulation of cognitive development (Andreassen & Fletcher, 2007). Both scales measure maternal sensitivity and engagement with the child and together, are good indicators of parental behavior during early childhood.

Cognitive development. Three measures were used as indicators of overall child cognitive development when the study child was 24-months-old. The following measures were obtained via home visits through direct child assessments.

Bayley Short Form-Research Edition (BSF-R). The Bayley Short Form-Research Edition (BSF-R) was administered during home visits. The BSF-R was chosen as an indicator of overall cognitive development for the current study because it provides information on children's developing motor and mental abilities and provides a comprehensive snapshot of varying skills that are critical for later development, (Andreassen & Fletcher, 2007). In addition, previous research has recommended that a developmental assessment be administered around 24-months as a means to identify potential disabilities in vulnerable populations (Johnson & Marlow, 2006). The BSF-R was derived from the Bayley Scales of Infant Development-Second Edition (BSID-II; Bayley, 1993), a standardized assessment of children's developmental status from birth through 42-months of age. The BSID-II is recognized as one of the best available assessments of developmental status for infants and young children, in terms of reliability and validity, including precision of scores, stability of scores across time, and predictive validity (Andreassen & Fletcher, 2007).

The BSID-II is an individually administered test that consists of two scales, a mental and a motor scale. The mental scale, which consists of 178 items, assesses such abilities as memory, habituation, problem solving, ability to vocalize, language, and social skills (Andreassen & Fletcher, 2007). The motor scale, which consists of 111 items, assesses fine motor abilities, such as grasping and writing skills; and gross motor abilities, such as rolling, crawling, sitting, standing, walking, running, and jumping (Andreassen & Fletcher, 2007). All BSID-II items are arranged in order of developmental difficulty and are organized into age sets such that sets of specific items are administered depending on the child's chronological age. For example, a 24-month-old is typically administered 31 mental items and 19 motor items from the BSID-II. Raw scores obtained from the number of items passed/failed from the administered age-set are then converted into a Mental Development Index (MDI) and Psychomotor Development Index (PDI), with a mean of 100 and a standard deviation of 15.

Because of time constraints, ECLS-B staff created a shortened and streamlined version of the original BSID-II. In developing the BSF-R, items for the BSF-R mental and motor scales were selected at roughly equal intervals across the ability distribution for targeted age ranges from the BSID-II (Nord et al., 2006). BSID-II items were selected and retained for the BSF-R if they possessed strong psychometric properties and if they covered the necessary content strands from the mental (e.g. memory, means-end behavior, exploratory competence, and communication) and motor (i.e. gross and fine motor domains) scales on the BSID-II. Items selected for the BSF-R mental and motor scales were organized into a core set of items that were administered to all ECLS-B participants, analogous to the 23 to 25 month age set on the BSID-II (Nord et al., 2006). Children's performance on this core set determined whether additional items from lower age sets or higher age sets were administered. The BSF-R was designed to assess children ages 22-months, 16-days (23-month age set on the BSID-II) to 25-months, 15-days (25-month age set on the BSID-II). Approximately 90% (n = 8,050) of all participants were assessed within this age range. The core set for the 23 to 25 month mental scale had a total of 19 items and the motor scale had a total of 17 items.

Item response theory (IRT) scores were used to report ECLS-B BSF-R results on the same scale that is used by the full BSID-II. IRT scores use the overall pattern of right and wrong responses and the characteristic of individual items to estimate a child's true ability. This number was used to determine the number-right raw score the child would have obtained had the full BSID-II been administered (Nord et al., 2006). At 24-months, the raw score (number-right) for the BSF-R mental scale ranged from 0 to 19 and for the motor scale ranged from 0 to 17 for the core sets (see Andreassen & Fletcher, 2007 for details on IRT and for information on exact motor and mental items used from the BSID-II). The IRT scale scores are a model-based estimate of the raw score and the range of these scores is based on the number of items in the publisher's BSID-II (i.e., 178 mental items; 111 motor items) and range from 0 to 178 for the mental score and 0 to 111 for the motor scale, and were used for the current study.

Two-Bags Interaction Task. In addition to the BSF-R mental and motor scores, an additional indicator of early cognitive development was used in the current study. One of the child scales from the Two-Bag Interaction Task (described above), *Child Sustained Attention,* was used as an indicator of cognitive development when the study child was approximately 24-months-old. This scale measured the child's ability to sustain attention during the ten-minute play interaction task and the child's ability to remain involved with the items. A child high on sustained attention was involved with the task and able to remained focus at the task at hand; a child low on sustained attention demonstrated behavior that appeared aimless, distracted, or bored.

Social-Emotional outcomes. Parents and teachers provided ratings of children's social-emotional skills and behavior when ECLS-B participants entered kindergarten. Key social-emotional constructs related to children's early learning experiences that could be measured indirectly were initially identified during the ECLS-B design phase. Key social-emotional constructs chosen included children's pro-social skills, problem behaviors and emotions, emotion knowledge, temperament, approaches to learning, and friendships. Specific items from the Preschool and Kindergarten Behavior Scales-Second Edition (PKBS-2; Merrell, 2003), a strong measure of pro-social skills, problem behaviors, and emotion knowledge, the Social Skills Rating System (SSRS; Gresham and Elliott 1990), and the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), were chosen and combined to create one socioemotional battery that was administered to caregivers and teachers during kindergarten.

ECLS-B socioemotional items measured a variety of social-emotional behaviors, including pro-social behavior (e.g. empathy, cooperation, friendliness), friendship (involvement and interactions with other children), emotional knowledge (e.g. understanding of emotions), internalizing problems (e.g. emotions and related behaviors that impeded social interactions) externalizing problems (e.g. overt and aggressive actions), temperament (e.g. individual differences in arousal and emotions, including attention span and inhibition), and approaches to learning (e.g. tendencies, behaviors, and skills that support a positive attitude about learning). Parents and teachers rated children's behavior on a 5-point response scale that ranged from never (1) to very often (5). A total of 28 items composed the parent-reported social-emotional battery and 22 items composed the teacher-reported social-emotional battery.

Parent and teacher rated social-emotional behaviors were used as indicators of children's social-emotional development during kindergarten entry in the current study because of the increased interest in the broader range of social and emotional outcomes, including the behavior and social development of children born preterm (Bylund et al., 2000; Hille et al., 2001). Children born preterm have been found to be at an increased risk for both internalizing and externalizing behavior problems according to teacher and parent ratings (Samara et al., 2008). Compared with full term controls, children born preterm have demonstrated significantly higher incidences of emotional problems, conduct problems, hyperactivity, overactivity/impulsivity, lower levels of school adaptation, poorer peer relationships, and limited pro-social behavior (Samara et al., 2008).

Because individual items were provided in the ECLS-B data set and no composites were created, factor analyses were conducted as a means to combine items to represent specific constructs of interest. Parent and teacher ratings were used separately as indicators of overall social-emotional development to reflect overall behavior during kindergarten, and were not combined because parent and teacher ratings of behavioral adjustment often capture different types of behaviors in different contexts, and demonstrate low inter-rater agreement (Achenbach, McConaughy, & Howell, 1987). Exploratory Factor Analysis (EFA) using MPlus student version (Muthén & Muthén, 2010) was conducted using all 47 parent- and teacher-rated items. Based on the factor loadings from the original EFA, theoretical considerations, and key social-emotional constructs first identified by the ECLS-B, five distinct social-emotional constructs emerged. Construction of all five scales included consideration of individual items that appeared to fit, theoretically, with the five constructs of interest. The five scales created for the current study were: attention, teacher-rated externalizing behaviors, parent-rated externalizing behaviors, teacher-rated pro-social skills, and parent-rated pro-social skills. The first construct, attention, consisted of four teacher-rated items thought to represent attention. Items from the original ECLS-B socioemotional battery that were included in this scale included: “child has difficulty concentrating,” “child pays attention well,” “child works/plays independently,” and “child keeps working until finished.” Items that were phrased negatively (“child has difficulty concentrating”) were reversed coded so that all items on this scale were phrased positively.

The second construct consisted of seven items thought to represent externalizing behavior or over-activity in school. Items from the original ECLS-B socio-emotional battery that were included in this scale were: “child is restless/fidgety,” “child is overly active,” “child acts impulsively,” “child annoys other children,” “child disrupts others,” “child has temper tantrums,” and “child is physically aggressive.” The third construct consisted of five items that were thought to represent parent ratings of externalizing behavior or over-activity at home. Items from the original ECLS-B socio-emotional battery that were included in this scale were: “child is physically aggressive," child is angry," child has temper tantrums," "child annoys other children," and "child destroys others' things." All items were negatively phrased, so they all were reverse-coded so that all items were phrased positively.

The fourth construct consisted of three items that were thought to represent friendship/pro-social skills observed at school. Items from the original ECLS-B socio-emotional battery that were included in this scale were: "child comforts others," child tries to understand others," and "child stands up for others' rights." The fifth construct consisted of four parent-rated items that were thought to represent friendship/pro-social skills observed at home. Items from the original ECLS-B socio-emotional battery that were included in this scale were: "child volunteers to help others," "child comforts others," "child stands up for others' rights," and "child tries to understand others." All items were phrased positively; therefore no reverse coding was needed.

Confirmatory Factor Analyses (CFA) specifying the items representing the five constructs using MPlus student version (Muthén & Muthén, 2010) was conducted with the current study sample. Confirmatory Factor Analysis defines sets of variables that reliably measure the constructs of interest (Kline, 2005). The analysis included 23 individual items that were hypothesized to compose five social-emotional constructs, as described above, with approximately 5,050 participants. See Table 9 for the final factor loadings and their standardized and unstandardized coefficients. All of the included items loaded substantially on their hypothesized factors. The model fit the data adequately. Fit indices included a Root Mean Square Error of Approximation (RMSEA) equal to .075 (CI = .073-.077), CFI=.970, and TLI=.0965.

Prior to combining the individual items, the reliability of each of the five scales was conducted using Statistical Package for the Social Sciences (SPSS) version 18.0. A reliability coefficient greater than 0.7 was considered "adequate." A reliability coefficient greater than 0.8

was considered “good,” and a reliability coefficient greater than 0.9 was considered “excellent” (Kline, 2005). Reliability coefficients for the current sample for the social-emotional constructs were: .92 for Teacher-Rated Externalizing, .78 for Parent-Rated Externalizing, .90 for Attention, .89 for Friendship/Pro-Social at school, and .78 for Friendship/Pro-Social at home. The means of the individual items were summed and divided by the number of items to create the final five social-emotional constructs.

Covariates. Socioeconomic Status (SES), Gender, Age at Assessment, Race, Birth Plurality, Five Minute Apgar Scores, and C-Section delivery, were included in the model to control for their differential influence on parenting behavior, cognitive development, and social-emotional outcomes between groups.

Socioeconomic status. Socioeconomic status (SES) is a measure of social standing (Duncan, 1961) and was computed at the household level using parent interview data from the Computer Assisted Parent Interview (CAPI), Parent Self-Administered Questionnaire (PSAQ) and the Resident Father Questionnaires. Parents were asked to provide information about the study child, themselves, the home environment, parent characteristics, and parent attitudes. The SES variable represents the socioeconomic standing of the household when the study child was approximately 9-months-old. Only the 9-month (wave 1) SES variable was used in the current study. Because the 9-month SES variable was highly correlated with subsequent SES variables at 24-months ($r = .90$), and kindergarten entry ($r = .89$), it was not necessary to include all SES variables into the analysis as a control. The SES variable used in the current study was a composite variable that was constructed for the ECLS-B and derived from measuring annual household income, mother/female guardian’s education, father/male guardian’s education, mother/female guardian’s occupational prestige, and father/male guardian’s occupational prestige. The continuous variable ranges from -4.75 to 2.75 with the higher values representing higher SES. The SES composite is the average of up to five measures, each of which was standardized to have a mean of 0 and a standard deviation of 1, hence the negative values. For households with only one parent present, SES was computed by averaging the available components (see Nord et al., 2004 for further information). For ease of interpretation, the SES composite was converted to a continuous positive scale by adding 4.977 to each value of the original SES scale. The new SES composite ranged from 2.87 to 7.18, with higher values representing higher SES. The variables below made-up the SES composite.

Income. Annual household income was reported during the parent interview via a home visit when the study child was 9-months of age. Income, in the current study, is defined at the household level and represents the primary caregiver's annual reported household income. Detailed-ranged income questions were asked of all participants and responses were coded on a scale ranging from 1 ($5,000 or less) to 13 ($200,001 or more).

Mother and father occupation. Occupations were coded using the *Standard Occupational Classification Manual (*Executive Office of the President, Office of Management and Budget, 2000). Occupation codes were collapsed into 23 aggregated categories and an additional category, unemployed, retired, disabled, and unclassified, was added (Snow et al., 2009). Occupation was recoded to reflect the average of the 1989 General Social Survey (GSS; Nakao & Treas, 1992) prestige score. This was computed as the average of the corresponding prestige scores for the 2000 Census occupational categories covered by the ECLS-B occupation. The 22-position scale ranks occupations according to their relative prestige (see Snow et al., 2009 for a detailed description).

Mother and father education. The respondent parent reported the highest level of education attained during the 9-month interview.

Race. A composite of child's race was included, which consisted of parent report of child's race when the study child was 9-months-old.

Birth certificate data. Plurality, Five Minute Apgar Scores, and C-Section delivery where all obtained from the child's birth certificate and included in the longitudinal model to control for their influence on birth status.

Table 9

Confirmatory Factor Analysis for a Five-Factor Model of the ECLS-B Social-Emotional Battery

Items	Unstandardized	Standard Error (SE)	Standardized
Attention			
Pays attention well	1.000	0.000	0.889
Has difficulty concentrating[a]	1.066	0.007	0.948
Keeps working until finished	0.961	0.007	0.854
Works/Plays independently	0.901	0.008	0.802
Teacher Externalizing			
Child is restless/fidgety[a]	1.000	0.000	0.939
Child is overly active[a]	0.984	0.005	0.923
Child acts impulsively[a]	0.887	0.006	0.832
Child annoys other children[a]	0.930	0.005	0.873
Child disrupts others[a]	0.930	0.005	0.873
Child has temper tantrums[a]	0.789	0.010	0.741
Child is physically aggressive[a]	0.886	0.008	0.832
Teacher Friendship/Pro-Social			
Child comforts others	1.000	0.000	0.946
Child tries to understand others	0.954	0.009	0.903
Child stands up for others' rights	0.851	0.008	0.832

Table 9 (cont'd)

Parent Negative Emotionality			
Child is physically aggressive[a]	1.000	0.000	0.740
Child is angry[a]	0.861	0.020	0.637
Child has temper tantrums[a]	0.956	0.020	0.707
Child annoys other children[a]	0.993	0.021	0.735
Child destroys others' things[a]	1.024	0.022	0.757
Parent Friendship/Pro-Social			
Child volunteers to help others	1.000	0.000	0.733
Child comforts other children	1.020	0.022	0.748
Child stands up for others' rights	0.957	0.021	0.701
Child tries to understand others	1.007	0.022	0.738

Note. All factor loadings were significant ($p<.001$). High communalities >.6.
[a]Items reversed coded to be phrased positively. Higher scores represent higher indices of positive behavior.

Analyses

MPlus version 6 (Muthén & Muthén, 2010) was used to model data, and Statistical Package for the Social Sciences (SPSS) version 18.0 was used to manage, describe, organize, prepare data, and run preliminary analyses. MPlus was chosen as the Structural Equation Modeling software for the current study because of its ability to handle full sample and replicate weights. Final analyses were conducted with and without sample and replicate weights. Variables of interest were extracted from the ECLS-B data set and imported to SPSS. All data analyses occurred on a freestanding computer in Erickson Hall at Michigan State University, as required by the restricted-use license agreement. Investigators received approval for use of the ECLS-B data set for this project by the Institute of Education Sciences (IES) and Michigan State University Institutional Review Board (IRB; see Appendix A).

Data preparation and screening. The ECLS-B staff members collected kindergarten data during two separate waves depending on when the study child first entered kindergarten. Approximately 75% of the sample entered kindergarten in 2006 and 25% entered kindergarten in 2007. The original ECLS-B data set differentiated the two kindergarten entry time periods by labeling them Time 4 (T4) and Time 5 (T5). The original sample was not entirely represented if the analyses were limited to one kindergarten time point over another (e.g. 2006 only). Thus, a new "kindergarten wave" variable was created by combining the two waves of kindergarten outcome data (e.g. 2006 and 2007) to represent the full sample of children at kindergarten entry. The data was restructured so that the social-emotional outcome variables represented teacher and parent responses when the study child first entered kindergarten, in year 2006 or 2007. Data screening and descriptive statistics (see Tables 10, 11, and 12), including a correlation matrix (see Table 13) of all study variables, were conducted to better understand the ECLS-B population and variables of interest. No study variables were highly correlated ($r > .85$), ruling out problems of multicollinearity (Kline, 2005). Study variables were examined for potential outliers. Outliers were retained in the current study. Given the large sample, outliers were expected as part of the distribution (Tabachnick & Fidell, 2007), and it was expected that children would fall on the high and low end of a continuum for clinical gestation and performance on developmental measures. Since the current study was interested in examining differences between groups as measured via gestational age criteria, including extreme data points were important to the study.

Preliminary analyses. Prior to testing the structural equation model, preliminary analyses on individual observed predictor and outcome variables were performed, without latent variable modeling. Means and standard deviations of the independent and outcome variables are presented (see Table 10). An independent samples t-test was conducted to determine whether there were significant differences on mean scores on all study variables between the dichotomized clinical gestation groups, preterm (<37 weeks) and full term (<37 weeks). Next, a between-group one-way Analysis of Variance (ANOVA) was conducted to determine whether there were mean differences in the observed covariates, parenting behavior, cognitive, and social-emotional variables between the four clinical gestation groups (full term, preterm, very preterm, and extremely preterm). Lastly, the direct relations among specified observed variables (indicators) were tested as a means to build the model and demonstrate associated relations between paths. For example, the relations between preterm birth and parenting subscales, preterm birth and social-emotional indices, and preterm birth and cognitive indices, were examined by running the regressions with and without covariates. Additionally, the relations between parenting subscales and social-emotional indices, and cognitive indices, was tested.

Testing the direct paths using regression enabled the exploration of the relations between variables in the model to test for salience. These preliminary analyses preceded structural equation analyses, in which the model fit was tested taking into account all variables simultaneously across five years.

Longitudinal Structural Equation Analysis. Prior to testing the proposed conceptual model (Figure 1), the proposed latent factor structure was tested through Confirmatory Factor Analysis using MPlus student version (Muthén & Muthén, 2010; see Table 16). The four specified latent variables in the model were each presumed to be measured by several indicators or observed variables; together, the indicators and the underlying latent variables (factors) made up the measurement model (Kline, 2005). Each indicator loaded on one specified factor. Estimating the measurement model for each construct separately has been recommended as a first step prior to estimating the full structural model (Brown, 2006; Jöreskog, 1993). The latent variables for the longitudinal model included birth status, parenting behavior, cognitive development, and social-emotional outcomes using the mixed sample of children born preterm and full term (n=5,050). Indicators for each latent variable are described under the measures and variables section above.

After the latent structure was modified and confirmed, the full structural model was tested (Figure 1) using structural equation modeling (SEM) techniques. SEM was chosen as the appropriate statistical procedure to answer the proposed research questions because it allowed for hypothesis testing and was especially valuable for use with ECLS-B non-experimental data (Keith, 1999). SEM allowed for testing of unobserved latent variables that were critical to the current proposed model, and allowed for multiple observed variables to be associated with a single, specified latent construct (Kline, 2005).

Figure 1 specifies a conceptual model for better understanding the relations between birth status, parenting behavior, cognitive development and social-emotional outcomes during the first five years of life. It was hypothesized that birth status would positively predict parenting behavior, cognitive development, and social-emotional outcomes at kindergarten entry. In addition, it was hypothesized that optimal parenting behavior and cognitive development would positively predict social-emotional outcomes at kindergarten entry in a mixed sample of children born preterm and full term. Latent variable SEM (Structural Regression) was used to test this longitudinal conceptual model and to answer the first research question. Latent variable SEM was chosen because it specified both a measurement and structural model for the current study allowing for joint confirmatory factor analysis for all latent variables, while determining the magnitude of the strength of the relationship between constructs (Keith, 1999), and was aligned with the purpose of this study.

Multiple-Group Structural Equation Analyses. The second and third research questions aimed to understand whether group membership moderated the relations specified in the original model. Specifically, is the magnitude of the relations between variables the same for children born with varying degrees biological risks? Multiple-group SEM was used to simultaneously fit the model to children born preterm, before 37 weeks gestation, and children born full term to determine whether the relations specified in the model were similar or different across groups. The third research question sought to determine whether parenting differentially predicted cognitive and social-emotional outcomes, and whether cognitive development differentially predicted social-emotional outcomes based on group membership, defined by specific categories of preterm birth. It was hypothesized that parenting behavior would differentially positively predict cognitive development and social-emotional development in children born preterm when compared to children born full term. Specifically, it was hypothesized that parenting behavior would be a stronger predictor of cognitive and social-emotional outcomes in high-risk children, born preterm. A multiple-group (i.e. multi-sample) analysis of the longitudinal structural regression model was used to test this hypothesis.

Prior to running multiple-group SEM, a dichotomized variable (research question 2) was created splitting the sample into full term (>37 weeks) and preterm (<37 weeks). Next, a preterm type variable was created splitting the sample into four groups, children born full term (≥ 37 weeks gestation), preterm (< 37 weeks gestation), very preterm (<32 weeks gestation), and extremely preterm (<28 weeks gestation), based on estimated clinical gestational age obtained via birth certificate data. Multiple-group SEM initially specified cross-group equality constraints to test group differences on parenting behavior, cognitive development, and social-emotional outcomes (Kline, 2005). A cross-group equality constraint forced the program to derive equal unstandardized estimates of parameters within all samples (Kline, 2005). Next, the parameters in the model were specified to be freely estimated within all samples. The fit of the constrained model was compared to the model with relaxed restrictions using the chi-square difference statistic (Kline, 2005). The fit indices of the constrained model were compared to the fit indices of the relaxed parameters model to determine whether the fit of the model worsened with constrained parameters, which would suggest that the population direct effects are unequal across groups (Kline, 2005). Multiple-group SEM provided insight as to whether parenting and cognitive development have the same effect on outcomes across children born preterm, very preterm, extremely preterm, and full term. Maximum likelihood estimation was used to estimate model parameters.

Determining model fit. Absolute and relative fit indices were used to determine model fit. Absolute fit indices including the chi-square statistic were used. A non-significant chi-square ($p > .01$) indicates adequate model fit in which the null hypothesis is not rejected (i.e. null = perfect fit in the population). However, the chi-square statistic is affected by sample size, which could lead to rejection of the model even if differences between observed and predicted covariances are found (Kline, 2005). Thus, additional fit indices were considered given the large sample size of the current study. The Comparative Fit Index (CFI) and Tucker-Lewis Fit Index (TLI), both relative fit indices, which account for sample size, were also used. Additionally, the Root Mean Square Error of Approximation (RMSEA), a parsimony-adjusted index (Kline, 2005), was used to determine adequate model fit with an RMSEA < .05 that falls within the 90% Confidence Interval (CI) considered ideal. The RMSEA relies on the degrees of freedom to indicate the discrepancy in fit and adjusts for sample size (Spoelstra et al., 2010). The Standardized Root Mean Square Residual (SRMR) was also used as an indicator of absolute fit, with smaller values, indicating a better fit. Significant criteria for an adequate fit for all research questions in the current study included an RMSEA below .05 (suggests an overall good fit), and CFI and TLI values greater than .90 (Kline, 2005). Modifications to the model were conducted based on the fit statistics, modification indices and theoretical considerations.

Chi-square significant testing was conducted for multiple-group analyses. The difference in chi-squares and degrees of freedom between the constrained model and model with relaxed parameters were calculated and tested using the chi-square difference (X^2_D) statistic (Kline, 2005). A significant difference between the two models suggested that the parameters are unequal across groups.

Summary. Structural Equation Analyses, including Multi-Group SEM involves many steps to identify the underlying measurement model, test the structural paths, and test group differences. The results mirror the steps that were taken when running analyses and are organized by research questions. The steps taken to achieve the results included: a) preliminary analyses of group differences on means across all study variables; b) Confirmatory Factor Analysis for the longitudinal structural model using the full sample; c) testing the longitudinal structural model using the full sample; d) testing the structural model (minus the birth status construct) separately for children born preterm and full term; d) running multi-sample SEM taking into account both groups simultaneously (constraining parameters and relaxing constraints); e) testing the underlying measurement model (CFA) separately for categories of preterm birth (four groups); f) testing the structural model separately for categories of preterm birth; and g) running multi-sample SEM taking into account all four group simultaneously (constraining parameters and relaxing constraints).

Table 10

Descriptive Statistics for Full Sample

Measures	Mean	S.D.	Range	Weighted Mean	Weighted S.D.
Covariates					
SES	5.01	0.86	2.87-7.18	4.92	0.81
Age at Assessment	24.42	1.22	21.10-38.20	24.39	1.20
Birth Status					
Clinical Gestation	37.45	3.85	20-47	38.75	2.50
Birth Weight	2,947.93	865.20	227-5,443	3,320.02	590.84
Cognitive Development					
Mental Scale Score	125.93	10.83	92.61-168.53	127.52	10.60
Motor Scale Score	80.82	5.26	59.65-101.44	81.50	5.00
Child Sustained Attention	4.43	1.13	1-7	4.50	1.15
Parenting Behavior					
NCATS parent scale	34.54	4.55	17.0-49.0	34.78	4.53
Two-Bag Parent Support	4.37	0.87	1-7	4.41	0.89
Parent Intrusiveness	6.80	0.58	1-7	6.82	0.55
Parent Negative Regard	6.88	0.46	1-7	6.89	0.44
Parent Detachment	6.94	0.37	1-7	6.95	0.33
Social-Emotional					
Teacher-Rated Attention	3.85	0.89	1-5	3.88	0.89

Table 10 (cont'd)

Teacher-Rated Externalizing	4.09	0.81	1-5	4.10	0.82
Teacher-Rated Pro-Social	3.36	0.95	1-5	3.41	0.93
Parent-Rated Externalizing	3.78	0.66	1-5	3.79	0.66
Parent-Rated Pro-Social	3.69	0.73	1-5	3.73	0.73

Table 11

Unweighted Descriptive Statistics between Full Term and Preterm Samples

Variable	Full Term		Preterm		
	N	Mean (SD)	N	Mean (SD)	Independent Samples T-Test (df)
SES	3,650	5.05 (.87)	1,300	4.96 (.85)	3.12 (4,925), p=.002**
Age at Asses.	3,650	24.43 (1.22)	1,300	23.40 (1.24)	.82 (4,925), p=.412
Clinical Gestation	3,650	39.29 (1.65)	1,300	32.34 (3.59)	67.16 (1,498.61), p<.001**
Birth Weight	3,550	3,289.68 (553.78)	1,300	1,983 (853.59)	51.10 (1,686.68), p<.001**
Mental Scale Score	3,350	127.36 (10.51)	1,200	122.03 (10.78)	14.97 (4,553), p<.001**
Motor Scale Score	3,350	81.51 (4.96)	1,200	78.76 (5.62)	14.99 (1,891.94), p<.001***
Sustained Attention	2,950	4.50 (1.14)	1,050	4.24 (1.08)	6.56 (1,856.44), p<.001***
NCATS Parenting	2,900	34.68 (4.55)	1,050	34.19 (4.58)	2.97 (4,111), p=.003**
Two-Bags Support	2,800	4.39 (.86)	1,050	4.32 (.88)	2.34 (3,958), p=.02*
Negative Regard	2,950	6.88 (.46)	1,050	6.86 (.47)	1.46 (3,959), p=.149
Intrusiveness	2,950	6.81 (.55)	1,050	6.75 (.66)	2.91 (1,523.76), p<.05*
Detachment	2,950	6.94 (.37)	1,050	6.93 (.37)	.104 (3,827), p=.858

Table 11 (cont'd)

Teacher Attention	3,550	3.91 (.88)	1,300	3.71 (.90)	6.98 (4,837), p<.001***
Teacher Externalizing	3,500	4.10 (.80)	1,250	3.71 (.85)	3.39 (4,761), p=.001***
Teacher Pro-Social	3,500	3.37 (.93)	1,250	3.33 (.97)	1.49 (4,775), p=.1235
Parent Externalizing	3,550	3.79 (.65)	1,300	3.75 (.68)	1.84 (4,906), p=.065
Parent Pro-Social	3,350	3.70 (.72)	1,300	3.67 (.76)	1.11 (4,811), p=.267

Note. All sample sizes are rounded to the nearest 50. Equal variance not assumed for all variables.

Table 12

Weighted Descriptive Statistics between Full Term and Preterm Samples

Variable	Full Term		Preterm		
	N	Mean (SD)	N	Mean (SD)	Independent Samples T-Test (df)
SES	3,299,535	4.95 (.81)	443,455	4.81 (.81)	107.9 (568,106), p<.001**
Age at Asses.	3,298,306	24.39 (1.18)	443,455	24.39 (1.34)	-3.78 (540467), p<.001**
Clinical Gestation	3,299535	39.40 (1.61)	443,455	33.92 (2.69)	1325.47 (486,848), p<.001**
Birth Weight	3,263,655	3.41[a] (.49)	434,803	2.64[a] (.81)	613.16 (477,095), p<.001**
Mental Scale Score	3,055,790	128.01 (10.45)	403,764	124.19 (10.45)	207.46 (502,945), p<.001**
Motor Scale Score	3,035,645	81.66 (4.94)	402,568	80.18 (5.32)	167.33 (498,904), p<.001**
Sustained Attention	2,732,004	4.54 (1.15)	355,829	4.24 (1.06)	156.78 (470,923), p<.001**
NCATS Parenting	2,774,575	34.90 (4.56)	360,075	34.14 (4.29)	99.27 (471,942), p<.001**
Two-Bags Support	2,730,022	4.44 (.88)	355,965	4.22 (.91)	139.55 (446,095), p<.001**
Negative Regard	2,732,109	6.90 (.43)	355,965	6.86 (.48)	44.59 (433,998), p<.001**
Intrusiveness	2,731,498	6.83 (.54)	355,912	6.73 (.65)	85.02 (423,766), p<.001**

Table 12 (cont'd)

Detachment	2,732,109	6.95 (.31)	355,965	6.91 (.42)	55.58 (409,116), p<.001**
Teacher Attention	3,249,410	3.89 (.89)	433,140	3.73 (.88)	112.61 (558,334), p<.001**
Teacher Externalizing	3,190,601	4.10 (.81)	425,983	4.00 (.88)	64.09 (534,313), p<.001**
Teacher Pro-Social	3,187,084	3.42 (.93)	425,364	3.40 (.94)	8.38 (542,930), p<.001**
Parent Externalizing	3,289,895	3.79 (.65)	441,646	3.76 (.67)	28.37 (561,478), p<.001**
Parent Pro-Social	3,242,431	3.74 (.72)	437,953	3.66 (.75)	70.63 (553,701), p<.001**

Note. [a]Birthweight values divided by 1,000. Equal variance not assumed.

Table 13

Correlation Matrix for Full Term (upper) and Preterm (lower) Samples

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-----	-.00	**-.06**	**-.05**	**.06**	**.25**	**.33**	**.10**	**.14**	**.13**	**.27**	.03	**.19**	**.15**	**.22**	**.11**	**.23**	.02
2	.00	-----	-.00	.03	**-.12**	**.05**	**.07**	-.03	.02	.04	**.18**	**.08**	**.17**	**.29**	**.22**	**.20**	**.18**	**.19**
3	-.05	-.01	-----	.01	-.02	-.01	.03	.03	.01	-.01	**.17**	**.22**	**.07**	-.02	-.03	-.03	-.04	.01
4	.04	-.01	-.05	-----	**.24**	.00	-.03	-.01	.01	-.01	.04	.01	-.01	.02	.01	.01	.02	.03
5	.01	-06	-.03	**.77**	------	.04	.04	.04	**.09**	.04	**.09**	.02	.02	.01	.03	.02	.02	-.02
6	**.32**	-.05	.00	.03	.05	------	**.25**	**.06**	**.11**	**.11**	**.19**	**.07**	**.16**	**.07**	**.11**	**.09**	**.06**	**.07**
7	**.40**	.07	.05	.03	.00	**.28**	------	**.33**	**.29**	**.28**	**.36**	**.13**	**.58**	**.09**	**.16**	**.12**	**.10**	**.10**
8	**.10**	.06	.06	-.05	-.03	.07	**.29**	------	.03	**.11**	**.11**	**.06**	**.14**	.04	.03	.03	.02	.05
9	**.24**	.01	-.02	**.10**	.08	**.19**	**.27**	.01	------	**.43**	**.18**	**.06**	**.19**	**.10**	**.12**	**.06**	.04	.02
10	**.20**	-.04	.01	.04	.06	**.19**	**.32**	**.09**	**.47**	------	**.13**	.04	**.18**	**.09**	**.10**	**.05**	**.06**	.01
11	**.24**	**.18**	**.18**	**.30**	**.30**	**.13**	**.27**	.07	**.20**	**.12**	------	**.41**	**.42**	**.17**	**.26**	**.19**	**.12**	**.16**
12	.03	**.08**	**.18**	**.31**	**.30**	.04	**.12**	-.01	**.11**	-.01	**.51**	------	**.21**	.04	**.09**	**.11**	.03	**.11**

Table 13 (cont'd)

13	**.19**	**.16**	**.09**	**.12**	**.08**	**.17**	**.56**	**.09**	**.17**	**.14**	**.36**	**.21**	------	**.15**	**.21**	**.14**	**.11**	**.10**
14	**.19**	**.26**	-.01	**.06**	.06	.04	**.14**	.04	**.12**	**.09**	**.20**	.06	**.11**	------	**.71**	**.29**	**.35**	**.15**
15	**.20**	**.25**	.00	**.18**	**.16**	.07	**.19**	.08	**.12**	.07	**.33**	**.17**	**.21**	**.70**	------	**.44**	**.29**	**.20**
16	**.10**	**.19**	-.04	**.09**	**.09**	.04	**.12**	.04	**.07**	.03	**.22**	**.11**	**.18**	**.31**	**.49**	------	**.18**	**.26**
17	**.18**	**.20**	.01	.07	**.06**	.02	**.10**	.07	**.08**	.08	**.14**	.06	.08	**.38**	**.29**	**.19**	------	**.24**
18	**.10**	**.21**	.01	**.09**	.03	.06	**.15**	.04	**.13**	.04	**.21**	**.14**	**.18**	**.21**	**.25**	**.28**	**.29**	------

Note. 1=SES; 2=gender; 3=age at assessment; 4=clinical gestation; 5=birthweight; 6=NCATS; 7=Two-Bags Total Parenting; 8=detachment; 9=intrusive; 10=negative regard; 11=mental scale score; 12=motor scale score; 13=sustained attention; 14=teacher externalizing; 15=teacher attention; 16=teacher pro-social; 17=parent externalizing; 18=parent pro-social. p<.01=bolded.

CHAPTER 4
RESULTS

Preliminary Analyses

Means and standard deviations of predictor, covariate, and outcome variables for the study sample are displayed in Table 10.

Differences between preterm and full term. Group mean differences are displayed in Tables 11 and 12. In terms of covariates, significant differences between children born preterm and full term were found in parent's SES scores during wave 1. Children born preterm lived in families with lower SES during wave 1 when compared to children born full term. No significant differences in children's age of assessment during wave 2 were found. As expected, children born preterm were born with significantly lower birth weights and had significantly shorter clinical gestation periods than children born full term. Additionally, in terms of cognitive indices, children born preterm performed significantly lower on the BSF-R mental and motor assessments and demonstrated lower levels of sustained attention during a 10-minute semi-structured play task at 24-months. In terms of parenting behavior, parents with children born preterm scored significantly lower on the total parenting scale during the NCATS teaching task at 9-months, and on total parent supportiveness during a semi-structured play task at 24-months. Parents with children born preterm also showed higher levels of intrusiveness at 24-months during the semi-structured play task. There were no significant differences between the two groups in parents display of detachment or negative regard during the semi-structure play task at 24-months. The weighted data revealed significant differences on mean scores across all study variables between the two groups; however, these results should be interpreted with caution because of the large sample size. Significant differences were found when mean scores revealed minimal differences between the two groups.

Correlations. Correlations between all study variables were computed separately for children born preterm (less than 37 weeks) and children born full term to examine whether the strength of the correlation coefficients was relatively similar or different across groups of interest. Table 13 displays a correlation matrix for both groups. When comparing the strength of the correlation coefficients between children born preterm and children born full term, several significant differences emerged. Parents' socioeconomic status during wave 1 was more strongly correlated with parenting behavior at 9-months ($r=.32$, $p<.001$), total parent supportiveness ($r=.40$, $p<.001$), intrusiveness ($r=.24$, $p<.001$), and negative regard ($r=.20$, $p<.001$) at 24-months in the sample of children born preterm. Similarly, motor and mental scaled scores at 24-months had a significantly stronger correlation for children born preterm ($p=.51$, $p<.001$). As expected, clinical gestation and birth weight both had significantly stronger correlations with children's mental scaled scores ($r=.30$, $p<.001$), motor scaled scores ($r=.31$ and $r=.30$, respectively, $p<.001$), and sustained attention ($r=.12$ and $r=.08$, respectively, $p<.001$) in a sample of children born preterm. Total parenting supportiveness at 24-months was more strongly correlated to mental scaled scores at 24-months for children born full term ($r=.36$, $p<.001$) when compared to children born preterm ($r=.27$, $p<.001$). Parent intrusiveness at 24-months was more strongly correlated with parent-rated externalizing ($r=.08$, $p<.001$) and pro-social behaviors ($r=.13$, $p<.001$) at kindergarten entry in children born preterm. No significant correlations between intrusiveness and parent-rated behaviors at kindergarten entry in children born full term were found. Total parenting at 24-months was significantly correlated with all outcome variables at kindergarten entry for both children born preterm and full term, with slightly greater correlations found in children born preterm for teacher-rated externalizing behavior (r=.14, p<.001), attention (r=.19, p<.001), and parent-rated pro-social behavior (r=.15, p<.001).

Differences between categories of preterm birth. In order to examine the differences in mean scores on individual study variables between types of preterm birth, as defined via gestational age criteria, a between-group, one-way analysis of variance (ANOVA) was conducted. Unweighted and weighted subpopulation means and standard deviations can be found in Tables 14 and 15. A new variable was computed and ECLS-B participants were grouped via gestational age classifications, full term (>37 weeks gestation; *n*=3,650), preterm (32-37 weeks gestation; *n*=800), very preterm (28-31 weeks gestation; *n*=300), and extremely preterm (≤27 weeks gestation; *n*=150), and was used as the grouping variable. Because the assumption of homogeneity of variance was not met with regard to motor scaled score, sustained attention, parental negative regard and intrusiveness, the Welch correction (Welch, 1951) was applied to these ANOVAs and Games-Howell post-hoc analyses were used. No significant group differences were found for age of assessment at 24-months.

Cognitive development group differences. Significant group effects on mental scaled score, F (3, 4550) = 109.36, p<.001, and motor scaled score, F (3, 500) = 99.24, p<.001 were found. The effect size, calculated using eta squared, was .07 for mental scale score, and .08 for motor scale score, suggesting small effect sizes. Scheffe and Games-Howell post-hoc analyses revealed that children born full term performed significantly higher than children born preterm, very preterm, and extremely preterm on both the mental and motor subtests (p<.001) of the BSF-R. Similarly, children born preterm performed significantly higher than children born very preterm and extremely preterm (p<.001), and children born very preterm performed significantly higher than children born extremely preterm (p<.05).

As expected, children born extremely preterm scored significantly worse on the BSF-R than any other group. On average, they obtained approximately twelve fewer points on the mental subscale, and approximately six fewer points on the motor subscale, compared to same-age full term peers. Additionally, children born preterm performed significantly worse on the mental and motor subscales compared to children born full term, however, performed significantly better when compared to children born very preterm and extremely preterm. Mean mental scores decreased by approximately three to five points with increased biologic immaturity as determined via classification criteria. For example, children born full term, on average, obtained a scale score of 128, compared to a score of 124 for children born preterm. This score continued to decline with earlier gestational ages; children born very preterm obtained an average mental score of 121. The most significant decline was seen between very preterm and extremely preterm children, where children born extremely preterm obtained the lowest scale score of 116. Similarly, mean motor scores decreased approximately two points with increased biologic immaturity, showing the same pattern as seen in mental performance.

A significant, but small (eta squared = .02), group effect was also found for sustained attention at 24-months, $F(3, 450) = 18.50$, $p<.001$. Games-Howell post-hoc analyses revealed that children born full term displayed greater levels of sustained attention during a semi-structured play task at 24-months when compared to children born preterm, very preterm, and extremely preterm ($p<.001$). Children born preterm demonstrated significantly greater levels of sustained attention when compared to children born extremely preterm ($p=.002$), however, children born preterm did not significantly differ from children born very preterm ($p=.66$). No significant differences were found between very preterm and extremely preterm children on sustained attention ($p=.08$). Children born extremely preterm displayed lower levels of attention compared to the other three groups. Children born extremely preterm obtained an average score of 3.6 out of 7 on sustained attention, which was significantly lower compared to full term peers, who obtained an average score of 4.5. This score declined slightly as biologic immaturity increased.

Parenting behavior group differences. A significant group effect was found for total parenting at 9-months, $F(3, 4{,}100) = 3.68$, $p=.01$, parent supportiveness at 24-months, $F(3, 4{,}000) = 2.63$, $p<.05$, and parent intrusiveness at 24-months, $F(3, 400) = 4.21$, $p<.01$. Although a significant group effect was found for total parenting at 9-months and parent supportiveness at 24-months, parents of children born full term and preterm obtained only slightly higher scores when compared to children born very preterm and extremely preterm; differences were minimal. The most significant difference was found between parents of full term children and parents of very preterm and extremely preterm children, whereby parents of full term children obtained significantly higher scores on both the NCATS parenting scale at 9-months and total parent supportiveness at 24-months. Scheffe post-hoc analyses revealed that children born full term had parents who showed lower levels of intrusiveness at 24-months when compared to parents of children born very preterm ($p=.002$), and extremely preterm ($p=.019$). Parents of preterm children showed lower levels of intrusiveness than parents of very preterm children ($p<.05$). No significant differences in parental intrusiveness were found between children born extremely preterm and very preterm, and children born full term and preterm. No significant group effects were found for parental detachment and negative regard.

Social-emotional outcomes group differences. A significant group effect was found on all outcome variables, including teacher-rated attention, $F(3, 4850) = 31.69$, $p<.001$, teacher-rated externalizing behavior, $F(3, 4800) = 5.93$, $p<.001$, teacher-rated pro-social behavior, F (3,

4800) = 3.79, p=.01, parent-rated externalizing behavior, F (3, 4950) =4.69, p=.003, and parent-rated pro-social behavior, F (3, 4,850) = 4.86, p=.002. Children born full term were rated by their teachers as displaying less externalizing behavior in the classroom when compared to children born very preterm (p=.007). Children who were born full term were rated as displaying greater indices of attention when compared to children born preterm (p<.10), very preterm, and extremely preterm (p<.001). Similarly, children born preterm had higher indices of teacher-rated attention when compared to children born very preterm (p=.009) and extremely preterm (p<.001), and children born very preterm had higher indices of attention than children born extremely preterm (p=.01). In terms of teacher-rated pro-social skills, children born extremely preterm had significantly lower ratings of pro-social skills when compared to children born full term (p=.015), and preterm (p=.029). Lastly, children born extremely preterm were rated by their parents as displaying greater indices of externalizing behavior when compared to children born full term (p=.005), and preterm (p=.014), and lower indices of pro-social behavior when compared to children born full term (p=.005) and preterm (p=.004).

Table 14

Unweighted Subpopulations Descriptive Statistics

	Full Term	Preterm	Very Preterm	Ex. Preterm
Variable	(*n*=3,650[a])	(*n*=800[a])	(*n*=300[a])	(*n*=150[a])
	M (SD)	M (SD)	M (SD)	M (SD)
SES	5.05 (.87)	4.98 (.87)	4.91 (.83)	4.90 (.79)
Age at Asses.	24.43 (1.22)	24.36 (.88)	24.40 (1.39)	24.51 (1.41)
Clinical Gest.	39.29 (1.65)	34.77 (1.27)	29.54 (1.13)	25.68 (1.37)
Birth Weight	3.29 (.55)	2.44 (.66)	1.36 (.53)	.90 (.28)
Mental Score	127.36 (10.51)	124.18 (10.25)	119.48 (10.86)	116.09 (9.91)
Motor Score	81.51 (4.96)	79.92 (5.01)	77.25 (5.90)	75.66 (9.92)
Sust. Attention	4.50 (1.14)	4.32 (1.05)	4.22 (1.11)	3.94 (1.09)
NCATS Parent	34.68 (4.55)	34.38 (4.34)	33.93 (4.97)	33.93 (4.94)
Two-Bag Supp.	4.39 (.86)	4.35 (.88)	4.29 (.88)	4.24 (.85)
Negative Regard	6.88 (.46)	6.88 (.43)	6.81 (.59)	6.83 (.43)
Intrusiveness	6.81 (.55)	6.80 (.54)	6.67 (.75)	6.66 (.95)
Detachment	6.94 (.37)	6.93 (.41)	6.94 (.35)	6.97 (.17)
T. Attention	3.91 (.88)	3.82 (.86)	3.62 (.91)	3.33 (.95)
T. Extern.	4.10 (.80)	4.06 (.85)	3.93 (.84)	3.61 (.73)
T. Pro-Social	3.37 (.93)	3.37 (.95)	3.32 (1.02)	3.13 (.96)

Table 14 (cont'd)

P. Extern.	3.79 (.65)	3.79 (.66)	3.75 (.69)	3.61 (.73)
P. Pro-Social	3.70 (.72)	3.72 (.76)	3.66 (.74)	3.49 (.82)

Note. [a]Sample size rounded to the nearest 50. Birthweight values divided by 1,000. T = teacher rated; P = parent rated.

Table 15

Weighted Subpopulations Descriptive Statistics

	Full Term	Preterm	Very Preterm	Ex. Preterm
Variable	(*n*=3,299,535)	(*n*=368,966)	(*n*=55,929)	(*n*=18,560)
	M (SD)	M (SD)	M (SD)	M (SD)
SES	4.94 (.81)	4.82 (.81)	4.71 (.82)	4.76 (.74)
Age at Asses.	24.39 (1.18)	24.37 (1.19)	24.49 (1.53)	24.44 (1.40)
Clinical Gest.	39.40 (1.61)	34.96 (1.16)	29.79 (1.07)	25.68 (1.37)
Birth Weight	3.41 (.49)	2.82 (.65)	2.00 (.90)	.96 (.40)
Mental Score	128.12 (10.45)	124.99 (10.76)	121.66 (12.14)	115.94 (9.89)
Motor Score	81.66 (4.94)	80.62 (4.99)	78.60 (6.23)	76.16 (6.33)
Sust. Attention	4.54 (1.15)	4.25 (1.04)	4.32 (1.22)	3.96 (1.07)
NCATS Parent	34.90 (4.56)	34.29 (4.13)	33.33 (4.99)	33.87 (4.47)
Two-Bag Supp.	4.44 (.88)	4.21 (.92)	4.28 (.89)	4.21 (.83)

Table 15 (cont'd)

Negative Regard	6.90 (.43)	6.86 (.46)	6.83 (.62)	6.84 (.42)
Intrusiveness	6.83 (.54)	6.74 (.62)	6.69 (.67)	6.65 (.96)
Detachment	6.95 (.31)	6.89 (.45)	6.97 (.23)	6.97 (.17)
T. Attention	3.89 (.89)	3.76 (.88)	3.71 (.85)	3.29 (.94)
T. Extern.	4.09 (.81)	4.01 (.87)	3.96 (.72)	3.55 (.74)
T. Pro-Social	3.42 (93)	3.40 (.94)	3.53 (.92)	3.09 (.91)
P. Extern.	3.79 (.66)	3.77 (.66)	3.79 (.70)	3.55 (.74)
P. Pro-Social	3.74 (.72)	3.67 (.75)	3.60 (.69)	3.45 (.82)

Note. Birthweight values divided by 1,000. T = teacher-rated; P = parent-rated.

Research Question One: Influence of Variables for All Children

The first research question sought to test a longitudinal structural latent variable model that examined the relations between birth status, parenting behavior, cognitive development and social-emotional outcomes using a mixed sample of children born full term and preterm (n=5,050) with race, gender, SES, and age at assessment included in the model as covariates. It was hypothesized that the latent factor measurement model, along with the broader path model, would be empirically supported and thus, fit the data well.

Measurement model: Establishing the factors. Prior to running the structural equation modeling (Figure 1), Confirmatory Factor Analysis was conducted to test the four-factor measurement model of the overall structural model. The first latent factor, birth status, was indicated by two individual variables, clinical gestation and birthweight, both obtained from participant's birth certificates. The second latent factor, cognitive development, was indicated by three individual variables, mental scaled score, motor scaled score, and sustained attention, all at 24-months of age. The third latent factor, parenting behavior, was indicated by five individual variables, including total parenting at 9-months (NCATS), parental supportiveness, parental detachment, parental intrusiveness, and parental negative regard at 24-months. Lastly, the social-emotional latent variable was indicated by five variables, teacher-rated attention, externalizing behavior, and pro-social behavior, and parent-rated externalizing behavior and pro-social behavior at kindergarten entry. All factors were assumed to covary with one another; their associations were specified as unanalyzed in the measurement model (Kline, 2005).

The original four-factor CFA fit the data reasonably well, RMSEA = 0.064, lower bound of 90% CI = 0.061 and SRMSR=.045. The chi-square test of model fit was unavailable due to the use of replicate weights in the model (Muthén, & Muthén, 2010). Modifications to the model were examined and conducted based on the evaluation of factor loadings, modification indices, theoretical considerations and absolute fit indices. Since modification indices were large and interpretable, changes to the original four-factor model were conducted. This process led to the removal of three specific variables, parental detachment, parental negative regard, and parent-rated pro-social behavior. All three variables had low communalities ($<.30$). Additionally, preliminary analyses revealed little to no variance in these variables. Parental detachment and parental negative regard had similar mean scores across groups and in the full sample. Parents scored on average 6.9 out of 7 on both subscales, indicating extremely high and skewed indices of parenting. Thus, these two variables did not uniquely contribute to the model and were removed in subsequent analyses. In addition, because sustained attention was measured during the same play task as parental supportiveness, their residuals were specified to covary. Modifications improved the measurement model significantly. The final measurement model fit the data well, RMSEA = 0.042, lower bound of 90% CI = 0.039, SRMR=.026. All factor loadings were significant. For the final measurement model, the RMSEA was within the CI range; the chi-square and relative fit indices were unavailable because sample and replicate weights were applied to the analyses. See Table 16 for unstandardized and standardized estimates of individual factor loadings for the final measurement model.

Testing the longitudinal structural model. Figure 2 displays the results of the structural model. As hypothesized, the longitudinal, structural model fit the data well, RMSEA = .042, lower bound of 90% CI = .04, and SRMR = .027. Unweighted estimates included, $X^2 = 973.33$, $p = 0.0$, $df = 87$, RMSEA = 0.045, lower bound of 90% CI = 0.043, CFI = 0.949, TLI = .934, SRMR = .034. All structural paths were significant ($p<.001$). Birth status significantly positively predicted parenting behavior ($\beta=.17$, $t>1.96$) as well as cognitive development at 24-months

($\beta=.10$, $t>1.96$), suggesting that longer gestation and higher birth weight predict higher performances on cognitive indices at 24-months, and influenced more optimal parenting behavior. Birth status did not directly significantly predict social-emotional outcomes, so this path was removed from the final model. In addition, positive parenting behavior predicted better cognitive development at 24-months ($\beta=.65$, $t>1.96$) and better social-emotional outcomes at kindergarten entry ($\beta=.10$, $t>1.96$). Cognitive development at 24-months significantly and positively predicted social-emotional outcomes at kindergarten entry ($\beta=.25$, $t>1.96$). Children's mental scaled scores were significantly associated with their motor scaled scores (.28), and child sustained attention was significantly associated with parent supportiveness (.52), but was not significantly associated with parental intrusiveness. Table 17 displays the factor loadings and path estimates for the final structural model, and the final structural model is displayed in Figure 2.

Influence of covariates. In addition to the main variables of interest, several covariates were included in the model as a means to control for their effect on birth status, parenting behavior, cognitive development, and social-emotional outcomes. Originally, parent SES, child gender, and child race were freely allowed to predict all latent variables. Age at assessment was specified to predict cognitive development at 24-months. All insignificant paths were removed and the final structural model included only those covariates that significantly uniquely contributed to the model. Higher parent SES significantly predicted more optimal indices of birth status ($\beta=.14$, $t>1.96$) and positive parenting behavior ($\beta=.59$, $t>1.96$), but did not significantly influence cognitive development or social-emotional outcomes.

Child gender significantly predicted all four latent variables, including birth status ($\beta=-.05$, $t>-1.96$), parenting behavior ($\beta=.10$, $t>1.96$), cognitive development ($\beta=.18$, $t>1.96$), and social-emotional outcomes (β=.22, t>1.96). This finding suggests that males are more likely to be born with greater gestational ages and higher birth weights, and females are more likely to perform higher on cognitive indices at 24-months, and be rated higher on social-emotional outcomes at kindergarten entry. Additionally, being a female predicted more optimal parenting behavior at 24-months. Child race and age at assessment were not significant in the model and therefore, were removed from the final structural model. Lastly, birth plurality and cesarean birth status were included in the model and hypothesized to predict birth status. Birth plurality, as obtained from participant's birth certificate data, significantly negatively influenced birth status (β=-.38, t>1.96), suggesting that the greater number of babies resulting from a single pregnancy significantly predicted shorter gestational ages and lower birth weights. Lastly, women who did not receive a c-section were more likely to have children born at longer gestational ages and with greater birth weights (β=.13, t>1.96).

Table 16

Final Confirmatory Factor Analysis for a Four-Factor Model

Items	Unstandardized	Standard Error (SE)	Standardized	R^2
Birth Status				
Clinical Gestation	1.000	0.000	0.793	.358
Birth Weight	3.201	0.570	0.598	.628
Cognitive Development				
Mental Scaled Score	1.000	0.000	0.877	.770
Motor Scaled Score	0.267	0.015	0.497	.247
Sustained Attention	0.065	0.004	0.530	.280
Parenting Behavior				
Parental Supportiveness	1.000	0.000	0.678	.460
Total Parenting (NCATS)	2.849	0.217	0.375	.141
Parental Intrusiveness	0.350	0.036	0.382	.146
Social-Emotional Outcomes				
Teacher-Rated Externalizing	1.000	0.000	0.779	.132

Table 16 (cont'd)

Teacher-Rated Attention	1.285	0.049	0.920	.846
Teacher-Rated Pro-Social	0.724	0.038	0.494	.607
Parent-Rated Externalizing	0.374	0.022	0.364	.132

Note. All factor loadings were significant (p<.001). Weights and replicate weights applied.

Table 17

Parameter Estimates for a Four-Factor Structural Regression Model of Parenting, Cognitive Development and Social-Emotional Outcomes

	Unstandardized	Standard Error	Standardized	R^2
		Factor Loadings		
Birth Status				.195 (.174)
Clinical Gestation	1.000	0.000	0.957 (.586)	.642 (.343)
Birth Weight	3.723 (3.075)	0.087 (.172)	0.801 (.808)	.915 (.653)
Cognitive Development				.526 (.505)
Mental Scaled Score	1.000	0.000	0.780 (.763)	.608 (.582)
Motor Scaled Score	0.248 (.209)	0..012 (.017)	0.398 (.338)	.158 (.115)
Sustained Attention	0.075 (.085)	0.003 (.005)	0.559 (.598)	.312 (.358)
Parenting Behavior				.353 (.391)
Parental Supportiveness	1.000	0.000	0.628 (.682)	.394 (.466)
Total Parenting (NCATS)	3.390 (3.142)	0.190 (.207)	0.404 (.420)	.163 (.176)

Table 17 (cont'd)

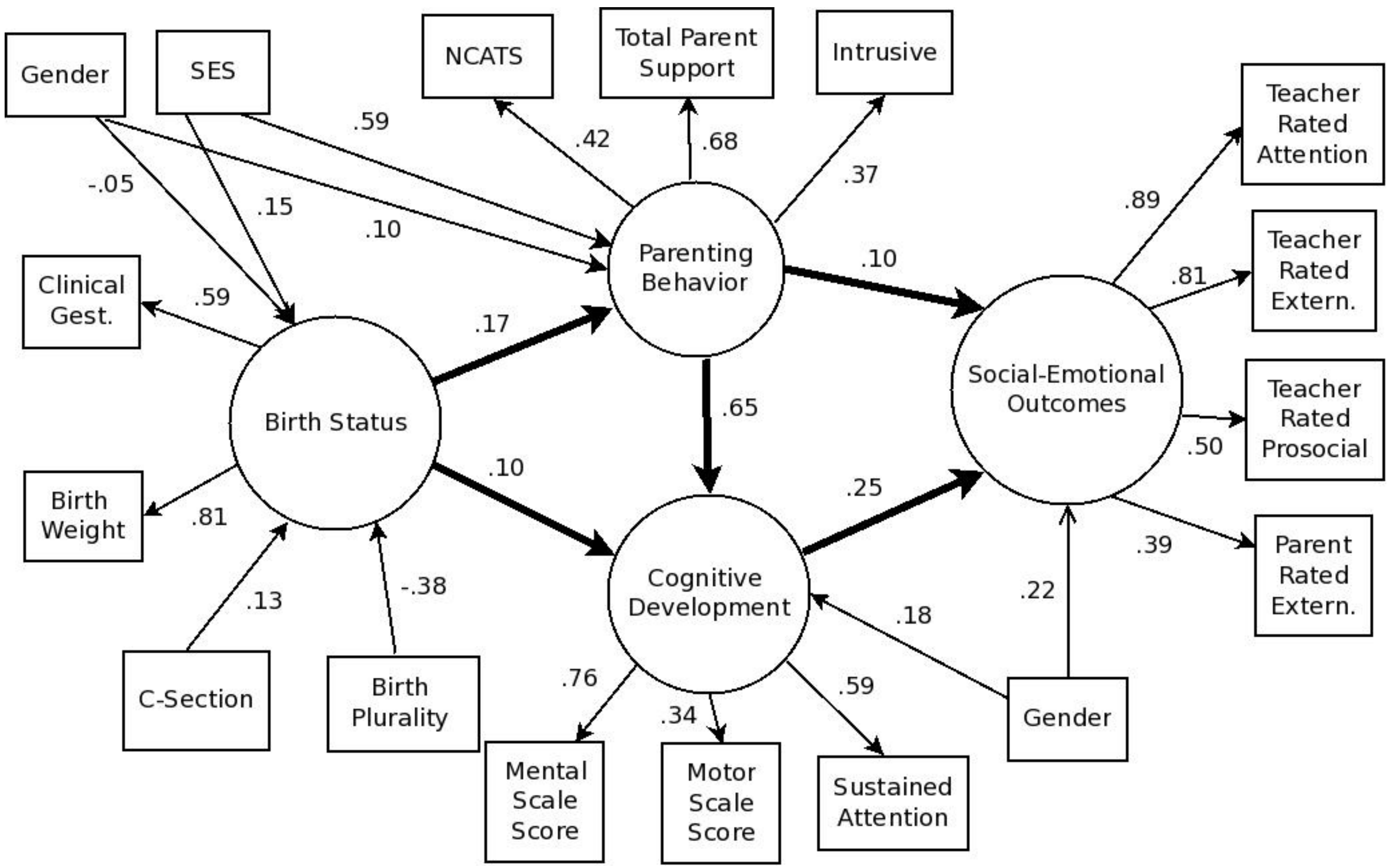
Parental Intrusiveness	0.398 (.342)	0.023 (.034)	0.374 (.373)	.140 (.139)
Social-Emotional Outcomes				.222 (.190)
Teacher-Rated Externalizing	1.000	0.000	0.777 (.805)	.603 (.647)
Teacher-Rated Attention	1.277 (1.201)	0.027 (.039)	0.904 (.888)	.817 (.788)
Teacher-Rated Pro-Social	0.720 (.704)	0.023 (.039)	0.480 (.496)	.230 (.246)
Parent-Rated Externalizing	0.379 (.385)	0.016 (.021)	0.363 (.386)	.132 (.149)

Direct Effects

Birth Status → Cognitive Dev.	2.663 (1.759)	.201 (.423)	.261 (.104)
Birth Status → Parenting Behavior	.089 (.173)	.013 (.025)	.136 (.137)
Parenting Behavior → Cognitive Dev.	9.260 (8.640)	.413 (.535)	.593 (.645)
Cognitive Dev. → Social-Emotional	.020 (.020)	.002 (.004)	.269 (.251)
Parenting Behavior → Social-Emotional	.170 (.113)	.037 (.041)	.146 (.104*)

Note. All factor loadings were significant (p<.001). Weighted estimates are in parentheses.
*significant at (p<.01). All other structural paths were significant (p<.001).

Figure 2. Longitudinal Structural Model



Research Question Two: Full Term vs. Preterm

The second research question sought to examine whether the relations between parenting, cognitive development, and social-emotional outcomes, as tested in research question one, differed between children born full term (*n*=3,550) and children born preterm (*n*=1,300). The birth status latent construct was removed from the original structural model because clinical gestation was used as the grouping variable. Birthweight was included in the model as a covariate to control for its influence on cognitive development. Because birthweight was highly correlated with intrauterine growth restriction (IUGR, r=.80) in the current sample, it was not used as the grouping variable.

Testing the model separately to preterm and full term samples. The same structural model (Figure 1) was tested separately for each group, with birthweight specified to influence cognitive development. The same covariates, SES and gender, that were significant in the model for research question one, were again included in the multi-sample model. These covariates were included to control for their influences on latent variables because it was hypothesized that they would differentially influence variables based on group membership. Results demonstrated that the model fit the data well with children born full term, RMSEA = .052, lower bound of 90% CI = .048, and SRMR = .031. Unweighted estimates for the full term sample included, $X^2 = 531.30$, $p = 0.0$, $df = 55$, RMSEA = 0.049, lower bound of 90% CI = 0.045, CFI = 0.941, TLI = .920, SRMR = .032. The model also fit the data well with the sample of children born preterm, RMSEA = .052, lower bound of 90% CI = .045, and SRMR = .039. Unweighted estimates for the preterm sample included, $X^2 = 263.42$, $p = 0.0$, $df = 55$, RMSEA = 0.054, lower bound of 90% CI = 0.048, CFI = 0.936, TLI = .913, SRMR = .041.

Multi-group model: Differences between two groups. The same model tested above was used to specify a multi-sample model to test for equivalence across full term and preterm samples. By testing the model simultaneously for preterm and full term children, it was found that there were significant group differences in the relative influence of parenting on cognitive and social-emotional development, and cognitive development on social-emotional outcomes. Specifically, positive parenting behavior influenced positive social-emotional outcomes for children born full term, but not for children born preterm. In addition, although more optimal cognitive development influenced better social-emotional outcomes for both groups, it had a stronger influence on social-emotional development for children born preterm.

Procedural steps. The structural paths and factor loadings in the initial multi-sample model were freely estimated across groups (see Figure 3). In other words, there were no requirements that the magnitude of the paths and factor loadings had to be the same across groups. The results of the model where the paths were freely estimated fit the data well, RMSEA = 0.053, lower bound of 90% CI = 0.049, SRMR = .051. Unweighted estimates included, X^2 = 865.180, p = 0.0, df = 117, RMSEA = 0.051, lower bound of 90% CI = 0.048, CFI = 0.934, TLI = .916, SRMR = .051. The results of this initial model were compared to subsequent models in which factor loadings and specific paths were constrained to be equal across groups. The fit of the model significantly worsened, based on the chi-square distribution for 8 degrees of freedom ($p<.001$), when the factor loadings and path estimate from parenting to social-emotional outcomes were constrained to be invariant for children born preterm as compared to children born full term, X^2 = 963.59, p = 0.0, df = 125, RMSEA = 0.053, lower bound of 90% CI = 0.05, CFI = 0.926, TLI = .912, SRMR = .057.

Next, the factor loadings and paths between cognitive development and parenting behavior, parenting behavior and social-emotional outcomes, cognitive development and social-emotional outcomes, and birthweight and cognitive development, were constrained to be equal across both groups, and the model significantly worsened based on the chi-square distribution for 10 degrees of freedom (p<.001), when compared to the original freely estimated model, and significantly worsened (p<.001) based on 2 degrees of freedom when compared to the less constrained model (path from parenting to social-emotional outcomes constrained), X^2 = 1008.732, *p* = 0.0, *df* = 127, RMSEA = 0.053, lower bound of 90% CI = 0.05, CFI = 0.923, TLI = .909, SRMR = .055. As expected, when the factor loadings, covariate estimates, and structural paths were all constrained to be equal across groups, the resulting model significantly worsened when compared to the original freely estimated model, based on 17 degrees of freedom (p<.001), X^2 = 1039.56, *p* = 0.0, *df* = 135, RMSEA = 0.053, lower bound of 90% CI = 0.05, CFI = 0.920, TLI = .911, SRMR = .076. Weighted estimates of the fully constrained model included an RMSEA = .052, lower bound of 90% CI = .049, SRMR = .073.

In the model where all parameters were freely estimated, positive parenting behavior influenced more optimal social-emotional outcomes for children born full term (β=.110, p<.001), but not for children born preterm (β=.08, p=.41). Furthermore, there was a difference in the amount of variance in social-emotional outcomes explained by cognitive development across the two groups. Although this path was significant for both groups, cognitive development explained more of the variance in social-emotional outcomes for children born preterm (β=.25, p<.001), when compared to children born full term (β=.19, p<.001). Positive parenting behavior at 24-months influenced better cognitive development at 24-months for both children born full term (β=.66, p<.001), and children born preterm (β=.57, p<.001). Birthweight was significant in the model for children born preterm only; for children born preterm, being born with higher birthweights predicted more optimal cognitive development at 24-months ($\beta=.27$, $p<.001$), but did not influence cognitive development for children born full term ($\beta=.03$, $p=.06$). Additionally, children's gender had a stronger influence on cognitive development for children born preterm ($\beta=.23$, $p<.001$), when compared to children born full term ($\beta=.16$, $p<.001$), such that being male and preterm confers more risk of having poorer cognitive outcomes than being male and full term. Similarly, gender had a stronger influence on social-emotional outcomes in children born full term ($\beta=.24$, $p<.001$), when compared to children born preterm ($\beta=.11$, $p<.001$), suggesting that gender more strongly influences social-emotional outcomes in full term children, when compared to preterm children. High parent SES predicted positive parenting behavior for both children born full term ($\beta=.59$, $p<.001$), and preterm ($\beta=.63$, $p<.001$), and had slightly stronger effects on parenting for children born preterm. Lastly, the strength of factor loadings for the three latent constructs differed between groups, suggesting that these constructs differ across groups (see Table 18 for group differences on factor loadings and path estimates).

Table 18

Parameter Estimates for a Four-Factor Structural Regression Multi-Sample Model Across Children Born Full Term and Preterm

Items	Unstandardized	Standardized	Unstandardized	Standardized
	Full Term		Pre Term	
Cognitive Development	Factor Loadings		Factor Loadings	
Mental Scaled Score	5.675 (5.983)	0.772 (0.792)	4.733 (5.341)	.659 (.695)
Motor Scaled Score	1.220 (1.323)	0.350 (.369)	0.720 (1.068)	.191 (.289)
Sustained Attention	0.448 (.468)	0.571 (.574)	0.403 (0.411)	.534 (.535)
Parenting Behavior				
Total Parenting (NCATS)	1.493 (1.403)	0.394 (0.386)	1.415 (1.397)	.410 (.420)
Parent Supportiveness	0.456 (0.479)	0.636 (.679)	0.445 (.497)	.663 (.719)
Parental Intrusiveness	0.174 (0.168)	0.378 (.382)	0.165 (.172)	.332 (.353)
Social-Emotional Outcomes				

Table 18 (cont'd)

Teacher-Rated Externalizing	0.560 (0.592)	0.782 (0.807)	0.563 (.634)	.778 (809)
Teacher-Rated Attention	0.715 (0.714)	0.901 (.888)	0.684 (.745)	.903 (.940)
Teacher-Rated Pro-Social	0.396 (0.408)	0.470 (.486)	0.414 (.463)	.505 (.543)
Parent-Rated Externalizing	0.213 (.221)	0.367 (.377)	0.211 (.225)	.369 (.366)
	Direct Effects		Direct Effects	
Parenting Behavior → Cognitive Dev.	.805 (.742)	.672 (.662)	.657 (.612)	.593 (.574)
Cognitive Dev. → Social-Emotional	.174 (.187)	.224 (.235)	.318 (.245)	.393 (.314)
Parenting Behavior → Social-Emotional	.141 (.097**)	.152 (.108)	$.072^{ns}$ ($.066^{ns}$)	0.081 (0.079)
Birthweight → Cognitive Development	.214 (0.076^{ns})	.082 (0.027^{ns})	.564 (.473)	.330 (.274)
Socioeconomic Status → Parenting	0.753 (0.905)	.546 (.587)	1.011 (1.024)	.649 (.629)
Gender → Parenting Behavior	.232 (.215)	.096 (0.086)	.140 (.327)	$.053^{ns}$(.123*)

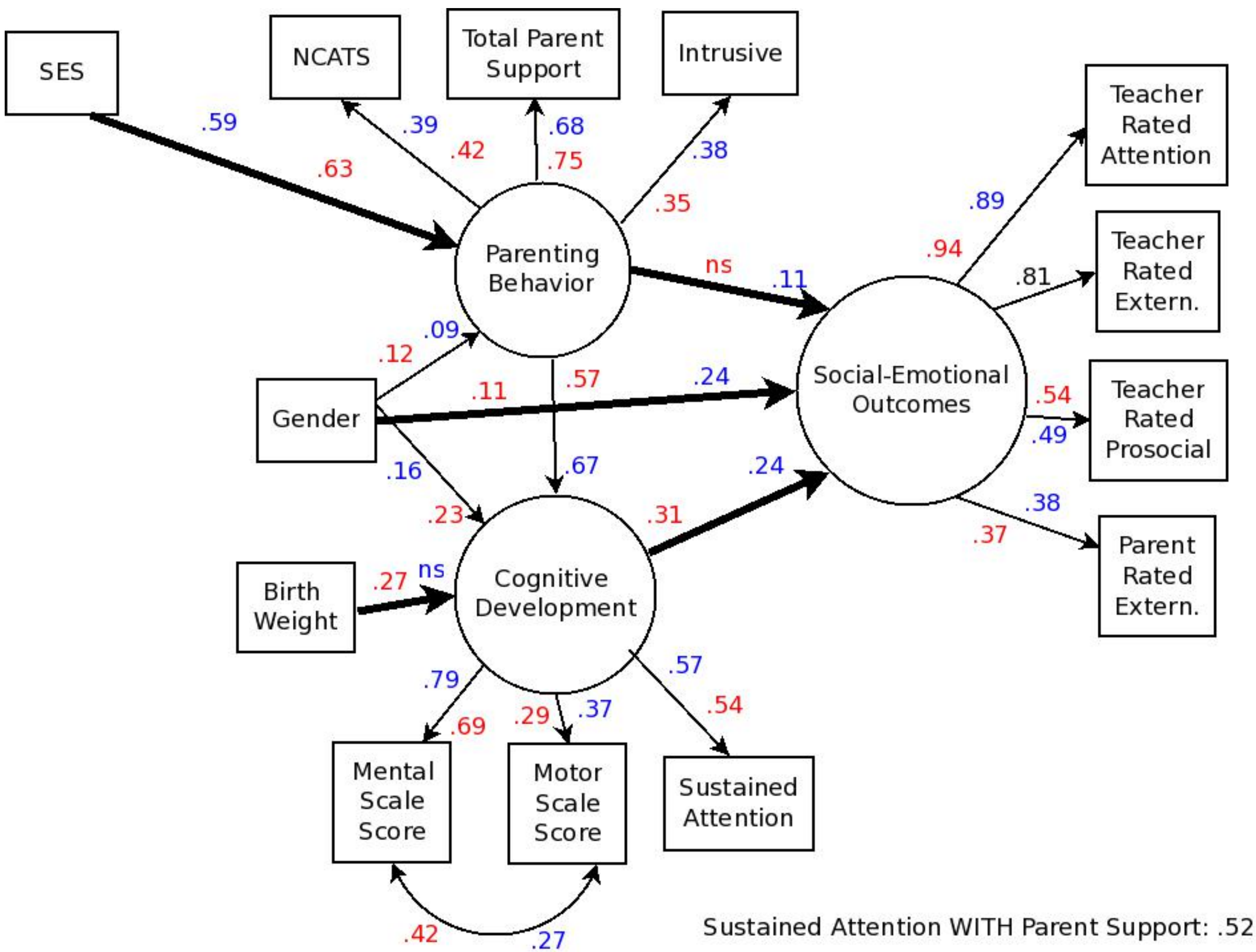
Table 18 (cont'd)

Gender → Cognitive Development	.546 (.454)	.190 (.163)	.726 (.664)	.249 (.234)
Gender → Social-Emotional	.485 (.532)	.217 (.240)	.479 (.237)	.203 (.107)
Mental Score WITH Motor Score	8.680 (7.911)	.275 (.265)	18.902 (16.229)	.444 (.418)
Attention WITH Parent Supportiveness	.311 (.310)	.504 (.519)	.328 (.322)	.531 (.556)

Note. All factor loadings were significant (p<.001). Weights and replicate weights applied and weighted estimates are included in parentheses next to unweighted estimates.

**significant at p<.01, *significant at p<.05, ^{ns}not significant (p>.05). All other structural paths significant (p<.001).

Figure 3. Two-Group Multi-Sample Structural Equation Model with Standardized Estimates. Red = Preterm; Blue = Control. (For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this disseration).



Research Question Three: Differences Across Categories of Preterm Birth

The third research question sought to examine whether group membership moderated the relations between parenting, cognitive development, and social-emotional outcomes. Similar to research question two, clinical gestation was used as the grouping variable and the sample was separated into one of four groups, full term (greater than 37 weeks; *n*=3,600); preterm (32 to 36 weeks; *n*=800); very preterm (28 to 31 weeks; *n*=300), and extremely preterm (*n*=200). Overall, as expected, results suggest that relations between the constructs and factor loadings specified in the model differ across children of varying degrees of biologic risk, as determined via gestational age categories. Specifically, positive parenting behavior influenced positive social-emotional outcomes for children born full term, but not for children born preterm, very preterm, or extremely preterm. In addition, although more optimal cognitive development influenced better social-emotional outcomes for all four groups, it exerted the strongest influence on social-emotional development for children born preterm and very preterm. Positive parenting behavior significantly influenced cognitive development in all four groups, exerting the greatest influence for children born full term, preterm, and very preterm.

Procedural Steps

Measurement Model. As a first step in running the four-group multi-sample analyses, the measurement model was tested separately with each group to confirm that the measurement model fit the data well for each group. The measurement model included three factors, parenting behavior, cognitive development, and social-emotional outcomes. The same indicators were used in the multi-sample CFA that were used in the full structural model CFA seen in research question one. The birth status latent variable was dropped, because clinical gestation was instead used as a grouping variable. Mental and motor scaled scores, as well as child sustained attention and parent supportiveness were specified to covary. The three factor measurement model fit the data well for the control group, RMSEA=.049, lower bound=.044, SRMR=.025, (unweighted estimates for the control group included, $X^2 = 235.70$, $p = 0.0$, $df =$ 30, RMSEA = 0.043, lower bound of 90% CI = 0.038, CFI = 0.971 TLI = .956, SRMR = .026), and also for the preterm group, RMSEA=.046, lower bound=.034, SRMR=.033 (unweighted estimates for the preterm group included, $X^2 = 73.72$, $p = 0.0$, $df = 30$, RMSEA = 0.042, lower bound of 90% CI = 0.030, CFI = 0.972, TLI = .958, SRMR = .033). The data fit the model adequately for the very preterm group, RMSEA=.094, lower bound= .075, SRMR=.075 (unweighted estimates for the very preterm group, $X^2 = 64.50$, $p = 0.0$, $df = 30$, RMSEA = 0.061, lower bound of 90% CI = 0.040, CFI = 0.943, TLI = .915, SRMR = .052). Finally, the data fit the model extremely well for the extremely preterm group, RMSEA = .00, SRMR = .036 (unweighted estimates for the extremely preterm group included, $X^2 = 31.63$, $p = 0.39$, $df = 30$, RMSEA = 0.018, lower bound of 90% CI = 0.00, CFI = 0.995 TLI = .992, SRMR = .039).

Testing the model separately with each group. Next, the structural model tested in research question two was tested separately for each of the four groups. The data fit the model well for the full term group, RMSEA = .052, lower bound of 90% CI = .048, SRMR = .031. Unweighted estimates include, $X^2 = 531.302$, $p = 0.0$, $df = 55$, RMSEA = 0.049, lower bound of 90% CI = 0.045, CFI = 0.941, TLI = .920, SRMR = .032. The data fit the model well for the preterm group, RMSEA = .065, lower bound of 90% CI = .057, SRMR = .05. Unweighted estimates include, $X^2 = 134.01$, $p = 0.0$, $df = 55$, RMSEA = 0.042, lower bound of 90% CI = 0.033, CFI = 0.960, TLI = .945, SRMR = .039. Additionally, the data fit the model well for the very preterm group, X^2 = 113.588, *p* = 0.0, *df* = 55, RMSEA = 0.059, lower bound of 90% CI = 0.044, CFI = 0.918, TLI = .888, SRMR = .057, and the extremely preterm group, RMSEA = .046, lower bound of 90% CI = .010, SRMR = .06. Unweighted estimates include, X^2 = 70.05, *p* = 0.83, *df* = 55, RMSEA = 0.040 lower bound of 90% CI = 0.00, CFI = 0.960, TLI = .945, SRMR = .055.

Multiple-Group CFA. Because the measurement model and structural model fit the data well for each group separately, a multi-group analysis was conducted, which simultaneously tested the model across all four samples (Kline, 2005). Prior to testing the multi-sample structural model, a multi-group CFA was first conducted to determine whether there were differences in factor loadings and constructs across groups. Initially, the CFA specified all parameters to be freely estimated across groups. The resulting CFA fit the data well, RMSEA = .050, lower bound of 90% CI = .046, SRMR = .037. Unweighted estimates included, X^2 = 493.41, *p* = 0.0, *df* = 143, RMSEA = 0.045, lower bound of 90% CI = 0.040, CFI = 0.963, TLI = .954, SRMR = .042. The fit of this original freely estimated CFA was compared to a subsequent model in which all factor loadings were constrained to be invariant across groups. The fit of the constrained CFA based on the chi-square distribution for 25 degrees of freedom ($p<.001$), significantly worsened the fit of the model, RMSEA = .053, lower bound of 90% CI = .049, SRMR = .079. Unweighted estimates of the constrained CFA included, X^2 = 654.866, *p* = 0.0, *df* = 168, RMSEA = 0.049, lower bound of 90% CI = 0.045, CFI = 0.949, TLI = .945, SRMR = .075. The results suggest that the measurement of the three-factors and observed indicators may differ slightly across groups.

For all groups, the standardized factor loadings for the three latent variables suggest that the observed variables provide relatively valid measures of underlying constructs. For cognitive outcomes, however, children's mental scaled score and sustained attention were better indicators of overall cognitive development for children born full term and preterm, whereas mental and motor scaled scores were better indicators of overall cognitive development for children born very preterm and extremely preterm. For the parenting variable, total parent supportiveness at 24-months was consistently the best indicator of parenting behavior for all groups, except for the very preterm group, whereby parent intrusiveness was a slightly stronger indicator of parenting behavior (.57). Lastly, for all groups, teacher reports of behavior appear to be considerably more valid estimates of social-emotional outcomes at kindergarten entry, as teacher reports of attention, externalizing behavior, and pro-social behavior had much stronger loadings on social-emotional outcomes, than parent ratings of externalizing behavior.

Multiple-sample SEM: Differences between four groups. Similar to research question two, initially the structural paths and factor loadings in the multi-sample model were freely estimated across all four groups. The results of the model where the paths were freely estimated fit the data well, RMSEA=.059, lower bound 90% CI = .056, SRMR=.062. Unweighted estimates included, $X^2 = 921.71$, $p = 0.0$, $df = 241$, RMSEA = 0.048, lower bound of 90% CI = 0.045, CFI = 0.939, TLI = .924, SRMR = .047. The fit of the model significantly worsened, based on the chi-square distribution for 24 degrees of freedom ($p<.001$), when the factor loadings and the direct path from parenting to social-emotional outcomes were constrained to be invariant across groups, $X^2 = 1088.83$, $p = 0.0$, $df = 265$, RMSEA = 0.051, lower bound of 90% CI = 0.05, CFI = 0.926, TLI = .916, SRMR = .058 (weighted estimates include, RMSEA = .059, lower bound 90% CI = .056, SRMR = .063). This finding suggests that parenting differentially predicts outcomes based on group membership. As expected, when the factor loadings, covariate estimates, and structural paths were all constrained to be equal across groups, the resulting model significantly worsened when compared to the original freely estimated model, based on 51 degrees of freedom (p<.001), $X^2 = 1162.213$, $p = 0.0$, $df = 292$, RMSEA = 0.050, lower bound of 90% CI = 0.047, CFI = 0.922, TLI = .920, SRMR = .067. Weighted estimates of the fully constrained model included an RMSEA = .058, lower bound of 90% CI = .055, SRMR = .077.

In the model where all parameters were freely estimated, the relations between parenting and social-emotional outcomes was significant for children born full term (β=.115, p<.001; unweighted, β=.147 p<.001), but not significant for children born preterm (β=.06, p=.66; unweighted, β=.08, p=.33), very preterm (β=.07, p=.55; unweighted β=.18, p<.10), and extremely preterm (β=.17, p=.34; unweighted, β=.14, p=.32). Thus, for children born full term, positive parenting at 24-months significantly influences better social-emotional outcomes at kindergarten entry. However, this direct effect disappears for children born earlier than 37 weeks gestation.

Furthermore, as seen in research question two, there was a difference in the amount of variance in social-emotional outcomes explained by cognitive development. Although this path was significant for all groups, increased cognitive development had a stronger influence on positive social-emotional outcomes for children born preterm (β=.32, p<.001), very preterm (β=.35, p<.001), and extremely preterm (β=.32, p=.03) when compared to children born full term (β=.23, p<.001). Positive parenting behavior significantly predicted more optimal cognitive development at 24-months for all four groups; full term (β=.68, p<.001), preterm (β=.70, p<.001), very preterm (β=.47, p<.001), and extremely preterm (β=.49, p<.001).

Birthweight had significantly larger effects on cognitive development in samples with shorter gestational ages. Being born preterm, but with a higher birthweight predicted better cognitive development for children born extremely preterm ($\beta=.86$, $p<.01$), and very preterm ($\beta=.46$, $p<.001$). Although birthweight still significantly predicted cognitive development in the preterm and full term samples, the effect was not as strong ($\beta=.25$, $p<.001$, $\beta=.15$, $p<.001$, respectively). Additionally, children's gender had a stronger influence on cognitive development for children born preterm ($\beta=.47$, $p<.001$), very preterm ($\beta=.59$, $p<.001$), and extremely preterm ($\beta=.45$, $p=.02$) when compared to children born full term ($\beta=.38$, $p<.001$), however, did not differently predict social-emotional outcomes. This suggests that being born early and being a female resulted in higher performances on cognitive development, placing males born early at greater risk for lower cognitive scores. Lastly, higher parent socioeconomic status significantly predicted better parenting behavior for all four groups, but had a stronger effect on cognitive development in the sample of children born preterm ($\beta=.83$, $p<.001$), and very preterm ($\beta=.71$, $p<.001$), when compared to the children born extremely preterm ($\beta=.57$, $p<.001$), and full term ($\beta=.63$, $p<.001$), suggesting that higher SES has a stronger effect on cognitive development in children born preterm with less biologic risk.

CHAPTER 5
DISCUSSION

Developmental models describe and quantify the important influences of early childhood factors on subsequent outcomes. There is overwhelming agreement in the literature identifying specific constructs deemed important for influencing developmental outcomes for all children, including neurological, environmental, and physiological processes that interact to influence cognitive and social-emotional development. Specifically, parenting behavior has been consistently and widely studied and found to be a critical determinant of children's developmental outcomes, both cognitive and social-emotional. However, whether parenting operates similarly or differently across children born at varying degrees of biologic risk is relatively unknown. Little research has examined and quantified whether parenting has the same magnitude of effect on cognitive and social-emotional outcomes across different groups of children born preterm. Instead, previous research has focused solely on children born at the lower limits of viability, without including children born late preterm (i.e. near term). Using national longitudinal data and multi-group latent variable structural equation modeling, the current study extended previous research and provided additional insight into these important questions.

This longitudinal study examined the relations between birth status, parenting behavior during early childhood, cognitive development at 24-months, and social-emotional outcomes at kindergarten entry in a representative sample of children born in the year 2001. Moreover, the current study evaluated differential patterns of relations between parenting behavior, cognitive development, and social-emotional outcomes with preterm birth classifications as a potential moderating variable. The longitudinal hypothesized model was empirically supported. Results indicated that longer clinical gestation and larger birthweights influenced positive parenting behavior and optimal cognitive development at 24-months. Further, positive parenting behavior predicted optimal cognitive development and better social-emotional outcomes at kindergarten entry, beyond the effects of parent's initial socioeconomic status at 9-months, gender, and delivery type. Birth status, however, did not directly predict social-emotional outcomes at kindergarten entry. Rather, birth status exerted its influence on social-emotional outcomes through its influence on parenting behavior and cognitive development at earlier time points. Results suggest that cognitive and social-emotional outcomes likely occur as a product of many interacting components across early childhood periods.

Relative to models testing group differences, it was hypothesized that parenting would differentially predict cognitive development and social-emotional outcomes for children born with varying degrees of biologic risk, and in particular, that positive parenting would more strongly predict optimal cognitive and social-emotional outcomes for children born at earlier gestation periods. Overall, this hypothesis was partially supported. Group status moderated the relations between parenting behavior, cognitive development and social emotional outcomes, however, the longitudinal salience of parenting contradicted the original hypothesis. For full term children, parenting behavior was a stronger predictor of social-emotional outcomes than for preterm children at kindergarten entry. In contrast, parenting behavior predicted cognitive development at the earlier time point for children born preterm, but lost influence on social-emotional outcomes by kindergarten for all children born before 37 weeks gestation. Interestingly, cognitive development explained more of the variance in social-emotional outcomes in the preterm samples, suggesting that the relations between the constructs during the first five years of life differ across children born at varying degrees of risk, defined by clinical gestation.

This study offers a unique contribution to the literature on outcomes associated with preterm birth because it examined development across the first five years of life, controlled for important variables that affect outcomes, examined the magnitude of the effect of birth status on cognitive development, parenting behavior, and social-emotional outcomes, examined differences across subpopulations of preterm birth, utilized a control group, and employed weighting techniques that allowed for the results to generalize to children born in the year 2001. A closer examination of the current results follows.

Parenting as a Predictor of Social-Emotional Development

As expected, positive parenting behavior during early childhood significantly predicted better social-emotional outcomes, including lower externalizing behavior, higher levels of attention and increased pro-social behavior at kindergarten entry in a representative sample of children born in 2001. Parenting behavior during the first two years of life continued to be a significant predictor of social-emotional outcomes at kindergarten entry. Although parenting behavior significantly influenced outcomes at kindergarten entry in the representative sample, the longitudinal influence of parenting behavior substantially weakened over time, and parenting had the greatest effect on cognitive development for children at 24-months. This finding is likely due to the timing of data collection. Parenting behavior and cognitive development were both measured when children were 24-months of age, suggesting that parenting has a stronger, more proximal effect on child cognitive outcomes, and although parenting continued to influence outcomes at kindergarten entry, this effect weakened across time. It is likely that other factors, including child care arrangements, preschool enrollment, neighborhood effects, parental stress, and home characteristics, which were not accounted for in the current study, also contribute to social-emotional outcomes at kindergarten entry.

Group Differences. It was originally hypothesized that parenting behavior during early childhood would differentially predict outcomes in kindergarten entry for children born preterm when compared to children born full term, specifically having a greater effect on outcomes for children born at earlier gestation periods. This hypothesis was based on previous research that has documented the unique effects of consistent positive parenting behavior in establishing a strong foundation for subsequent development in children born preterm (Bradley et al., 1988; Landry et al., 2001; 2003; Smith et al., 2006; Wakschlag & Hans, 1999). In contrast to this initial hypothesis, parenting significantly influenced social-emotional outcomes for the full term sample only, and did not significantly influence social-emotional outcomes at kindergarten entry in children born preterm, very preterm or extremely preterm.

The non-significant longitudinal effect in the preterm samples may be interpreted in several ways. First, based on previous research, parenting behavior likely exerts a stronger proximal effect on social-emotional development in high-risk children, rather than a longitudinal effect, which was specified in the current model. Landry, Smith, & Swank (2006) found that increased maternal responsiveness across the first 13-months of life facilitated greater growth in infants' social, emotional, communicative, and cognitive competence in a sample of infants born with low birthweights, and mothers who received a targeted intervention were able to reduce negative behaviors that were seen in infants with the most severe neonatal complications. These results documented the important influence of responsive parenting on infant development during the earliest stages of life, within the first year. Similarly, Forcada-Guex and colleagues (2006) found that maternal responsivity and sensitivity lessened the effect of preterm birth on behavioral outcomes, including cooperativeness, compliance, and difficult behavior, when children were 18-months. Both studies documented the proximal effect of parenting, but did not look at parenting across time. Therefore, parenting behavior appears to have the strongest effect on development during early childhood when children's neural systems underlying cognitive, attention, language and social-emotional processes undergo rapid development. Because children born early are at increased risk for experiencing disruptions to central nervous system functions, they might be most susceptible to environmental influences on this system during the first two to three years to support optimal growth and development. Future research should expand the current model and include measures of infant emotion regulation during year one and two, attention processes at year two and three, and behavioral outcomes, including measures of executive functions during years four and five, to better understand how parenting across times influences this developing system in high-risk children to inform intervention efforts to reduce adverse outcomes.

Next, previous research has found that consistent responsive caregiving, including sensitivity, responsiveness, low levels of intrusiveness, restrictiveness, and negative regard during infancy, toddlerhood, and preschool contributed to better outcomes in children born full term, and low birthweight children with less severe medical complications (Smith et al., 2006). The current study also demonstrated a similar relationship in social-emotional outcomes, rather than cognitive outcomes as seen in the Smith and colleagues study (2006). Parenting behavior during 9-months and 24-months had a stronger effect on social-emotional outcomes in children born at higher gestational ages. Interestingly, Smith and colleagues found that a consistent responsive parenting context was more beneficial for children born with less severe medical complications, suggesting that there may actually be a limit to the extent to which early responsive parenting can support more medically-compromised children to “catch up” with same-age peers. Although the current study did not classify children into high-risk groups based on medical complications, this pattern was identified when categorizing children into types of preterm birth, with the assumption that children born at lower gestational ages were at increased risk for experiencing medical and neurological complications. Because the magnitude of the effect of parenting behavior on social-emotional outcomes substantially weakened in children born with increased-risk, it is likely that environmental factors differentially exert their influence on subsequent behavioral outcomes depending on risk status.

Limitation in outcome variables. The limited variability in social-emotional outcomes as measured in the current study could also explain the non-significant effect of parenting for preterm children. Although mean social-emotional differences did emerge between children born full term, preterm, very preterm, and extremely preterm, these differences were subtle at kindergarten entry. It is likely that the items used in the current study did not accurately capture underlying deficits in executive functions, internalizing symptoms, and externalizing symptoms, that might manifest later in development and precede more significant psychiatric diagnoses or challenges seen in children born preterm. Additionally, the demands placed upon children at kindergarten entry are significantly less than what are seen at higher grade levels. As classroom demands increase, the differences between these groups might become more apparent, and parenting behavior across early childhood and elementary school could differentially influence this system across time. Since children born preterm are at increased-risk for developing ADHD and frequently manifest externalizing or internalizing symptoms at later ages, it is important to understand when and how these early subtle differences become more prevalent. Future studies should utilize behavioral measures that are more sensitive in identifying underlying symptoms, and which account for the interaction between parenting and social-emotional growth across development.

The role of cognitive development. Much of the available research has examined parenting behavior in relation to cognitive outcomes in children born preterm, because cognitive deficits have been more widely documented in this population. Similar types of positive parenting behavior measured in the current study have been linked to increased language development, higher IQ scores later in development, and the promotion of cognitive skills during early childhood. Smith and colleagues (2006) found that parenting behavior during early childhood periods continued to influence cognitive development in children up to 10 years of age, demonstrating a longitudinal effect of parenting on cognitive outcomes. Although the current study did not measure long-term cognitive outcomes, parenting behavior had the strongest effect on cognitive development in all children. Given the extensive research that documents that children born preterm are more susceptible to a wide range of neurodevelopmental disorders, including more subtle disorders of central nervous system functions, it is likely that parenting behavior exerts its influence on social-emotional outcomes through its influence on cognitive development for children born preterm, as confirmed in the current study.

Parenting as a Predictor of Cognitive Development

Parenting behavior during early childhood strongly and significantly predicted cognitive outcomes in a representative sample of children born full term and preterm. Thus, toddler's cognitive skills develop, to a large extent, in the context of positive supportive parenting behavior. This finding is consistent with a well-established body of literature that documents the beneficial effects of parenting quality on young children's cognitive and language development and preparation for school (Bornstein, 2002; Leseman & de Jong, 1998; Storch & Whitehurst, 2001). More specifically, characteristics of early childhood parenting behavior that were used in the current study, including non-intrusiveness, contingent, sensitive responding, maternal positive regard, and cognitive stimulation, have been previously found to promote optimal growth and development (Baumrind, 1966; Bornstein & Tamis-LaMonda, 1989; Coates & Lewis, 1984; Masten et al., 1988; Olson, Baytes, & Bayles, 1984; Parpal & Maccoby, 1985; Werner, 1990).

The magnitude of the effect of parenting behavior on cognitive development remained strong for all four groups of children, revealing that positive parenting behavior influenced optimal cognitive development, regardless of group status. This finding suggests that the parental role during early childhood is a critical determinant of cognitive development in all children, and likely has the ability to alter developmental trajectories during early stages of development. Thus, increasing the quality of parenting behavior through early intervention efforts would, on average, result in better cognitive outcomes for children born at varying gestational periods, even after controlling for other important factors including birthweight, gender, and socioeconomic status.

The multi-sample findings are promising and suggest that mothers can mitigate cognitive risks associated with preterm birth through their behavior and interactions with their infants. Since children born preterm have difficulties sustaining and shifting their attention, organizing environmental input, and become easily overwhelmed with excess stimulation, mothers have a unique role in responding to infant cues, assisting them in sustaining and shifting attention, while decreasing the demands placed on the infants' attention system, enabling early exploration, and development in both motor and mental domains (Landry et al., 1996). Interestingly, the current study also provides initial evidence of the influence of cognitive development on subsequent outcomes. Thus, promoting optimal cognitive development through parenting behavior might actually serve to lower long-term behavioral and attention deficits that are evident within high-risk populations.

Cognitive Development as a Predictor of Social-Emotional Outcomes

Social-emotional outcomes at kindergarten entry appear to be strongly influenced by children's cognitive development at earlier ages. In the current study, higher indices of cognitive development at 24-months significantly predicted better social-emotional outcomes at kindergarten entry. In contrast to the original hypothesis, cognitive development at 24-months more strongly predicted outcomes at kindergarten entry than parenting behavior at 24-months. The direct and unique influence of cognitive development on social-emotional outcomes for all children suggests that early developmental delays might actually precede subsequent behavioral deficits, including attention deficits, hyperactivity, pro-social difficulties, and increased externalizing behavior.

Group Differences. When examining this relationship across individual groups, cognitive development was more salient for children born preterm. Specifically, cognitive development more strongly predicted outcomes in children born preterm, very preterm, and extremely preterm, and had the strongest effect for children born preterm and very preterm. This suggests that early childhood factors, including parenting behavior and cognitive development, differentially exert their influence on outcomes based on gestational age group membership. For children born full term, social-emotional outcomes were influenced by both parenting and cognitive development, whereas for children born preterm, cognitive development was the main predictor of outcomes in the model, suggesting that social-emotional outcomes are strongly influenced by underlying cognitive processes in children born with increased biologic risk.

This finding is consistent with research that highlights the neuropathology of preterm birth, whereby being born too early can substantially disrupt the normal process of brain development and subsequently contribute to adverse developmental outcomes (Behrman & Butler, 2007; Hoon, 1995; Msall & Park, 2008; Taylor, 2010; Volpe, 2009). The neurological processes that contribute to cognitive delays in children born preterm likely underlie behavioral and social deficits, conferring a general vulnerability of social-emotional deficits and psychopathology in children born early (Szatmari et al., 1993). Although the current study did not account for neonatal complications and brain abnormalities, a significant group difference was found for cognitive development. Specifically, as suggested by Alyward (2002), a gradient of developmental sequelae was confirmed in the current study that was positively related to decreased birthweight and clinical gestation. Children born at shorter clinical gestation periods performed worse on tests of mental and motor development, and demonstrated lower levels of sustained attention at 24-months. The smallest and youngest children fared worse on all indices of cognitive development when compared to children born at longer gestation periods. The magnitude of the effect of these cognitive differences strongly predicted how parents and teachers rated social-emotional development at kindergarten entry. Children born earliest also received significantly lower social-emotional ratings at kindergarten entry, revealing a downstream effect across time.

Developmental perspective. The differential relationship between cognitive development and social-emotional outcomes in preterm samples can also be interpreted in the context of the developmental, hierarchical-integrative approach, which highlights the sequential development of regulatory functions, including physiological, emotional, attentional and self-regulatory (e.g. behavioral) processes across the first five years of life (Feldman, 2009). In the current study, deficits in cognitive development predicted increased social-emotional difficulties at age five, suggesting that earlier cognitive, motor, and attention processes relate to and predict subsequent development in the behavioral domain. Disruptions in earlier cognitive, motor, and attention processes, albeit minor, may lead to dysfunctions in higher-order systems of behavior adaption, indexed by externalizing symptoms, executive functions, and internalizing behavior (Feldman, 2009). Interestingly, the current study demonstrated this relationship in all children, however, found that the magnitude of this effect was stronger in children born earlier. This suggests that interventions targeted at optimizing developmental outcomes and increasing sustained attention in children born preterm may be an especially fruitful method for promoting social-emotional readiness at kindergarten entry.

Cognition and behavior. Previous studies have demonstrated the utility of cognitive measures as predictors of behavior (Taylor, 2010), which is in line with the current study findings. Breslau and colleagues (2000) found associations of cognitive and motor skills to adaptive behavior and behavior problems. Specifically, deviations in motor, sensory, and integrative functions, and lower IQ scores (<85) at age six were associated with an excess of internalizing problems, attention difficulties and externalizing problems at age eleven in a sample of low birthweight children. Similarly, motor development, which is consistently delayed in children born preterm and with low birth weights (de Kieviet, Piek, Aarnoudse-Moens, & Oosterlaan, 2009) has also been identified as a risk factor for subsequent behavior problems and learning disabilities (Anderson & Doyle, 2008), along with attention capabilities. The current study extends previous research and documents this relationship across the early childhood years. Because the attention and cognitive system undergo significant changes and transitions from an information-processing system to an executive function system during the preschool years (Davis, Bruce, & Gunnar, 2002; Feldman, 2009), and the early attention system is often compromised in children born preterm (Rose, Feldman, & Jankowski, 2001; 2002), it seems plausible that disruptions in these processes early in development contribute to a ripple effect influencing behavior competencies at later ages. Future research examining the neuropsychological and cognitive correlates of behavior problems in preterm children has the potential to clarify specific deficits that contribute to subsequent difficulties, which could ultimately lead to efforts to facilitate improvement in these processes (Taylor, 2010).

Group Risk Factors

There were some additional variables that appeared to confer greater risk of poorer outcomes based on group membership. Specifically, results revealed differential effects of gender socioeconomic status, and low birthweight on outcomes based on group membership. Being born preterm, and having one or more of these risk factors, may place children at increased for experiencing adverse outcomes.

Gender Differences. Gender more strongly predicted cognitive development in children born preterm when compared to children born full term. This suggests that boys who are born preterm are at highest risk for experiencing cognitive delays. This finding has been supported by previous research, which has found that males born preterm obtained lower developmental scores at age two (Hindmarsh, O'Callaghan, Mohay, & Rogers, 2000), and were more likely to have lower IQ scores, academic difficulties, and to receive special education services in comparison to females born preterm (Hille et al., 1994; O'Callaghan et al, 1996.). Although gender significantly influenced cognitive outcomes for full term children placing males in general at higher-risk for obtaining lower developmental scores, gender accounted for more of the variance in cognitive development in the preterm sample, and was the strongest predictor of outcomes in children born very preterm, suggesting that very preterm males are most susceptible for experiencing cognitive delays. Some scholars suggest that males are at increased risk for experiencing perinatal brain insults, which could explain why they have higher rates of disabilities, behavioral difficulties (Hintz, Kendrick, Vohr, Poole, & Higgins, 2006) and subtle cognitive delays. Thus, gender differences should be accounted for in subsequent models, and males born preterm should be especially monitored for adverse outcomes.

Environmental Differences. Socioeconomic status (SES) had a greater effect on parenting in the preterm samples. Similar to what was seen with gender, SES significantly predicted parenting behavior in all four samples, but exerted a stronger influence on parenting behavior for children born preterm. Interestingly, parenting behavior exerted the strongest influence on children born preterm, but at later gestational periods, born between 32 and 36 weeks gestation. This finding reveals that children born at higher gestational periods, but still considered preterm, might be more susceptible to environmental influences, when compared to children born with increased biologic immaturity. The social context likely adds an extra layer of support for this group of children, whereby higher socioeconomic status leads to more optimal parenting behavior, which in turn, could serve as an environmental mechanism of recovery in late preterm children. In contrast, children born preterm and who live in families with lower SES might be at increased-risk for being exposed to poorer parenting behavior, which could ultimately exacerbate the risk associated with preterm delivery. There is a wealth of information that details how a child’s low SES status adversely influences outcomes for all children in general, especially through its influence on parenting behavior (Brooks-Gunn &

Duncan, 1997). There is also research that suggests that preterm infants are disproportionately poor (Behrman & Butler, 2007), which was partially confirmed by the current study. SES significantly contributed to birth status, suggesting that lower SES predicted less optimal birth status, including having a child born preterm and with low birth weight; this relationship, however, was somewhat small. Thus, results reveal that the developing preterm infant is not immune from environmental factors, and preterm birth likely interacts with low SES toward increased disadvantage (Behrman & Butler, 2007).

Clinical Implications

The current study has implications for prevention and intervention efforts for children born preterm. Perhaps the most important implications concern the early identification of subtle cognitive deficits and underlying neuropsychological processes that contribute to or hinder subsequent developmental processes. The current study found significant group differences in cognitive development for children born at varying degrees of biologic risk, revealing a downward shift in cognitive processes based on clinical gestation. These differences were evident at 24-months, and found to have the greatest effect on subsequent social-emotional outcomes in children born early in a relatively high functioning sample. Thus, preventive intervention efforts should be targeted at screening and identifying early cognitive processes that seem to be weaker in children born at earlier gestation periods. Results from comprehensive assessments should be utilized to inform intervention and treatment planning to optimize early development in high-risk children. Children born preterm, even those born late preterm, should be followed and monitored across the first several years of development, and in frequent intervals, to ensure adequate identification of subtle deficits and to prevent adverse long-term behavioral and cognitive outcomes.

Comprehensive assessments should move beyond the administration of a single developmental battery, and should incorporate measures that are more sensitive in capturing neuropsychological processes including executive function processes, attention capabilities, visual-spatial development, emotion regulation, and psychomotor skills; processes that are weaker in preterm children and may not be captured through a single standard developmental measure. Early identification of individual deficits before school entry holds promise as a means to reduce long-term behavioral or academic consequences of high-risk birth through the implementation of intense targeted interventions (Taylor, 2010). Future studies evaluating interventions that improve developmental outcomes are also needed to better understand what methods are most effective and whether early intervention efforts demonstrate lasting effects in high-risk children (Taylor, 2010).

The current findings also have important implications for the timing and content of intervention programs for parents of preterm children. Although parenting behavior did not influence social-emotional outcomes in children born before 37 weeks gestation, it exerted a strong influence on cognitive development in all children, and remained a strong predictor of cognitive development even in the most vulnerable group of children, born before 28 weeks gestation. This result is promising and suggests that a responsive, sensitive, and stimulating caregiving context can positively support cognitive development and growth in young children. Thus, it is feasible that through targeted parenting programs aimed at supporting parents of preterm children, we can optimize cognitive development, and in turn, influence subsequent outcomes at school entry.

Findings from this study suggest that parents with children born preterm are interacting with their children slightly differently when compared to parents with children born full term. A significant group effect was found for parenting at 9-months and 24-months, with parents of preterm children scoring significantly lower on indices of parenting behavior when compared to parents with children born closer to term. Moreover, longer clinical gestation periods and higher birth weights significantly directly influenced more optimal parenting behavior, beyond the effects of SES, delivery type, and gender. This suggests that children born preterm are more likely to be exposed to less optimal parenting behavior. Interestingly, parents of children born earliest demonstrated higher levels of intrusiveness. Increased intrusiveness, as seen in the current study, might act as a compensatory mechanism to better support the child in managing his or her external environment. Thus, helping parents of preterm children build capacities to engage in sensitive, warm, supportive, and contingent interactions with their children early in development might be critical to promoting optimal growth and development (Bocknek, Brophy-Herb, & Banerjee, 2009). Previous research suggests that infants and toddlers born preterm are more likely to display irritability, increased negative emotions, distractibility, and irregular biological patterns (Brown, Doyle, Bear, & Inder, 2006; Eckerman, Oehler, Medvin, & Hannan, 1994; Hughes, Shults, McGrath, & Medoff-Cooper, 2002), making it more difficult for parents to respond in a consistent and supportive way. Working with parents from the onset to help them understand infant and child cues, while teaching them how to effectively support more difficult to manage children may provide a positive developmental context that supports optimal cognitive growth.

Lastly, the current study has implications for early intervention services. Specifically, parenting behavior, cognitive development, and social-emotional development may be more malleable during early childhood years and positive developmental trajectories may be more easily influenced in high-risk children, than compared to when they are older (Reid, 1994).

Future research should examine how parenting influences early emotion regulation and socialization processes in medically-vulnerable children. Supporting the development of early physiological processes, emotion regulation, attention, and cognitive development, through targeted, individualized, early intervention services may assist at-risk children in acquiring higher-order behavioral and academic skills that influence long-term success.

Limitations and Future Research

It is important to interpret these findings in light of several limitations. Because of the use of a pre-existing data set, the measures selected to operationalize the study variables of interest were not always ideal. The ECLS-B was beneficial because it oversampled children who were born preterm and utilized sophisticated weighting techniques to allow for the results to generalize to the population of interest. However, although the large, diverse sample followed by ECLS-B provided insight into the early development of children born preterm and full term, the information available was often limited. For example, the socioemotional battery created by ECLS-B was drawn from several different batteries that measured different types of social-emotional behaviors at kindergarten entry, including pro-social behaviors, friendship, internalizing and externalizing behavior, temperament, and approaches to learning. All of these behaviors and types of social-emotional outcomes were captured by a small number of items, limiting the variability in responses that were provided. Future research would benefit from using standardized scales that capture and differentiate between types of social-emotional outcomes and behaviors to detect small differences at kindergarten entry.

Similarly, coded parent behavior at 9-months and 24-months provided insight into parental behavior during play interaction tasks, but was limited to one ten-minute session. In the current study, parental detachment and negative regard were not used due to limited variability and skewed means. It is likely that certain aspects of detachment, intrusiveness, and negative regard were not accurately captured from one ten-minute session, which led to high indices of positive parenting behavior. The limited variability in parenting variables available might not have accurately differentiated between types of parenting behavior used by parents of children born preterm versus full term, and its influence on outcomes at kindergarten entry. Including additional measures that capture aspects of parenting that are important predictors of cognitive and social-emotional development would have strengthened the current study. For example, including provisions of cognitive stimulating parenting practices and indices of parental emotional warmth, as measured by the Home Observation and Measurement of the Environment (HOME; Caldwell & Bradley, 2003) would have added to the depth of the parenting construct. Parenting behavior at 3-, 4-, and 5-years of age was not included in the current study, and child social-emotional outcomes only at kindergarten entry were used. Capturing parenting behavior and social-emotional development across time will provide greater insight into the process through which parenting exerts influence on outcomes associated with preterm birth during early childhood periods.

Additionally, this study relied on parent and teacher reports of behavior at the start of kindergarten entry. Using standardized measures of executive function, attention capacities, along with standardized measures of social-emotional development beyond kindergarten entry would prove to be more reliable. The current study found significant, albeit small, differences in behavior at kindergarten entry between children born full term, preterm, very preterm, and extremely preterm. Children born with increased biologic immaturity were rated as having greater difficulties sustaining attention, had lower levels of pro-social behavior and increased externalizing behavior difficulties during kindergarten entry, when compared to children born very preterm, preterm, and full term in the current study, which is consistent with previous research (Samara et al., 2008; Taylor, Klein, & Hack, 2000). Although there were statistically significant differences found between groups of children born preterm on outcome variables, with children born full term demonstrating the best outcomes, these differences were small and unlikely to add much practical significance. However, it is likely that these differences exist. One possible explanation for the subtler finding in the study might be due to methodological issues. Behavior ratings were gathered from teachers and parents using a socioemotional battery that was adapted for the purpose of the ECLS-B, which provided a global rating of teacher and parents' perceptions of the child's behavior at kindergarten entry. While these individual items did provide a general sense of the child's overall behavior, they likely were not sensitive enough to capture the types and frequencies of behaviors that are commonly seen in children born preterm, including underlying executive function deficits that may precede externalizing behavior difficulties and attention deficits. A more sensitive measure administered later in the school year could have captured more significant group differences.

In the ECLS-B, data was collected during the Fall semester of kindergarten, requiring teachers to rate frequencies of specific behaviors seen in the classroom after only knowing the child for approximately one to two months. Collecting behavioral data early in the school year at kindergarten entry might actually have underestimated behavior differences given the novel classroom context. As children become more accustomed to school and attention, cognitive, academic, and behavior demands increase, these subtle differences seen at kindergarten entry in the current study would likely become more apparent at later ages (Bhutta et al., 2002) and perhaps warrant subsequent psychiatric diagnoses (McGrath et al., 2005).

Next, longitudinal data sets often have large amounts of missing data (Acock, 2005). The current study was no exception. A significant number of participants who were initially assessed at 9-months were not followed through kindergarten entry. Fortunately, missing data analyses revealed little to no significant differences between the excluded and included groups on demographic variables and study variables of interest. Rather, the missing data resulted in a sample size that was much smaller than what was originally accounted for, but larger than what is typically seen in research evaluating preterm birth. Additionally, the current study accounted for attrition by applying appropriate sample weights to all analyses, which helped adjust for differential selection probabilities and reduced non-response bias. The application of weights to the current analyses allowed the study to generalize to children born in the year 2001, which strengthened the interpretability of the findings. Although weighting techniques were applied to all analyses, specific fit indices, including the chi-square statistic were unavailable when applying replicate weights to MPlus. Thus, multi-sample analyses were conducted with and without sampling weights, and the chi-square test of significance was determined from comparing models without sampling and replicate weights applied. The results from the multi-sample analyses should be interpreted with caution, and should not be generalized to the population of interest. Instead, the results provide an initial glimpse into differential relations of parenting, cognitive development, and social-emotional outcomes in the final sample.

Lastly, the current study did not account for additional factors that are influential in preterm birth, including physiological factors (Feldman, 2009), and medical factors (Miceli et al., 2000) that could mediate the relations between birth status and developmental outcomes, and subsequent social-emotional development. Additionally, the current study did not account for parenting stress, or additional environmental factors that likely influence preterm birth and outcomes. Future inquiries should employ growth modeling techniques to extend the current model to examine and confirm the dynamic interplay between physiological, medical, environmental, and cognitive factors that contribute to development across the first five years of life. Growth modeling would also extend the current study by evaluating how parenting across childhood predicts rates of growth in cognitive and social-emotional development, which would provide insight into the timing of interventions that will support medically-vulnerable children.

Conclusion and Future Directions

This study provides an initial investigation into the differential relations between parenting behavior, cognitive development, and social-emotional outcomes in children based on preterm birth group membership. The results of the study support the notion that underlying cognitive processes, which tend to be weaker in children born at earlier gestation periods, contribute to subsequent developmental outcomes in the behavioral domain. It will be important for future researchers to continue to understand this relationship and how early cognitive processes unfold and influence subsequent developmental outcomes. Specifically, future research should examine the extent to which attention deficits, pro-social difficulties, externalizing and internalizing symptoms are mediated by early childhood psychomotor, cognitive, and attention processes in children born preterm, and how parenting influences this developing system. Future research should account for additional risk factors, including physiological processes, medical complications, neonatal risk factors, child temperament, and child emotion regulation, to more clearly discern the mechanisms that interact and contribute to adverse outcomes in children born preterm. Including additional factors that contribute to cognitive and social-emotional outcomes will inform preventative efforts that can ultimately mitigate risks associated with preterm birth.

The current findings also underscore the importance of early identification and intervention efforts. Children born preterm, very preterm, and extremely preterm performed worse on all indices of cognitive development when compared to children born full term, and parenting was a significant predictor of cognitive outcomes. This highlights the need to identify these differences early in development and support parents in facilitating cognitive growth in their preterm infants. Future research should examine how variations in parenting, cognitive and neuropsychological processes influence long-term cognitive and behavioral outcomes at school-age. Additional neuropsychological studies can help clarify the nature of early childhood cognitive deficits, as well as the implications of these deficits for learning and behavior (Taylor, 2010), and how parenting interacts with this developing system.

Lastly, in the current study, children born extremely preterm fared worse on all developmental, social-emotional and parenting measures, placing them at greatest risk for poorer outcomes and parenting contexts. Although significant relations were found, the magnitude of the effect of parenting on cognitive development, and cognitive development on social-emotional outcomes was weaker when compared to children born preterm and very preterm, suggesting that there are other factors that were not accounted for in the model that influence outcomes in this high-risk group. Moreover, it is plausible that there is a limit to the extent to which environmental and cognitive processes influence subsequent outcomes in the most medically-vulnerable children. Future research should continue to understand how environmental influences interact with child characteristics and neurological risk to promote success in children born early.

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