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UNIVERSITY OF SAN DIEGO

Hahn School of Nursing and Health Sciences

DOCTOR OF PHILOSOPHY IN NURSING

NEURODEVELOPMENTAL OUTCOMES OF HIGH RISK INFANTS

by

Lisa E. Miklush, RNC, MSN, CNS

A dissertation presented to the

FACULTY OF THE HAHN SCHOOL OF NURSING AND HEALTH SCIENCE

UNIVERSITY OF SAN DIEGO

In partial fulfillment of the

requirements for the degree

DOCTOR OF PHILOSOPHY IN NURSING

April 2010

Dissertation Committee

Cynthia D. Connelly, PhD, RN, FAAN, Chair

Jane M. Georges PhD, RN

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Abstract

Background: Infant developmental research has revealed amazing physical, cognitive, and social capacities of the human infant. Along with this knowledge is a growing appreciation of numerous factors that have the potential to impact the individual infant's developmental trajectory, either enhancing or compromising the eventual outcome. Enhanced understanding of those factors that shape infant developmental trajectories will provide an evidence base for the establishment of a supportive environment for the youngest members of society. **Purpose:** To determine the relationship between neurodevelopmental outcome and gestational age, birth weight, Apgar scores, NICU admission, infant gender, maternal depression, home environment, and parent-child interaction. **Methodology:** This study utilized a descriptive, correlational design and secondary analysis of data from the Healthy Families San Diego (HFSD) randomized controlled clinical trial conducted by Landsverk and colleagues (2002). **Data Analysis:** Multiple linear regression was utilized to produce the best combination of predictors of neurodevelopmental outcome, which was measured by the Bayley Scales of Infant Development, 2nd ed. (BSID-II) (Bayley, 1993). **Results:** The model of predictor variables significantly predicted all three BSID-II developmental outcomes (MDI, PDI, and BRS) measured at year 2. *Mental Development:* The model explained 34% of variance in the BSID-II MDI. MDI scores at year 1, parent-child interaction (NCAST) scores at year 2, and infant gender significantly contributed to the model. *Motor Development:* The model explained 16% of variance in the Y2 BSID-II PDI. PDI scores

at year one, BRS scores at year 1, birth weight, and infant gender significantly contributed to the model. *Behavioral Development:* The model explained 20% of variance in the Y2 BSID-II BRS. Y2 NCAST scores, Y2 home inventory (HOME) scores, birth weight, gestational age, and infant gender significantly contributed to the model. **Conclusions:** Optimal development of a community's children is a vital component of a healthy and sustainable society. Based on the results of this study, future research may focus on the unique contribution of gender to developmental dynamics. Also of interest is the significance of early parent-child interaction, the home environment, birth weight, and gestational age in shaping infant developmental trajectories. Research efforts may focus on determining which of these risk factors are most amenable to preventative and interventional strategies, and identifying the stage of development where these strategies would be most effective.

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Dedication

This dissertation is dedicated to some very special people who have enriched my life:

To my husband Henry, whose unwavering love, support, and encouragement carried me through my doctoral journey. I could not have asked for a more wonderful life partner.

To little Benjamin, “most precious boy,” whose short life taught me the true meaning of unconditional love and inspired my devotion to the health of children.

To my dear mother, who never doubted that her youngest daughter could come this far.

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This dissertation would not have been possible without the help and support of so many wonderful people. At the top of this list are three remarkable women who served on my dissertation committee:

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Chapter I

Problem and Background

The exquisite series of events that begins with the joining of two parental cells and culminates in the birth of a new human being has been a perpetual fascination throughout the ages. No less fascinating is the process by which a new life emerges from the womb and begins the precarious journey of transformation into a unique individual. This ontogenetic journey has not only been the focus of fascinated parents, but it has been a topic of considerable scrutiny by philosophers and scholars from a variety of disciplines over the millennia.

There is general consensus that the time one spends as an infant is of special significance, and that early experiences and the context in which they occur have an effect on the course of subsequent development (Institute of Medicine, 2000a; Lamb, Bornstein & Teti, 2002; Spitz, 1949). The nature of the subsequent development is of interest because of its potential to affect interpersonal relationships and the ability of an individual to function appropriately in society at large. Taking this to its logical conclusion, it becomes apparent that families and the broader community have a shared

responsibility to engage in activities that promote the health and well-being of infants and young children, with the higher objective of ensuring a healthy and sustainable society for all (Gomes-Pedro, 2002; Panksepp, 2001).

Factors that Affect Infant Development

Infant ontogenesis is a dynamic process of adaptation, growth, and development that depends on the support of an array of intrinsic and extrinsic factors for optimal outcome. The critical need for a body of scientific knowledge that can identify these factors has not gone unnoticed by a variety of professional disciplines, including nursing, pediatrics, education, developmental psychology, and anthropology, just to name a few. There has been a concerted effort by numerous researchers to uncover the complexities of development during the earliest hours, days, months, and years of a child's life (Brown, 2009; Brown & Pridham, 2007; Collins et al., 2000; Reyna & Pickler, 2009; Stewart & Meyer, 2004; Zimmerman et al., 2009).

Infant developmental research has become a burgeoning field, yet critical gaps in this knowledge base still exist (Institute of Medicine 2000a; 2000b). Areas that require further clarification include such questions as: Which social and biological risk factors should be the primary focus of preventative and interventional strategies for children and families at risk? Which children are best served by interventions that support development, and at what point during development would prevention and intervention be most effective? How can areas of resilience be identified and supported? How are developmental outcomes best measured and interpreted for each child? What is the most useful framework for understanding the interplay between risk factors, protective factors, cumulative burdens, individual vulnerability and resilience, and the heterogeneity of

children and families? What role do genomics and epigenetics play in determining developmental trajectories? Further research can add to existing knowledge and provide greater insight into infant developmental processes and its dynamic yet vulnerable nature.

Continued efforts to expand knowledge about specific factors that influence developmental outcomes is timely, given the many urgent problems that now affect infants and young children. Currently, many newborns face an uncertain future simply because they are among the 12.5 percent of babies in the United States who are born before adequate gestation has been completed. Prematurity is a major public health concern that is responsible for significant morbidity, mortality, human suffering, and the expenditure of a disproportionate amount of health care dollars (Institute of Medicine, 2007). Premature birth has a wide scope of untoward effects as normal fetal and neonatal developmental processes are interrupted. A fetus that makes its untimely debut into the extrauterine world is at a distinct disadvantage because of incomplete gestation and low birth weight (Institute of Medicine, 2007). Premature birth disrupts the attainment of the parenting role (Carmona & Baena de Moraes Lopes, 2006; Franck, Cox, Allen, & Winter, 2005), places stress on the family unit, and unduly alters family dynamics (Institute of Medicine, 2007). Each of these factors inhibits the neonate's ability to transition into the world outside the womb, and increases risk for developmental delay (Holditch-Davis, Bartlett, Blickman, & Miles, 2003; Holditch-Davis, Brandon, & Schwartz, 2003; Magill-Evans, 1999; Taylor, Klein, Minich, & Hack, 2001).

In addition, there are infants that may have difficulty navigating the path from intrauterine to extrauterine life because of other factors. If, for example, the intrauterine environment is in some way not conducive to the support gestational processes, the

quality of growth during gestation will be compromised. The outcome is often a neonate that demonstrates signs of fat and muscle wasting, chronic hypoxia, and a birth weight that is decreased in relation to gestational age (Fanaroff, Kiwi, & Shah, 2001; Harkness & Mari, 2004). Infants such as these will require extra support to stabilize physiological functioning. Normal family dynamics are altered at this juncture with the separation of the infant and family. Interruption of close contact immediately after birth compromises breastfeeding success, bonding, and attachment processes that may ultimately alter maternal behavior toward her infant (Klaus & Kennell, 2001).

Also of concern is the increasing number of families with sociodemographic characteristics that have the potential to negatively influence the developing infant (Institute of Medicine, 2000a). A considerable number of infants have uncertain futures because they happen to be born into family situations that are impacted by challenging social circumstances or parental impairment. Family structures – especially in Western cultures – are changing rapidly, and families are more mobile than they have been in previous centuries. These changes can result in added family stress along with the dissolution of support structures that were previously available to the family (Gomes-Pedro, 2002). Alterations in family dynamics in response to stressors can give rise to a spectrum of suboptimal infant developmental outcomes, neglect, and even abuse (Osofsky & Thompson, 2000). Prominent among the many family stressors is the presence of depressive symptoms, which often occur in conjunction with parental socioeconomic disadvantage, conflicted or unsupportive relationships, or medical comorbidities (Institute of Medicine, 2009). Depression – especially maternal depression –

has been associated with impaired infant developmental outcomes (Brown, 2007; Fowles, 1998; Hart, Field, & Roitfarb, 1999).

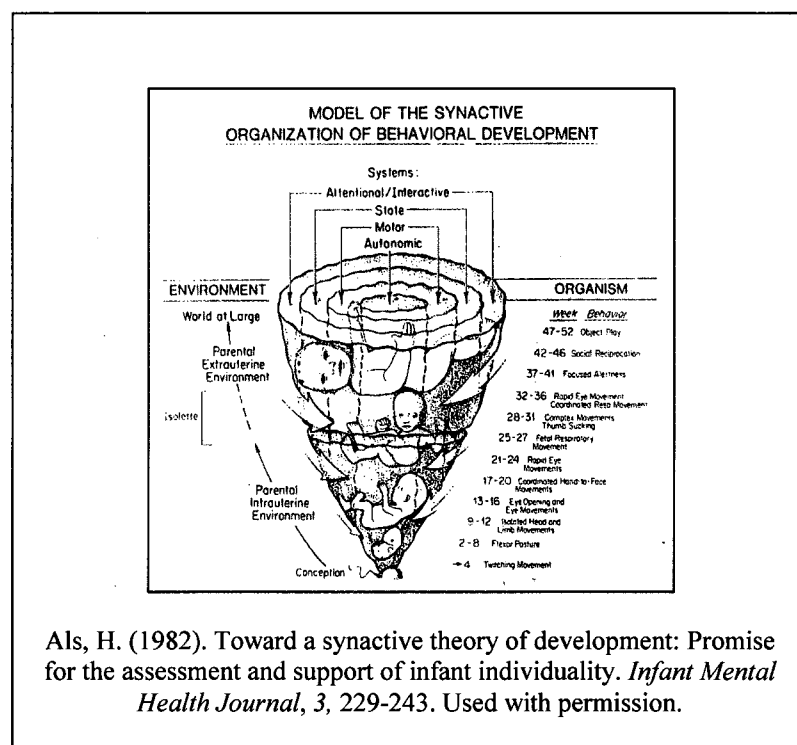
The age of the mother during pregnancy and birth also has implications for infant developmental outcomes. Adolescent motherhood, for example, is embedded in broader social contexts of single parenthood, poverty, low educational attainment, engagement in risky behaviors, social isolation, and the occurrence of depression (Eaton et al., 2006; Koniak-Griffin, 2001; Wakschlag & Hans, 2005). In addition, the adolescent's own developmental needs may conflict with infant developmental needs, creating a situation that may impair the relationship between mother and infant (Wakschlag & Hans, 2005). Delayed childbearing (childbearing after the age of 35) is also associated with risk factors for the developing fetus and infant. Although these mature mothers often have increased socioeconomic stability and often demonstrate psychosocial readiness for motherhood, a number of obstetrical risk factors and associated complications can negatively impact normal infant developmental trajectories (Heffner, 2004; Hollier et al., 2000; Odibo, et al. 2006; Treacy, Robson, & O'Herlihy, 2006).

Clearly, the characteristics of the infant's physiological state and the nature of the physical and social environment have relevance to infant developmental trajectories. The purpose of this present study is to identify those factors that predict neurodevelopmental outcomes in infants that are at risk for altered patterns of development.

Introduction to the Theoretical Framework

This present study is informed by the work of developmental psychologist Heidelise Als (1982), whose Synactive Theory of Development provides the framework for this inquiry. According to this theory, the ontogenesis of the developing human

proceeds within the neurobiologic social context, and is supported by the secure environments of womb, family, and community. The human organism is viewed as a complex system which is composed of individual subsystems. These subsystems are in continual interaction with each other and with the environment. The term *synactive* reflects this dynamic, interactive process. From the moment of conception and continuing on through the early years of postnatal life, the developmental agenda of the human organism is directed toward species-appropriate adaptation, growth, stabilization and integration of system functioning, and the effective fit between the organism and the environment (Als, 1999). Stability of one system supports the stability and function of other systems, and environmental stability supports overall system functioning. Likewise, environmental or system instability will be reflected in system dysregulation. A schematic of Als' original depiction of the model is provided below.



The Synactive Theory of Development provides the unifying theory that conceptualizes the manner by which intrinsic and extrinsic forces shape the developing organism. The origin and characteristics of these forces is informed by fundamental principles of human ontogenesis. These principles involve an appreciation of the unique attributes of the human developmental continuum as it progresses from embryo to young child. Primary among these attributes is the tremendous growth and differentiation that transpires during early development, resulting in the emergence of a wide array of structural and functional competencies in a relatively brief time span. The human brain, in particular, is unique when compared to other species with which we share the planet. The high degree of encephalization, along with organizational and structural characteristics of the human brain, gives rise to an exceptional degree of intelligence and ability to manipulate the environment (Bradbury, 2005). This central feature of the human brain is of singular importance, because it obliges the organism to accomplish a large degree of brain development in the early postnatal environment (DeSilva & Lesnik, 2008; Volpe, 2008). The corollary of this is an extended period of immaturity and dependency, coupled with periods of increased vulnerability along the developmental continuum (Rosenberg & Trevathan, 2002). These characteristics of human offspring result in a developing organism that is vulnerable to the effects of both intrinsic and extrinsic forces.

Intrinsic and extrinsic forces that can alter developmental trajectories can be understood as the ontogenetic forces of nature, nurture, and niche. This triad of forces allows one to conceptualize specific factors that have the potential to shape the process of human ontogenesis. In general, forces of nature include such aspects as the infant's

unfolding genome, inherent phenotypic characteristics, and infant subsystem functioning. The ontogenetic niche is comprised of the infant's environment, and forces of nurture include experiences that take place within that environment. These forces converge, intermingle, and interact with each other and with infant systems in a synactive manner. The unique interplay of these forces will shape the developmental trajectory as it proceeds from fertilized egg to young child, thereby influencing the eventual neurodevelopmental outcome.

Study Purpose and Aims

The purpose of this study is to identify the factors that predict neurodevelopmental outcomes of infants that are at risk for altered development. The specific aims of this present study are to describe:

- the level of neurodevelopment in a group of infants who have been identified as high risk for neglect or abuse.
- the relationship between gestational age, birth weight, Apgar scores, gender, maternal age, the presence of maternal depression, characteristics of the home environment, parent-child interaction, and motor, mental, and behavioral development.
- the influence that gestational age, birth weight, Apgar scores, gender, maternal age, the presence of maternal depression, characteristics of the home environment and parent-child interaction have on infant neurodevelopmental outcome.

Implications for Nursing

It is hoped that the results of this study will add to the continued efforts to more completely understand early developmental processes by clarifying which social and

biological risk factors have the greatest effect on neurodevelopmental outcomes. The knowledge gained from this study can be integrated into nursing education, daily bedside practice, and advocacy for policy and program development on all levels.

The many roles of professional nurses within the community and the health care delivery system provide numerous opportunities for nurses to positively influence the developmental health of infants, young children, and their families. As directed by nursing practice standards and ethical codes (ANA, 2001), nurses have a commitment to foster healthy lifestyles and to ameliorate those circumstances which contribute to altered health patterns. Nurses are well positioned to advocate for a professional and societal commitment to the health and stability of families, and to engage in preventative and interventional activities that promote the well-being of this patient population. As research continually refines the profession's understanding of the forces that shape developmental trajectories, nurses can meet the moral imperative of creating a benevolent and supportive environment for infants, young children, and their families, thus enhancing the quality of life for all.

Chapter II

Review of the Literature

The span of time that encompasses the moment of conception and the early postnatal years is comprised of a series of astounding transformations that are more dramatic than at any time in the human lifespan (Amiel-Tison, Gosselin, & Infante-Rivard, 2002; Lamb, Bornstein, & Teti, 2002; Nelson & Bosquet, 2005; Volpe, 2008). Even the casual observer of the transformation of egg to child will likely be prompted to speculate about how these marvelous changes in growth and behavior come about. Indeed, a central theme in developmental research has been to identify and understand those elements that are contributors to the complex phenomena of human development.

This section will provide a critical review of the literature as it relates to the unique nature of human ontogenesis, the distinctive nature of the immature brain, and the influence that specific factors bring to bear on the developmental trajectory and subsequent neurodevelopmental outcome of infants. Factors that influence developmental processes will be described in light of the theoretical framework that informs this inquiry.

The Unique Nature of the Developing Human

The premise of this discussion rests on fundamental principles of human ontogenesis that describe the nature of the developing organism. The human embryo, fetus, neonate, infant, and young child possess unique attributes that are related to the high degree of development that takes place during early development. These unique attributes are significant because they impart tremendous growth potential while at the same time conferring a certain degree of vulnerability.

There are two primary reasons for this innate vulnerability. First, the ontogeny the human central nervous system is characterized by rapid and distinctive patterns of development, which makes it particularly vulnerable to disturbances as developmental processes unfold. The brain is the orchestrator of developmental processes, so its successful development is of primary importance. The formation of essential neural structures, specialized cells, and functional circuits begins in the early weeks of embryonic development and continues through the second year of life and beyond (Moore & Persaud, 2003; Volpe, 2008). The neural tube – from which the brain and spinal column will arise – is formed first. This structure closes at approximately twenty-eight days after conception, before most women realize they are pregnant (Johnston, 2009). This is followed by a rapid proliferation of precursor neural cells, called neuroblasts, which will form the structures of the forebrain, midbrain, and hindbrain. Additional neuroblasts and glioblasts (precursor supporting cells of the central nervous system) then migrate outward toward these brain structures in great numbers. All of this is accomplished during the first six weeks of gestation (De Graaf-Peters & Hadders-Algra, 2005; Nelson & Bosquet, 2005). Intense differentiation, myelination, and synaptogenesis begins at this point and

continues in earnest, especially during the first year of life (Volpe, 2008). Also of significance is the tremendous proliferation in the volume of cortical gray matter, which increases fourfold from the 30th to 40th weeks of gestation (Hüppi et al., 1998).

The rapid and complex nature of development results in episodes of sensitive periods (also referred to as critical periods) along the developmental continuum (de Graff-Peters & Hadders-Algra, 2005; Hüppi et al., 1998; McLean & Ferriero, 2004; Moore & Persaud, 2003; Shonkoff & Marshall, 2006; Young, 2003). During sensitive periods, the organism is poised for a surge in growth, but at the same time is less able to adapt to disequilibrium or environmental hazards, putting the organism's physical and psychosocial integrity at risk. Alternatively, exposure to positive influences during these sensitive periods will result in normal, if not enhanced, growth and development.

A well-documented illustration of the impact of specific influences during sensitive periods is the example of teratogen exposure during the embryonic period, a time when the majority of organogenesis is accomplished. Teratogenic agents such as drugs, metabolic imbalances, or infections can alter the process of organogenesis, resulting in numerous sequelae arising from structural and functional deficits (Moore & Persaud, 2003). Optimal nutrition, on the other hand, especially a diet enriched with folic acid, promotes embryonic development and normal neural tube development (Blackburn, 2007; Johnston, 2009; Stables, 2000). Also noteworthy is the notion that early experiences have the capacity to alter brain structure and function via epigenetic mechanisms (Novik et al., 2002; Weaver et al., 2004). As an example, Lundy and colleagues (1999) reported that maternal depression during the prenatal period predicted inferior newborn performance on the Brazelton Neonatal Behavioral Assessment Scale

(Brazelton & Nugent, 1995), suggesting a prenatal mechanism that negatively affects newborn behavior. Similarly, a prospective-longitudinal study by Van den Bergh and colleagues (2008) produced some compelling data that implicated maternal anxiety at 12 – 22 weeks' gestation with depression in their female adolescent offspring. The proposed mechanism of this outcome involves the developmental vulnerability of the hypothalamic-pituitary-adrenal (HPA) axis, where maternal anxiety altered fetal HPA-axis function – the effects of which became evident in adolescence when the HPA-axis reaches full maturation. In addition, Als and colleagues (2004) tested the effect of a developmental intervention on infants in the neonatal intensive care unit (NICU). With an acknowledgement of the tremendous growth potential and corresponding sensitive periods, a developmentally-based, individualized approach to care of preterm infants demonstrated the ability to alter brain structure, electrophysiology, and function that resulted in improved neurobehavioral functioning in these infants. The results of this and similar studies demonstrate the neuroplasticity of the developing brain that permits significant adaptation when exposed to an altered environment (Gunnar & Cheatham, 2003; Knapp & Mastergeorge, 2009).

Environmental influences and critical incidents that take place during sensitive periods often have enduring effects on the child. This is largely because once a specific sensitive period has passed, the critical incident – whatever it may be – is no longer likely to influence the developing organism in the same manner. In addition, biological pathways that are altered due to the actions of the critical incident are often difficult or impossible to change once they have occurred (de Graff-Peters & Hadders-Algra, 2005; Díaz-Rossello & Ferreira-Castro, 2008; Lamb, Bornstein, & Teti, 2002).

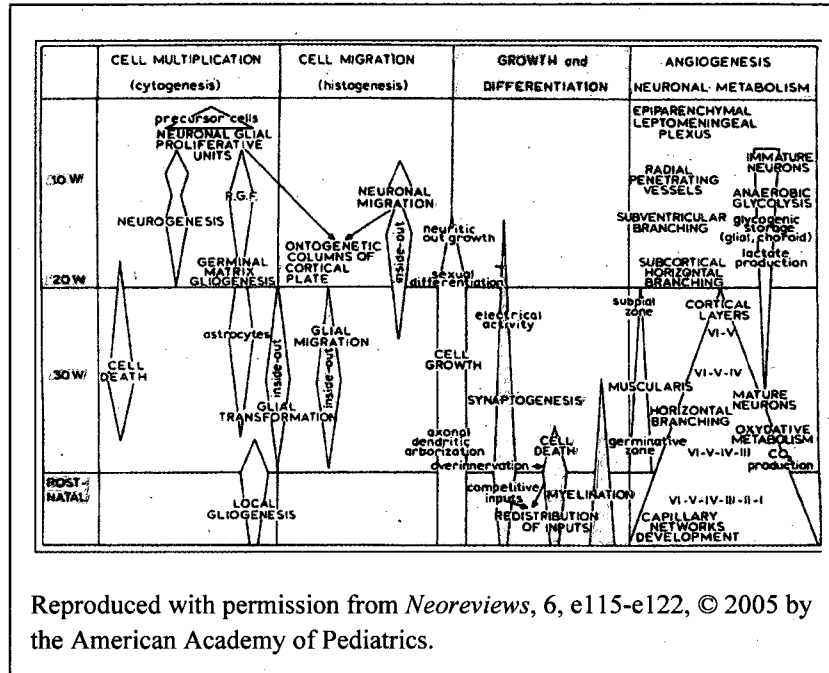
The second reason for developmental vulnerability lies in the nature of the immature human. The human infant is altricial; that is, human infants have an extended period of immaturity and dependency. This altriciality exceeds that of any other species (Rosenberg & Trevathan, 2002). The human neonate, for example, is independent only in his or her ability to breathe, suck, and swallow (Bagnall, 2005; Díaz-Rossello & Ferreira-Castro, 2008). Otherwise the infant is utterly helpless; consequently, someone must be immediately available who can ensure that nutritional and hygienic needs are met and to keep the neonate warm and protected. Ideally, these tasks will be accomplished by someone who has an invested interest in the well-being of the neonate. This period of dependency continues to a lesser degree as the child grows and develops, obligating someone to be available to provide for and guide the developing child until the child's physical and psychosocial characteristics begin to mature into adult forms (George & Solomon, 2008).

Although the offspring of some mammals also have relatively long periods of altriciality, nothing compares with that of the human child. A logical question would be: Why? Why humans and not polar bears or gorillas? The answer partially lies in human encephalization: the exceptional cognitive abilities of humans, which requires relatively large brains with extensive cortical development and neural circuitry (Rosenberg & Trevathan, 2002; Williams, 2002). The fetus itself has a large brain in relation to the rest of the body, although its size is in line with that is expected when taking into account the size of the adult brain. This fact, however, presents a problem when taking into account the relatively small pelvic opening through which the fetus must emerge (DeSilva & Lesnik, 2008; Gomes-Pedro, 2002; Kilpatrick & Garrison, 2007; Rosenberg & Trevathan,

2002). An obstetrical dilemma is created when the aforementioned encephalization is coupled the constraints of the curved and compacted pelvis that is characteristic of human bipedalism (upright posture and walking on two legs) (Rosenberg, 1992; Rosenberg & Trevathan, 2002; Stables, 2000; Tague & Lovejoy, 1986). The relationship between the fetal cranium and the maternal pelvis is the primary determinant of the ease by which a vaginal birth is accomplished. The close correspondence between the dimensions of the fetal cranium and the maternal pelvis compels the human fetus to make a series of maneuvers during descent to navigate the birth canal, thus exploiting the widest point of each plane of the maternal pelvis (Rosenberg & Trevathan, 2002; Stables, 2000). Most of the time the fetus successfully navigates this narrow passageway; in addition, the sutures of the fetal cranium are not fused, allowing the cranial bones to mold and overlap somewhat as it squeezes its way into the extrauterine environment. Even so, cephalopelvic disproportion is a primary cause of the failure of the fetus to successfully descend through the birth canal (Stables, 2000).

The most relevant consequence of the obstetric dilemma created by the cephalopelvic ratio is that a great deal of brain development necessarily occurs in the postnatal environment (DeSilva & Lesnik, 2008). Once the infant begins life outside the womb, accelerated brain growth and intense differentiation, myelination, and synaptogenesis occurs, supporting extensive changes in physiological, motor, cognitive, social, and emotional growth that takes place in the early years of life (Crockenberg & Leerkes, 2000; de Graaf-Peters & Hadders-Algra, 2005; Volpe, 2008). All of these significant neurodevelopmental processes occur at a time when the infant is quite helpless and very vulnerable. Consequently, the infant's environment must be one that is both adequate to

meet physiological needs and supportive to meet psychosocial and developmental needs of the infant (Gomes-Pedro, 2002). The magnitude of growth and differentiation that occurs in the postnatal period is illustrated in the schematic depiction brain development below.



The demands of human altriciality and postnatal encephalization necessitates a mechanism to ensure the survival and optimal development of the infant. It is the contention here that the means by which the highly dependent infant is supported during an extended period of immaturity is through the mechanism of parenting. The act of parenting involves a complex set of nurturing behaviors derived from neuroendocrine adaptations and responsiveness to infant stimuli (Numan & Stolzenberg, 2008; Swain & Lorberbaum, 2008). The concept of parenting denotes a focused relationship between the infant and an adult (or adults), who is (are) emotionally invested and consistently available to the infant (Institute of Medicine, 2000a). Clearly, this concept of parenting

goes far beyond the provision of food and other basic necessities of life. Classic experiments using animal models have provided clues about the necessity of bodily contact and psychological attachment as necessary ingredients for healthy emotional development. Harlow (1959) famously discovered how maternal bodily contact and the comfort it provided was a central factor in the emotional development of baby rhesus monkeys (Harlow, 1959; Harlow & Harlow, 1962). Recent investigations with non-human primates clearly demonstrate the importance of maternal behaviors in shaping either normal or abnormal development of offspring (Rosenblum & Andrews, 2008). In addition, lessons learned from investigations of state-run orphanages in post World War II Europe along with more contemporary studies have clearly illustrated that institutionalization (and thus deprivation of an intimate family unit) imposes numerous constraints on the developing child, producing a spectrum of devastating social, emotional, cognitive, and even physical effects (Bowlby, 1951; Groark et al., 2005; Muhamedrahimov et al., 2004; Spitz, 1949). Likewise, family dysfunction, stressful home environments, and various forms of social deprivation are related to impaired development, failure to thrive, and other poor child outcomes (Kohen, Leventhal, Dahieten, & McIntosh, 2008; Benoit, 2005; Benoit et al., 2001). Clearly, there is much evidence to attest to the need for caregiving that is consistent, responsive, and sensitive to infant physiological, psychosocial, and developmental needs (Als, 1999; Bronfenbrenner, 2002; Bornstein et al., 2008; Bowlby, 1982; Brazelton & Cramer, 1990). As will be discussed shortly, vital parental functions include assuming the role of the child's social partner and shaping the structure of the child's immediate surroundings and experiences (Barnard, 1999; Lamb, Bornstein, & Teti, 2002; Talmi & Harmon, 2003). These and

other parental roles are essential for the establishment of the child's intellectual and social competencies and an optimal developmental trajectory.

Theoretical Framework

Thus far it has been demonstrated that human development is characterized by dynamic processes that yield tremendous growth potential while at the same time conferring a degree of vulnerability upon the immature organism. Innate vulnerability stems from the high degree of growth and differentiation that occurs in early development and the extended period of immaturity that is characteristic of the human infant. Together, these attributes create the potential for intrinsic and extrinsic forces to engender alterations in the developmental trajectory of the developing organism.

In the discussion that follows, the argument will be supported that the ontogenetic forces of nature, nurture, and niche come together to fuel the transformation of the developing child. This triad of forces provides the basic framework for identifying specific factors that are relevant to the process of human ontogenesis. A unifying theory that conceptualizes the manner by which these forces shape the developing organism during early life is provided by the Synactive Theory of Development (Als, 1982).

Nature, nurture, and niche

The controversy of nature versus nurture has permeated perceptions of developmental theory for many years. These two forces have traditionally been regarded as competitive and antagonistic. Historically, nativists and maturationists have advanced the idea that the root from which growth and development springs is inborn, biological, and genetic; environmental influences are insignificant according to this view (Lamb, Bornstein, & Teti, 2002; Snow & McGaha, 2003). Nevertheless, emerging science

supported by neuroendocrine, genetic, and behavioral studies has provided much evidence that the forces of nature and nurture do not play oppositional roles. Instead, these forces exist in reciprocity, working collaboratively to shape the developing human (Bronfenbrenner & Ceci, 1994; Collins et al., 2000; Eisenberg, 1995; Greene, 2002). Moreover, an inherent characteristic of human development is that the process involves interactions among multiple factors and systems, producing a range of potential outcomes (Bronfenbrenner, 1979; Seifer, 2001).

A major contributor to the dismissal of the nature-nurture dichotomy is the discovery of the instruction book for the human body, the human genome. While the human genome was being decoded, there was great hope that once the entire sequence of the genome was mapped, all would be laid bare and all would become clear. It was the expectation that answers to how genotypes are transformed into phenotypes would be apparent as the genomic lexicon was read. The discovery of epigenetics, the alteration in genetic expression that does not involve alterations in the DNA sequence (Morley, Saffery, Hacking, & Craig, 2009), brought with it the realization that genetic expression often stems from gene-environment interaction, and not simply from the unfolding of the genetic blueprint. An ever-increasing body of knowledge supports the argument that specific environments can modify the epigenome of individual cells, tissues, and whole organisms (Morley, Saffery, Hacking, & Craig, 2009; Novik, 2002). As an example, Weaver and colleagues (2004) demonstrated how postnatal maternal behavior resulted in epigenetic programming, where non-nurturing maternal rat behavior altered the behavior of her offspring. When offspring were exposed to low levels of maternal care (in the form of licking, grooming, and arched-back nursing), the result was offspring that

demonstrated a higher degree of fearfulness. Surprisingly, this behavioral trait persisted into adulthood. And, as mentioned previously, Als and colleagues (2004) demonstrated how brain structure and function could be beneficially altered in human neonates who were exposed to a developmentally supportive environment.

Evidence suggests that the epigenotype is characterized by more plasticity than the genotype (Jiang, Bressler, & Beaudet, 2004). Given that the genotype exerts its effects in the context of the epigenome, it follows that epigenomic alterations can mediate genetic penetrance and eventual phenotype (Jiang, Bressler, & Beaudet, 2004; Youngson & Whitelaw, 2008). Epigenetic mechanisms are at work during gametogenesis and throughout an individual's life – evidence that gives particular significance to the quality of the intrauterine environment and early postnatal events (Morley, Saffery, Hacking, & Craig, 2009). The weight of evidence indicates that genes interact with the environment, thereby modulating development (Gressens et al., 2001); consequently, genes will often function differently in different environments. Although the importance of genes should not be underestimated, it can safely be surmised that DNA is not destiny, after all.

The other side of the nature-nurture dichotomy is supported by those who maintain that nurture is the foremost initiator of development. Proponents of this view have included such influential figures as John Locke (1699), the English philosopher who described the infant mind as a *tabula rasa*, and James B. Watson, an American behaviorist who characterized infants as passive creatures with no competencies of their own. Watson declared that he could train an infant to become a doctor, lawyer, or thief – depending on Watson's whim (Lamb, Bornstein, & Teti, 2002; Snow & McGaha, 2003). Just as the reductionist view of biological determinism is rejected, a singular reliance on

environmental effects to explain developmental phenomena should also be set aside. Development is neither predestined by the genome, nor is it completely at the mercy of environmental influences; instead, developmental outcomes are jointly constructed by both of these forces (Eisenberg, 1995; Knapp & Mastergeorge, 2009). Therefore, the question is not which one of these forces shapes development. A more relevant question would be: *How?* How do the forces of nature and nurture interact to produce developmental outcomes?

Some of the most helpful models that depict the interaction of nature and nurture are transactional models that describe developmental processes in terms of continuous and dynamic interactions between the individual and the experiences in the individual's environment (Bronfenbrenner & Ceci, 1994; Collins et al; 2000; Eisenberg, 1999; Plomin & Rutter, 1998). The transactional perspective asserts that the developmental effects of experience will depend on both the characteristics of the experience itself and the genetic endowment of the individual. In accordance with this view, these forces work together to determine the course, direction, and the eventual developmental outcome of the infant (Lamb, Bornstein, & Teti, 2002). There has been widespread adoption of this transactional view in developmental research, and it provides a means to appreciate the complexities of the relationship between an individual's genetic endowment and the effects of experiences that occur within the child's environment.

The transactional perspective is useful in understanding the interdependence of nature and nurture in infant developmental processes, yet one element is required in order to achieve a more panoramic view of infant development. The third element of relevance is the specific context of womb, family, community, and broader social milieu within

which development unfolds. Traditionally, mechanisms of nurture have included all that is in the external environment surrounding the developing organism. However, it is advantageous to make a distinction between the environment itself and the social interactions that take place within that environment. Some developmentalists have made such a suggestion. Harkness and Super (2002) argue that infant development should be understood within the context of the *cultural niche* in which the infant is raised, and West & King (1987) advanced the concept of *ontogenetic niche* as a means of properly framing the forces of nature and nurture. This view makes an explicit distinction between the concept of niche and the concept of nurture. Niche has an ecological sense, referring to the “environment-as-habitat,” whereas nurture refers to the “business of living and developing within the niche” (West & King, 1987, p. 551). The infant, then, inherits an ecologic setting – a niche – along with the genes that he or she inherits from the parents (Eisenberg, 1999; West and King, 1987).

The word *niche* is etymologically derived from the Latin word for *nest* (Mish, 1998). Accordingly, a niche has a supportive role, just as a robin’s nest serves the developmental needs of young hatchlings. West & King (1987) assert that a niche can be viewed as the physical and social entity that surrounds the growing organism which unites and supports its occupants in their various ontogenetic endeavors. The ecology of the developing organism’s first niche is the intrauterine environment, which has numerous characteristics that make it an ideal niche for supporting the growth and development of the embryo and fetus. The embryo and fetus are protected from the external environment and are continually nourished through placental circulation. The fetus receives kinesthetic, vestibular, and auditory stimuli as well as signals originating

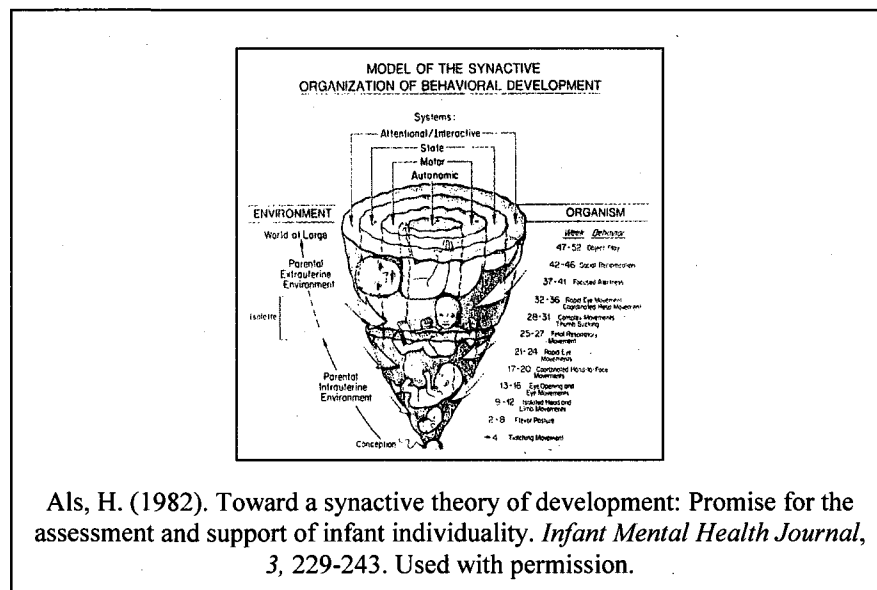
from maternal biorhythms (Blackburn, 2007). In addition, a variety of studies have demonstrated that maternal biochemistry is directly reflected in fetal and neonatal biochemistry, producing changes in fetal activity neonatal behavior (Field, et al., 2003; Gitau, Cameron, Fisk, & Glover, 1998; Van den Bergh, Mulder, Mennes, & Glover, 2005).

The postnatal niche includes the characteristics of the home and the family unit, and extends to the broader ecology of extended family, neighbors, neighborhood structures, and society at large (Bronfenbrenner, 1979; Eisenberg, 1999). It is the parent or parents who provide structure and function to the environmental niche in which the infant develops. The qualities of the environment are affected by a multitude of factors, including household economic stability, spousal relationships, family dynamics, and the degree of social support available to the parent or parents (Institute of Medicine, 2000a; Singer et al., 2003). These qualities, along with parental attitudes, values, and beliefs, can either directly or indirectly affect parental action and nurturant behaviors. Infant characteristics such as temperament and general state of health will impact how the parent regards the infant and parental behavior toward the infant (Krebs, 1998). Parental behaviors will, in turn, affect the quality of parent-infant interaction and the type of formative experiences that are provided to the infant (Lamb, Bornstein, & Teti, 2002). In this way, the forces of nature, nurture, and niche converge, interact, and direct the developmental trajectory of the infant.

The Synactive Theory of Development

This present study is informed by the Synactive Theory of Development (Als, 1982), which provides a framework for conceptualizing the forces of nature, nurture, and

niche that shape developmental processes in early life. The theory integrates relevant developmental principles into an elegant model which has significant utility for examining an infant's developmental trajectory. The Synactive Theory of Development serves as the foundational model for individualized, behaviorally-based developmental care practices for premature and other at risk infants. Als and colleagues (1999) have been early pioneers, advocating models of care that involve naturalistic observation of the infant's behavior and the implementation of developmentally sensitive, family-centered care. This approach to care provides a secure environment and supports the parental role, facilitating growth and development of the infant and family. A schematic of Als' original depiction of the model is provided below.



A transactional perspective is evident in this theory. As such, the theory illustrates how an individual infant integrates his or her sensory, cognitive, and social capacities with environmental input, thereby negotiating a unique developmental trajectory (Als, 1982). In accordance with this view, the infant does not take on the role of a passive recipient of sensory input; instead, each infant brings distinctive characteristics to the

interactive process, allowing the infant to exert some degree of influence on the nature of relationships. The term *synactive* reflects this dynamic, interactive process (Als, 1982).

The Synactive Theory of Development organizes the human organism into subsystems: the autonomic system, the motor system, the state system (also referred to as the state-organizational system), the attention and interaction system, and a self-regulatory-balancing system. The primary developmental task of the infant is to integrate these dimensions of functioning (Brazelton & Nugent, 1995). This systems view of the individual infant gives the theory an integrative, holistic perspective. According to Laszlo (1996), a system is composed of a number of discrete entities, or subsystems, where the system itself is qualitatively distinct from the sum of each of the individual parts. Accordingly, the infant is a complex system composed of individual subsystems, where the expression of individual characteristics are a reflection of the continual interaction of these subsystems with each of the other subsystems and with the environment.

Autonomic subsystem functioning is an indication of the infant's baseline physiological functioning, and is reflected in parameters such as cardiac and respiratory patterns, color variations, visceral functioning, and temperature stability. Motor subsystem functioning is reflected in posture, muscle tone, and movement. State organization is an indication of intact central nervous system control, which is reflected in the ease by which the infant transitions between various states of consciousness, and by the degree to which the infant responds to caregivers and the environment. The attention and interaction system indicates the ability to come to an alert state and interact with the environment, and the self-regulatory-balancing system is the system by which

the infant maintains a balanced integration of subsystem functioning (Als, 1982; Als & Lawton, 2004).

Als (1982) asserts that, beginning in embryonic life and continuing throughout the lifespan, the infant's developmental agenda is directed toward species-appropriate adaptation and achieving an ever-increasing degree of organization, differentiation, and functionality. Organization in this context implies a process of system integration where the various subsystems act as an integrated whole (Blackburn, 2007). This process requires the support of stable systems, where stability of one subsystem supports function of other subsystems. Likewise, an unstable subsystem can negatively impact the function of other subsystems (Als, 1982). The simplicity of this perspective belies its significance. The suggestion that an infant's autonomic subsystem can affect the state of the infant is noteworthy, especially in the context of the parent-infant relationship. For example, an infant who is physiologically unstable becomes disorganized and unable to appropriately respond to stimuli coming from the parent. As a consequence, the infant may be unable to respond to his or her parents as they may expect. The infant may become fussy and cry, or may be unable to sleep for the expected period of time. These behaviors interfere with normal developmental tasks of parent-infant bonding and attachment that are necessary for the attainment of normal developmental milestones. They may also cause the parents to regard the infant as "difficult," and as a result, the parents may not demonstrate sensitivity and consistency in meeting the infant's basic needs. This situation may put the infant at risk for delayed development, neglect, or even abuse (Brazelton & Nugent, 1995).

Unlike a physiologically unstable infant, a physiologically stable infant is organized and will easily integrate the functioning of all subsystems. This baby will transition smoothly between states of consciousness. When in an alert state, the infant is able to become socially engaged with parents and other caregivers. The infant is able to transition easily to sleep by appropriately blocking out environmental stimuli. This baby's behaviors facilitate parent-infant interaction, and will encourage parental sensitivity and engagement. This will, in turn, facilitate the development of trust, attachment, and bonding, thereby providing the foundation for developmental tasks to progress (Bowlby, 1982; Brazelton & Nugent, 1995; Klaus, Kennell, & Klaus, 1995).

Innate characteristics provide the newly born with a heightened potential for learning and plasticity. Far from being a *tabula rasa* (Locke, 1699) that experiences the world as a *buzzing confusion* (James, 1890), the newborn comes into the world with an extraordinary repertoire of perceptual, behavioral, and social capacities (Brazelton & Cramer, 1990). The interface between and among these innate characteristics with the unique features of the developing brain, along with early environmental and social influences allows the child to either assume a normal developmental trajectory, or to deviate from the expected developmental norms. A fateful combination of suboptimal or even harmful factors during early development has the potential to produce a spectrum of neurodevelopmental sequelae that may be expressed during neonatal life, early childhood, and beyond.

Factors that Affect Infant Development

The interacting variables that propel or impede development are many. The variables that will be examined in this present study include gestational age, birthweight,

Apgar scores, infant gender, maternal age, the presence of maternal depression, characteristics of parent-infant interaction, and characteristics of the home environment. Gestational age, birth weight, and Apgar scores specify forces of nature; that is, the infant's physical characteristics that influence developmental pathways. The characteristics of the home environment correspond to the contribution of niche to development, and nurturant factors are generally represented by maternal age, the presence of maternal depression, and characteristics of parent-infant interaction. In true transactional fashion, these forces converge, intermingle, and interact with each other and with infant systems in a synactive manner. Infant physical status affects infant state, which in turn affects the parent-infant relationship. Maternal age will have some bearing on the social structures, the physical environment in which the infant is reared, and the parent-infant relationship. In short, the unique interplay of these factors for the individual infant will shape the developmental trajectory as it proceeds from fertilized egg to young child, thereby influencing the eventual neurodevelopmental outcome.

Gestational age and birth weight

Gestational age and birth weight serve as a reflection of the quality of the intrauterine environment, and as such have relevance of evaluating developmental outcomes of the infant. A secure niche is required for normal development to proceed, and ideally, the intrauterine environment is supportive and nurturing to the developing fetus. This is not always the case, however, and when the intrauterine environment is not ideal, there is potential for negative factors to unduly impact growth potential and brain development. Consequently, neonates whose intrauterine growth patterns are outside

normal limits are at increased risk for short-term and long-term negative sequelae (Bukowski, 2004; Das & Sysyn, 2004; Jarvis et al., 2003).

Although birth weight does not always reflect the degree of fetal maturation, and gestational age does not always produce the expected birth weight, gestational age and birth weight usually have a parallel relationship (i.e. as gestational age increases, birth weight also increases), so they are considered together here. A multitude of factors determine fetal growth and birth weight, including maternal height and weight, parity, ethnicity, fetal gender (Bukowski, 2004), multiple gestation (Blair & Watson, 2006), the provision of prenatal care (Herbst et al., 2003), maternal smoking, substance use (Gressens et al., 2001), maternal depression and anxiety (Field et al., 2005) and the presence of maternal disease states such as hypertension and diabetes mellitus (Gressens et al. 2001).

Low birth weight has consistently predicted poor perinatal outcomes, including the occurrence of cerebral palsy and other developmental disabilities (CDC, 2004; Nelson & Ellenberg, 1986; Winter, Autry, Boyle, & Yeargin-Allsopp, 2002), although it has not always been found to be an independent risk factor (Taylor, Klein, Schatschneider, & Hack, 1998). A solid relationship is apparent, however, especially when extremes of weight are considered. A multi-center cohort study examining outcomes of extremely low birth weight infants (infants weighing between 401 g and 1,000 g) demonstrated the probability of abnormal neurological outcomes increased as the baby's birth weight decreased (Vohr et al., 2000).

A suboptimal intrauterine environment also has ramifications for the quality of growth that takes place during gestation. In cases of intrauterine growth restriction

(IUGR), neither the degree of maturation nor the presence of morbidity parallel birth weight. A fetus that experiences IUGR will not achieve his or her growth potential due to intrinsic or external forces that act upon the developing fetus. Often, the presence of IUGR will produce a neonate that is small for the corresponding gestational age, and the newborn will often display signs of fat and muscle wasting, chronic hypoxia, or both (Harkness & Mari, 2004). Glover and colleagues (1999) linked maternal depression – which resulted in increased maternal norepinephrine and increased uterine artery resistance – to decreased birth weight and IUGR. Badawi and colleagues (1998a, 1998b) identified IUGR to be one of the strongest risk factors of adverse neurological outcomes. Likewise, an investigation that followed 14,189 children from a British cohort study found that an IUGR cohort had significantly lower IQ scores and an increased utilization of special education (Strauss, 2000).

Clearly, gestational age and birth weight are relevant factors to be taken into consideration when examining fetal growth and neurodevelopmental outcomes. The intrauterine environment is the developing child's first niche, which is designed to support the many critical developmental tasks of human ontogenesis. A fetus that is able to attain full growth potential is more likely to have the physical constitution to support a smooth transition into the extrauterine environment. Successful transition from fetal to neonatal life correlates with stable infant subsystem functioning, and will prepare the infant to begin social interaction with his or her parents. This will facilitate the initiation of the attachment and bonding processes that are necessary to elicit care and nurturing behaviors which are crucial for optimal neurodevelopmental outcomes.

Apgar scores

Virtually every baby born in the United States today is assigned an Apgar score, and it has become the customary means of assessing the neonate's physical status during the first minutes after birth. Obstetric anesthesiologist Virginia Apgar developed the scoring system that bears her name in 1952 as an objective and standardized assessment of the newborn's physiologic condition during transition from intrauterine to extrauterine life (Apgar, 1953). Before 1952, assessment of the newborn's physiological state at the time of birth was expressed in terms of *breathing time* (the time of the first respiratory effort after the delivery of the head) and *crying time* (the time until the establishment of a satisfactory cry), or in degrees of depression (mild, moderate, or severe) – assessments which are prone to individual interpretation (Apgar, 1953).

The Apgar score was designed to give a more objective assessment at 1 minute and 5 minutes after birth. It has been described as a mini-examination of brainstem function of the newborn in the first minutes of life (ACOG & AAP, 2003). The score is comprised of 5 clinical signs: heart rate, respiratory effort, muscle tone, reflex irritability, and color. Each clinical sign is given a score of 0, 1, or 2. A total score of 7 or more indicates that the baby is in good to excellent condition; scores 4, 5, or 6 are intermediate; a score less than 4 is non-specific indicator of neonatal compromise and may be the first obvious sign of neurologic impairment and encephalopathy (ACOG & AAP, 2003).

As Virginia Apgar had hoped, Apgar scores have been shown to have value in predicting mortality. Casey & colleagues (2001) found that as Apgar scores increased, so did the infant survival rate. The score's value for predicting neurological outcome is mixed, however. Some studies have indicated that low 1 or 5 minute scores inconsistently

correlate with the infant's long-term neurodevelopmental outcome (Casey, McIntire, & Leveno, 2001; Moster, Lie, & Markestad, 2002; Nelson & Ellenberg, 1981). However a large population-based study found the odds of cerebral palsy to be significantly increased when the 5-minute Apgar score was under 7 (Thorngren-Jerneck & Herbst, 2001). The 5-minute Apgar score – particularly the change between the 1 and 5 minute scores – is a useful index of the baby's response to resuscitation efforts (AAP & ACOG, 2006). Not surprisingly, birth weight and gestational age have an inverse relationship on Apgar score values (Thorngren-Jerneck & Herbst, 2001).

Some practical limitations of the Apgar scoring system are that scores assigned during resuscitation may not be considered to be equivalent to scores assigned to an infant with spontaneous respirations (AAP & ACOG, 2006), nor does the Apgar score take into account preterm or intubated infants (Leuthner & Das, 2004). The score's value may also be related to the influence of extrinsic factors such maternal infection or medications commonly used in obstetric settings (Moster, Lie, & Markestad, 2002). Despite these limitations, the Apgar score has gained such widespread acceptance that “every baby born in a modern hospital anywhere in the world is looked at first through the eyes of Virginia Apgar” (Skolnick, 1996, p. 1939).

As with optimal gestation and birth weight, Apgar scores that are within normal limits are an indication of successful transition from fetal to neonatal life and stable infant subsystem functioning. An infant with stable autonomic subsystem functioning is less likely to be separated from his or her mother immediately after birth, and will more likely be put skin-to-skin against the mother's chest (Kattwinkel, 2006). Neonates placed skin-to-skin immediately after birth are able to more effectively stabilize temperature,

cardiorespiratory function, and oxygen saturation (Ludington-Hoe, Morgan, & Abouelfetoh, 2008; Moore, Anderson, & Bergman, 2007), modulate state and motor system regulation (Erlandsson, Dslina, Fagerberg, & Christensson, 2007; Ferber & Makhoul, 2004), and are more successful in breastfeeding (Martínez, 2008; Moore & Anderson, 2007). Successful attainment of these tasks results in the availability of energy that can be directed toward socialization, attachment, and bonding processes that are essential for optimal neurodevelopmental outcomes.

Infant gender

There is mounting evidence that gender plays a significant role in neurodevelopmental outcome. These differences are not simply attributed to the effects of the varying degrees of hormones found in males and females, but to innate differences and distinct chromosomal structures of male and female cells.

In general, males tend to demonstrate poorer neurodevelopmental outcomes than do females of similar gestational age. Numerous investigations have found that, in general, boys have a higher incidence of mortality and neurodevelopmental disabilities than girls (Tioseco et al., 2006; Wood et al., 2005), including cerebral palsy, learning disabilities, autism, and attention-deficit-hyperactivity disorder (Johnson & Hagberg, 2007). Confirming findings of an earlier study by Msall et al. (1993), a multi-center cohort study examining the neurodevelopmental, neurosensory, and functional outcomes of extremely low birth weight infants found that male gender was significantly associated with neurodevelopmental morbidity (Vohr et al., 2000). Similarly, Badawi and colleagues (1998a) found that male babies had a 50% higher risk of neonatal encephalopathy than their female counterparts. A study of 1 million term births conducted by Thorngren-

Jerneck & Herbst (2001) found that low Apgar scores occurred in girls less frequently than in boys, and this difference remained even after stratification for birth weight.

A recent study of a cohort of extremely premature infants (born between 22 – 25 weeks' gestation) produced intriguing results about the benefits of female gender. The investigators found that female gender yielded benefits to babies similar to benefits that are conferred by an increase in gestational age of one week (Tyson et al., 2008).

Gender-associated effects of preterm birth on cerebral gray matter and white matter was investigated by Reiss et al. (2004). Although both preterm boys and preterm girls in this study had reduced white matter volumes by eight years of age, males had significantly reduced white matter in comparison to girls, suggesting that males are particularly vulnerable to prematurity's untoward effects on white matter development. This may be partially explained by innate gender differences at the cellular level that give rise to gender-specific pathways to neuronal cellular death (Du et al., 2004).

Finally, Carter and colleagues (2001) found that maternal depressive symptoms during pregnancy and postpartum had a stronger association with problem behaviors in boys as compared to girls. These same authors also found that girls were more likely than boys to be adversely affected by the quality of early interactions with their mothers, leading them to conclude that risk pathways may be different for girls than for boys. These studies point to the intriguing possibility that significant neurobiological differences between males and females influence pathways to cellular growth, death, and eventual neurodevelopmental outcome.

Parent-Infant Interaction

The neonate comes into the world primed to interact with the surrounding world and the people in it. As interaction between the infant and the environment ensues, infant neurobiological and neuroaffective processes unfold, which then map out the infant's developmental trajectory.

Developmental theorists and others concerned with infant developmental outcomes have articulated a fascinating schema by which cortical cytoarchitecture and neural wiring is shaped by the social environment (Eisenberg, 1995; Collins et al. 2000; Panksepp, 2001; Siegel, 2001; Westrup, 2005). Parenting behaviors set the tone of the developmental environment and for the parent-infant relationships that are cultivated within that environment (Collins et al., 2000; Kelly & Barnard, 2000). Indeed, it is the pattern of interaction that occurs between the infant and the primary caregiver, usually the mother, that forms the basis of social and psychobiological development of the child (Bowlby, 1988; Erikson, 1963; Panksepp, 2001). Experiences with caregivers during daily activities initiate a process of mutual interaction that will bring about the child's understanding of self and others. The non-verbal and emotional exchanges between parent and child constitute the infant's first language and are the initial means of infant communication (Bornstein et al., 2008; Lamb, Bornstein, & Teti, 2002). Subsequent language development is facilitated by simple adult-child conversations and activities such as reading, story-telling, singing, and narratives during the day's events (Willis, Kabler-Babbitt, & Zuckerman, 2007; Zimmerman et al., 2009).

Parental emotional availability and responsiveness are key constituents of the reciprocal and synchronous interchanges that characterize healthy parent-infant

communication patterns (Amankwaa, Pickler, & Boonmee, 2007; Bornstein et al. 2008; Bretherton, 2000). These interactions are powerful regulators of socio-emotional growth, giving direction to the ontogenic path of the infant. Parental emotional availability is a construct that involves sensitivity (which is characterized by acceptance and flexibility), structuring (providing a supportive framework for interaction), nonintrusiveness (support that is not over-protective), and nonhostility (characterized by interactions that are patient and harmonious) (Bornstein et al., 2008). The infant responds to parental emotional availability by reciprocating infant emotional availability, which is characterized by age-appropriate responsiveness and willingness to engage in interaction (Bornstein et al., 2008).

Parental responsiveness is a related construct that denotes the parent's ability to recognize infant cues and to consistently act in response to them (Karl, 1995). It is implied that the parental response is sensitive to the moment-by-moment microshifts in infant subsystem functioning, and that it is in harmony with the infant affect and cues. Responsiveness and emotional availability of parent and infant will build synchrony and security, which are ingredients necessary for the formation of bonding and secure attachment (Amankwaa, Pickler, & Boonmee, 2007; Bowlby, 1982, Drake et al., 2007; Klaus, Kennel, & Klaus, 1995; Kraemer, 1992).

Because parent-infant relationships are truly synactive, there are additional factors that make subtle or not-so-subtle contributions to bonding and attachment processes. Raval and colleagues (2001) found that factors such as maternal sensitivity and responsiveness explained only a portion of the linkage with attachment. They posited that genetic, socio-cultural, and environmental influences, filtered through infant

psychobiological mechanisms would contribute to the development of either secure or insecure attachment patterns. Indeed, these and other factors will have some bearing on the ability of the parent to be emotionally available and to provide sensitive, responsive care, thus promoting a secure attachment bond (Browne & Talmi, 2005; Crockenberg & Leerkes, 2000; Holditch-Davis, Brandon, & Schwartz, 2003; Lamb, Bornstein, & Teti, 2000; Minde, 2000; Singer, et al. 2003).

As discussed above, attachment (Bowlby, 1988) and bonding (Klaus, Kennel, & Klaus, 1995) are integral to the parent-infant relationship and the nature of their interaction. English child psychiatrist John Bowlby and American developmental psychologist Mary Ainsworth described the mutual process by which infants and their primary caregivers interact with each other, resulting in the formation of the intimate emotional attachment bonds. They described a variety of infant behaviors that comprise a repertoire of signals that are designed to keep the individual to whom the infant is attached close at hand, thus ensuring that the infant's needs for comfort, security, and nourishment are met (Ainsworth & Bowlby, 1991). For example, babies smile, coo, and make eye contact with adults, thereby eliciting a reciprocal response of warmth and social contact from caregivers. As Bowlby (1959) describes it: "It is fortunate for their survival that babies are so designed by nature that they beguile and enslave their mothers" (p. 397).

As the infant elicits caregiver responses via signals such as crying or smiling, the baby soon learns *trust*, *effectance*, and *reciprocity*. The infant will trust that the caregiver will appropriately respond when signaled. Effectance occurs when the infant realizes that certain behaviors can evoke desired responses from caregivers. When a baby begins to

understand that partners in social situations take turns acting and reacting to each other's behavior, the infant learns the concept of reciprocity. Reciprocity denotes a certain synchrony in the adult-child interaction where, for example, a mother and her baby take turns touching and responding or vocalizing and answering (Bowlby, 1988).

Attachment is an essential component of bonding. It is generally believed that attachment and bonding refer to unidirectional phenomena, where attachment describes the infant's emotional tie to the parent and bonding refers to the parent's emotional bond to the infant. However, the term *bonding* is often used to refer to the strong emotions that bind one person to another in either direction (Klaus, Kennel, & Klaus, 1995). The formation of attachment, although primarily a developmental task for the infant, serves to bond the infants and significant others in a kind of a partnership (Crockenberg & Leerkes, 2000). Marshall Klaus and Phyllis Kennel, the foremost theorists in this area of infant mental health, define a *bond* as "a unique relationship between two people that is specific and endures through time" (Klaus & Kennel, 1982, p. 2).

The creation of this bond is influenced by a continuum of experiences that incorporates such variables as the parents' own childhood experiences and the circumstances surrounding the pregnancy and birth. Numerous factors have the potential to alter or distort the formation of this bond throughout the developmental continuum, including premature birth, infant temperament, the home environment, maternal depression (Crockenberg & Leerkes, 2000; Lamb, Bornstein, & Teti, 2000), adolescent parenthood (Secco, Ateah, Woodgate, & Moffatt 2002), parental substance abuse (French, Pituch, Brandt, & Pohorecki, 1998), maternal age (Wakschlag & Hans, 2005), socioeconomic status (Horodynski & Gibbons, 2004), preterm birth and its sequelae

(Browne & Talmi, 2005; Singer et al., 2003), including central nervous system immaturity and compromised organization and functionality (Holditch-Davis, Brandon, & Schwartz, 2003; Minde, 2000). The fundamental importance of the parent-child relationship is the basis for widespread interest in examining the influence of this relationship on infant developmental trajectories and developmental outcomes (Barnard 1978; Magill-Evans & Harrison, 2001; Paavola, Kunnari, & Moilanen, 2005; Stewart & Meyer, 2004; Zhu et al., 2007).

Maternal age

Maternal age – whether it involves adolescent mothers who transition early to the parenting role, or delayed childbearing and advanced maternal age – has implications for the outcome of the pregnancy and the subsequent developmental trajectory of the infant. Although neither adolescent mothers nor mothers of advanced age represent homogenous groups, each group has unique characteristics that may serve as developmental risk factors for the infant.

In general, adolescent motherhood is often embedded in broader social contexts of single parenthood, poverty, low educational attainment, engagement in risky behaviors, social isolation, and the occurrence of depression (Eaton et al., 2006; Koniak-Griffin, 2001; Lesser, Koniak-Griffin, & Anderson, 1999; Wakschlag & Hans, 2005). There are also a multitude of factors common in adolescent pregnancies that may contribute to obstetrical complications and/or serve as risks to the developing fetus, including poor nutrition and suboptimal maternal weight gain, experimentation with substance use, engaging in unprotected sex, sexually transmitted infections and other infections (e.g. urinary tract infections, asymptomatic bacteruria), delivery of a preterm or low

birthweight infant (Eaton et al., 2006; Koniak-Griffin, 2001; Wakschlag & Hans, 2005), and an increased risk of death in infancy (Martin et al., 2009). In addition, adolescent mothers tend to have less realistic developmental expectations of their infants and young children, are more likely to demonstrate harsh disciplinary tactics, and are less likely to exhibit responsiveness and sensitivity to their children (Wakschlag & Hans, 2005; Zenah, Boris, & Larrieu, 1997). These parenting practices are often influenced by unfavorable social conditions related to economic strain, lack of education, dysfunctional family dynamics, and the relative immaturity and lack of life experience of the adolescent mother (Koniak-Griffin, 2001). Indeed, the adolescent's own developmental needs are a significant factor in her ability to take on the maternal role. The challenge for the adolescent mother is to define herself and her role in relation to the needs of the infant and the changing roles of partners and family members (Wakschlag & Hans, 2005).

The United States has the highest percentage of adolescent pregnancy among industrialized nations. Although there was a recent decrease in incidence of teenage birth rate between 1991 and 2005, the birth rate for teenagers 15 – 19 years of age increased slightly in 2006. The birth rate in this group was 41.9 births/1,000, which is an increase from 40.5/1,000 in 2005 (Martin et al., 2009). At the other end of the childbearing spectrum, there has been an increase in the appearance of first-time mothers who are over the age of 35 at labor and delivery units across the country. Almost 500,000 women between the ages of 35 and 54 years of age gave birth in the United States in 2006; furthermore, the birth rate for women in all age groups of women aged 35 and above increased in 2006 (Martin et al., 2009).

There are numerous factors related to this trend toward delayed childbearing. Women who choose to become pregnant later in life tend to have increased opportunities related to education and careers, so this group is often composed of well educated, upwardly mobile professionals (Carolan, 2003). Sociological and technological trends have also contributed to this phenomenon, including an increased need for economic stability, a trend toward smaller family size, increased life expectancy for women, numerous contraceptive choices, and the advancement of reproductive technologies (Carolan, 2003; Viau, Padula, & Eddy, 2002).

Childbearing later in life is associated with a fairly long list of risk factors for the mother and fetus: prolonged labor, increased need for augmentation of labor, increased incidence of instrumented delivery and cesarean section (Treacy, Robson, & O'Herlihy, 2006), increased incidence of fetal anomalies (especially Trisomy 21) (Hollier et al., 2000), increased risk of IUGR (Odibo, et al. 2006), and increased risk for gestational diabetes, hypertension, preeclampsia, placenta previa, premature birth, spontaneous abortion, and intrauterine fetal death (Bianco, et al., 1996; Callaway, Lust, & McIntyre, 2005; Heffner, 2004). These obstetrical risk factors often carry with them associated complications which result in an increased length of hospital stay and related increase in the expenditure of health care dollars (Mulla, Gonzalez-Sanchez, & Nuwayhid 2007). Nevertheless, Viau and colleagues (2002) found that this group of more mature women was more aware of obstetrical risks associated with their pregnancies and they were more proactive in adopting health-promotion activities and seeking health-related information. These women also tended to have realistic expectations concerning postpartum life, including sleep deprivation, and the eventual balancing of work and family. So, although

older childbearing may contribute numerous physical health risks to mother and child, other characteristics of older mothers tend to play a role in an enhanced child-rearing environment. Stein & Susser (2000) support this view, suggesting that social advantages of some mothers of advanced age may ameliorate the biological disadvantages of this group.

In terms of educational and psychosocial child outcomes, a large birth cohort of 1,025 children gives some perspective of the relationship between maternal age and childhood risks (Fergusson & Woodward, 1999). This particular study found child developmental outcome risks consistently declined with increasing maternal age. Yet, the authors advocate adopting a more global perspective that children of younger mothers are not invariably disadvantaged and that children of older mothers are not invariably advantaged. A similar viewpoint is advocated by Bornstein and colleagues (2006). These authors examined the role that maternal age plays in parenting practices of new mothers. Again, the authors of this study argue against a monolithic view of parenting vis-à-vis maternal age.

Maternal depression

Depressive disorders are surprisingly common, especially among women (Lepine, 2001; Moussavi et al., 2007). Although there is some degree of uncertainty regarding the exact incidence of depression during the perinatal period, the literature reports that approximately 10 – 20% of all new mothers experience some degree of depressive symptomatology that either predated the pregnancy or emerged during the perinatal period (Gavin, et al., 2005; Josefsson, et al. 2002). In a study of 1,558 pregnant women, Joseffson and colleagues (2001) found depressive symptomatology in late pregnancy to

be 17%, 18% in the hospital maternity unit, 13% at 6 – 8 weeks postpartum, and 13% at 6 months postpartum. Wachs & colleagues (2009) assert that maternal depression has an almost infectious nature, where prenatal depression increases the risk for depression in the postpartum period, postpartum depression increases the risk for the continuation of chronic depression, and maternal depression increases the risk of paternal depression and depression in the offspring (Dennis, Janssen, & Singer, 2004; Goodman, 2004; Goodman & Gotlib, 1999; Murray et al., 1999).

Maternal depression is characterized by symptoms reflective of physiological and psychiatric dysregulation, including fatigue, decreased energy, disturbances in sleep and appetite, anhedonia, negative affect, and bouts of irritability, guilt, withdrawal, and feelings of worthlessness (American Psychiatric Association, 1994; Wachs, Black, & Engle, 2009; Wisner, Parry, & Piontek, 2002). Depression can be characterized as an etiologically diverse group of disorders (Lesch, 2004). Most cases of depression are idiopathic, but it appears to be partially explained by a combination of genetic, biochemical, psychobiological, and environmental factors. The “monoamine hypothesis” posits that a decrease in monoamine neurotransmitters is associated with depression, and pharmaceutical agents designed to either inhibit neuronal reuptake or inhibit degradation of monoamines have been useful in controlling depressive symptomatology in many patients (Krishnan & Nestler, 2008). Depression may also be related to such diverse mechanisms as atrophy in the regions such as the prefrontal cortex and hippocampus or related to dysfunction of the HPA axis (Krishnan & Nestler, 2008). There is also convincing evidence that complex interactions at numerous gene loci interact with each other and with the environment to create vulnerability for depression (Lesch, 2004). In

susceptible childbearing women, the rapid decline in female reproductive hormones that occurs after delivery may contribute to monoamine, reproductive hormone, and stress hormone dysregulation, leading to the development of depressive symptomatology (Wisner, Parry, & Piontek, 2002). In addition, the disruption of sleep that occurs in the final trimester and postpartum period has been shown to have a significant relationship with the onset of depressive symptomatology (Dennis & Ross, 2005; Ford & Cooper-Patrick, 2001; Manber & Armitage, 1999). Finally, factors such as social stressors, dysfunctional family dynamics, and decreased levels of social support are associated with increased risk of depression (Bloch, Rotenberg, Koren, & Klein, 2005; Grigoriadis & Romans, 2006; Robertson, Grace, Wallington, & Stewart, 2004).

Whatever the cause, the resulting symptomatology creates the potential for deleterious effects on family functioning and infant growth and development. As detailed previously, infancy is a particularly sensitive period where extensive brain growth and development occurs. Also, as outlined earlier, parenting is a critical factor necessary for the survival, growth, and development of the altricial infant. When one considers the importance of parent-infant interactions during early development, it follows that factors that impair the appropriate functioning of the parent-infant dyad will have untoward effects on infant developmental outcomes.

Numerous investigations into the association between depression and infant developmental outcomes have highlighted various harmful effects of depression on the developing child. Most of these studies examined depression in the mother, since it is the mother who typically spends the majority of the time with infants and young children, and women – especially pregnant women and new mothers – are at heightened risk for

depression. Fowles, (1997) demonstrated that depression in the postpartum period can interfere with cognitive, affective, and behavioral changes necessary to take on the maternal role. The implication is that a woman who is comfortable in her role as a mother is more likely to provide a nurturing environment that will facilitate infant development, whereas a woman who struggles with maternal role attainment will be less likely to provide essential nurturing behaviors. Sohr-Preston & Scaramella (2006) and others (Field et al., 2004; O'Conner et al., 2003) posit that sustained maternal stress and depression during pregnancy compromises fetal HPA development, resulting in a child that is more sensitive to environmental stressors. The HPA dysfunction hinders the child's emerging cognitive skills, negatively affecting learning, memory, and the ability to be attentive. In addition, depressive symptomatology such as negative affect, irritability, and social withdrawal inhibit maternal sensitivity and responsiveness (NICHD Early Child Care Research Network, 1999), thereby compromising infant engagement and maternal-infant synchrony. Diminished quantity and compromised quality of maternal behaviors that shape infant development are associated with the risk of cognitive and language delay in young children (Sohr-Preston & Scaramella, 2006). The weight of evidence suggests that maternal mental health is a crucial factor in infant neurodevelopmental outcomes.

Home Environment

Parents are the architects of the child's socio-ecological milieu: the home environment where most of early development takes place. The environment, as it is considered here, can be understood as the physical, social, cultural, and historical niche within which infant growth and development occurs (Bronfenbrenner & Ceci, 1994).

The qualities of the environment are affected by a multitude of factors, including household economic stability, spousal relationships, family dynamics, and the degree of social support available to the parent or parents (Institute of Medicine, 2000a; Singer et al., 2003). In addition, there has been increasing interest in the influence of “neighborhood effects,” which examines pathways from neighborhood characteristics to child development outcomes (Kohen et al., 2008). A growing body of literature is establishing connections between child development outcomes and social-interactional mechanisms such as neighborhood cohesion, social organization and control, neighborhood resources, and the availability of social role models (Institute of Medicine, 2000a). Neighborhood effects tend to be transmitted via family processes, and family processes are affected by neighborhood effects. Adverse neighborhood effects have been linked to many undesirable social phenomena, including family dysfunction, maternal depression, exacerbation of harsh parenting behaviors, and lower child test scores (Klebanov, Brooks-Gunn, McCarton, & McCormick, 1998; Kohen et al., 2008).

Urie Bronfenbrenner (1979) advanced the theory of multiple ecological systems that shape developmental processes via interaction of the child with the immediate environment. These systems are organized around the child in distinct layers, with the microsystem having the most intimate interface with the young child during early development. According to Bronfenbrenner (1979), family composition and dynamics within the home environment comprise some of the most influential forces in the young child’s microsystem.

The socialization that takes place in the ecological niche is actively constructed by the child over time, as he or she adapts to the environment (Nugent 2002). With this

principle in mind, a rich history of scientific inquiry has developed that has continued the theme of environmental influences on developmental outcomes (Bradley, Caldwell, & Rock, 1988; Farooqi et al., 2007; Graven et al., 1992; Gross et al., 2001; Msall & Park, 2008; Summerfelt, Markestad, & Ellersten, 1998; Whitfield, 2003). A significant finding by Miceli and colleagues (2000) provided evidence that the social environment of the child has the potential to be a stronger predictor of developmental outcome than physiological factors in the history of the child.

Realizing the close connection between development and the nature of home environment, Caldwell & Bradley (1984) developed the Home Observation for Measurement of the Environment (HOME), an instrument that measures the characteristics of the home environment. The instrument measures aspects of the home such as the safety of the environment, the provision of appropriate toys and books, and indications of maternal affection that reflect the degree of structure, stimulation, and support that is available to the child in the home environment.

It is clear that infants do not grow up in isolation. Babies exist, not as solitary beings, but as part of a dyad, a family unit, a community, and a broader social ecology, which are elements of the infant's ontogenetic niche. The infant is embedded in this ontogenetic niche, which is composed of distinctive components that interrelate with each other and the infant, creating a developmental and socialization process that shapes the infant into a unique individual.

Summary

Human ontogenetic mechanisms are as fascinating as they are complex. Unique developmental attributes of the human organism during transformation from embryo to

young child confer a great degree of developmental potential along with innate vulnerability to the forces of nature, nurture, and niche. Together, rapid intrauterine growth patterns, postnatal encephalization, and altriciality, point to the necessity for sensitive, consistent parental care and a supportive environment to promote an optimal developmental trajectory.

Each infant is a complex system that is composed of individual subsystems. Beginning with embryonic life and continuing throughout the lifespan, the infant's developmental agenda is directed toward species-appropriate adaptation and the achievement of an ever-increasing degree of organization, differentiation, and functionality. The continual interaction of infant subsystems with each other and with the environment determine are transactional and synactive, and they prescribe the course, direction, and eventual neurodevelopmental outcome of the infant.

Chapter III

Methods

The purpose of this study was to examine factors that predict neurodevelopmental outcomes of infants that are at risk for altered development. Relevant predictor variables examined in this study include: gestational age, birth weight, Apgar scores, infant gender, maternal age at the time of the child's birth, the presence of maternal depression, characteristics of the home environment, and parent-child interaction. In this chapter, the research design, sample and sample characteristics, procedures for data collection, measurement, as well as data analysis techniques are described. The protection of human subjects is also discussed.

The specific aims of this present study were to describe:

- the level of neurodevelopment in a group of infants who have been identified as high risk for neglect or abuse.
- the relationship between gestational age, birth weight, Apgar scores, gender, maternal age, the presence of maternal depression, characteristics of the home environment, parent-child interaction, and motor, mental, and behavioral development.

- the influence that gestational age, birth weight, Apgar scores, gender, maternal age, the presence of maternal depression, characteristics of the home environment, and parent-child interaction have on infant neurodevelopmental outcome.

Design

A descriptive, correlational design using secondary data analysis was used for this study. Secondary data analysis is a form of research in which the data collected by one researcher are reanalyzed by another researcher to answer new research questions (Hearst, Grady, Barron, & Kerlilowske, 2001). Although the database must be selected with care, there are numerous advantages to conducting a secondary analysis. Perhaps the greatest advantage lies in the money, time, and resources which are conserved by using data which have already been collected (Hearst et al., 2001). The implementation of the original study involved a considerable amount of time, effort, and expense. Economy of monetary resources, time, and effort are significant advantages for this proposed study. In addition, the researcher does not need to impose upon the time and patience of the members in the database, nor invade their privacy once again. If the sample is large enough, the database may contain considerably more variables than could be obtained in a smaller sample. Finally, another considerable advantage of secondary analysis, especially in this case, involves ethical considerations. Designing research that involves neonates, infants, and their families warrants careful considerations when working with this vulnerable group (Allmark & Spedding, 2007; Franck, 2005). The U.S. Department of Health and Human Services Code of Federal Regulations extends special protection to pregnant women, human fetuses, and infants involved in research (DHHS, Title 45, Part

46). The fact that newborns and young children are not competent decision makers necessitates proxy informed consent, which presents a set of unique challenges. Also of significance is the fragile nature of at-risk infants and children, especially those who are physiologically vulnerable as a result of a problematic perinatal history. This unique vulnerability creates the prospect of potentially significant harms as well as benefits which may not always be fully anticipated.

Secondary data analysis is not without limitation, however. The primary disadvantage of secondary data analysis has to do with the data itself. It was not possible for the investigator of this present study to have any degree of control over the data that has already been collected. The selection of data that is collected, the quality of the data, and the possibility of missing data are all concerns when doing a secondary analysis (Hearst et al., 2001). This study used a sample of participants ($n = 488$) who participated in Healthy Families San Diego (HFSD) (Landsverk, et al., 2002). HFSD, a randomized clinical trial conducted by Landsverk and colleagues (2002) was designed to examine the effect of paraprofessional home visitation for families of newborns deemed at risk for adverse health and developmental outcomes.

Sample and Setting

The original study sample consisted of 488 high-risk mothers and their babies. These mothers gave birth between February 1996 and March 1997 at a hospital located in San Diego County. San Diego County, with a racial and ethnic population that is similar in composition to the state of California as a whole, provided an ideal environment to obtain a diverse sample for the original study.

Procedure

High-risk subjects were initially identified for possible inclusion in the study through a two-step process of screening and assessment. The initial screen utilized the hospital computer systems to provide census and clinical data. Potential subjects met the inclusion criteria of (a) residing in the catchment area of the birthing hospital, (b) non-military, and (c) either English or Spanish speaking. The language criterion was utilized due to the availability of informed consent documents, standardized research tools, and available personnel fluent in these languages. A non-military inclusion criterion was utilized in order to increase the likelihood of successful follow-up. Exclusion criteria consisted of patients who were (a) unable to speak either English or Spanish, (b) currently involved with Child Protective Services (CPS), (c) not currently living in San Diego County, (d) residents of San Diego County that planned to move out of the area shortly, and (e) those who resided in certain geographical areas of San Diego County that made them eligible for other home visitation programs. Families currently involved with CPS were excluded from the study in order to more clearly determine if outcomes were due to the interventions of the study.

Records Screen

The patients that met the preliminary criteria were then identified for being at risk for altered parenting, child abuse, or child neglect using a 15-item screen comprised of potential risk factors for family functioning. The items in the screen are presented in Table 1.

1) Not married	6) Education < 12 years	11) History of psychiatric care
2) Partner unemployed	7) 0 – 1 emergency contacts	12) Abortion sought/attempted
3) Inadequate income	8) Substance abuse history	13) Adoption sought
4) Unstable housing	9) Late/poor prenatal care	14) Marital/family problems
5) No telephone	10) History of abortions	15) History of depression

A positive screen resulted if any of the following were true: (a) item 1 (single, separated, or divorced), item 9 (poor or late prenatal care), or item 12 (abortion sought or attempted); or (b) two or more items on the screen were true; or (c) seven or more items were unknown.

Family Stress Checklist

Mothers who screened positive during the first step of the recruitment process and who accepted the offer for an interview were then interviewed. The interview consisted of a psychosocial assessment using the Family Stress Checklist (FSC) (Murphy, Orkow, & Nicola, 1985; Schmitt, 1978). The FSC (which is also known as the Kempe Family Stress Assessment or Inventory) is a 10-item scale that is administered as a semi-structured interview. The scale covers several domains of personal and family functioning such as the level of family stress, the parent's perception of and attitude toward the child, emotional functioning, mental health history, criminal and substance abuse history, and the parent's own childhood history (Schmitt, 1978).

The FSC is widely used by Healthy Families America sites across the country to assess a parent's degree of risk for parenting difficulties and child maltreatment. It has demonstrated construct validity and clinical utility when used as part of a comprehensive risk assessment that utilizes multiple measures (Korfmacher, 2000). Interviewers rate the

parent on a 3-point scale for each of the 10 items: 0 = no risk, 5 = moderate risk, and 10 = severe risk. The maximum score is 100. After totaling the scores for each item, the mother is categorized as high/severe risk if she has a score of greater than 40; high/moderate risk if she has a score from 25 – 35; and low risk if she has a score of more than 25. A score of 25 or greater on this scale indicates that the family is considered to be overburdened and at risk for poor outcomes. For the purposes of this study, a score of 25 or greater was considered a positive screen. Mothers with a positive screen were offered the opportunity to participate in the study, and informed consent was then obtained from these mothers. A list of items in the FSC is presented in Table 2.

Table 2. Items in the Family Stress Checklist

<i>Item</i>	Scores
Parent beaten or deprived as a child	0 – 5 – 10
Parent has criminal or mental illness record, or substance abuse history	0 – 5 – 10
Parent suspected of abuse in the past	0 – 5 – 10
Parent with isolation, low self-esteem, or depression	0 – 5 – 10
Multiple stresses or crises	0 – 5 – 10
Violent temper outbursts	0 – 5 – 10
Rigid, unrealistic expectations of child's behavior	0 – 5 – 10
Harsh punishment of child	0 – 5 – 10
Child difficult and/or provocative or perceived to be by parent	0 – 5 – 10
Child unwanted or at risk for poor bonding	0 – 5 – 10

Research interview data were collected at four time points including delivery (92% received the baseline interview within one month of delivery, 8% received the interview within two to six months of delivery) and at the child's first, second and third birthdays (Connelly, Newton, Landsverk, & Aarons, 2000; Connelly, Newton, & Aarons,

2005; Landsverk et al., 2002; Newton, Connelly, & Landsverk, 2001). Demographic information was collected at the beginning of the study. In addition to face to face home interviews, telephone tracking surveys were conducted at 4, 8, 16, 20, 28, and 32 months (Newton, Connelly, & Landsverk, 2001).

Present Study

For the study presented here, predictor variables were chosen as a result of an in-depth literature review, the availability of relevant data from the existing data set, and for their potential to achieve an efficient equation by which to predict the outcome.

Sample Size

A power analysis was performed to estimate the sample size required for moderate effect size for this study. Level of significance was set at $p = 0.05$ and a power of .80. Sample size was determined for a moderate effect size ($r^2 = 0.13$, estimated) and power of 0.80 to avoid a Type II error (Munro, 2005). Sample size utilizing this method demonstrated a need for 131 participants to determine statistical significance and reduce the chance for a Type II error.

Measurement

All instruments utilized in this study have had considerable use in both clinical and non-clinical research with children and adults. Maternal variables included: mother's age at time of child's birth, race/ethnicity, marital status, educational level, and the presence of depression. Infant characteristics included gestational age, birth weight, Apgar scores, a neonatal risk index, and gender.

The Apgar score was designed to give an objective assessment at 1 minute and 5 minutes after birth. The score is comprised of 5 clinical signs: heart rate, respiratory

effort, muscle tone, reflex irritability, and color. Each clinical sign is given a score of 0, 1, or 2. A total score of 7 or more indicates that the baby is in good to excellent condition; scores 4, 5, or 6 are intermediate; a score less than 4 is non-specific indicator of neonatal compromise and may be the first obvious sign of neurologic compromise and encephalopathy (ACOG & AAP, 2003).

The *Neonatal Risk Index* is a composite variable where biological risk indicators were grouped for statistical control in data analysis. The variables included in the index are: birth weight of less than 2,500 g, gestational age of less than 37 completed weeks' gestation, an Apgar score of less than 7, and admission to NICU. Infants were given a score from 0 – 4, depending on how many of these risk factors the infant had. Neonatal scoring systems are commonly utilized as a means to assess biological and psychosocial risk in this patient population (Brazy, 1991; Thompson et al., 1994).

Parent-child interaction was measured by the Nursing Child Assessment Satellite Training Scales (NCAST) (Barnard, 1978). The NCAST scales consist of two different scales: the NCAST Teaching Scale and the NCAST Feeding Scale. The NCAST Teaching Scale, which was used in this study, measures the quality of the interactions between caregivers and the child are evaluated in terms of verbal and non-verbal communication directed toward the child. Specifically, the caregiver's sensitivity to the child's cues, response to the child's distress, and activities that foster social-emotional growth are evaluated by the NCAST Teaching Scales (Summer & Spietz, 1995). Because parents and other caregivers exert a significant influence on infant development, measurement of this important social phenomenon has facilitated numerous research applications in this area.

The NCAST Teaching Scale consists of 73 binary items organized into six subscales. Four of these subscales assess caregiver responses: sensitivity to the infant's cues, response to the infant's distress, fostering social and emotional growth, and fostering cognitive growth. The two remaining subscales assess the clarity of the infant's cues and the infant's response to the caregiver. There is solid evidence of the reliability and validity of the NCAST scales (Barnard et al., 1989; Britton, Gronwaldt, & Britton, 2001; Tesh & Holditch-Davis, 1997). See Appendix A, Measures for information regarding the NCAST scales.

The *characteristics of the home environment* were measured by the Home Observation for Measurement of the Environment (HOME) (Caldwell & Bradley, 2001). The authors of this instrument identified six environmental characteristics that influence early development in the infant and toddler. These environmental characteristics reflect the degree of structure, stimulation, and support that is available to the child in the home environment. Specifically, the HOME inventory measures: (1) emotional and verbal responsiveness of the mother, (2) avoidance of restriction and punishment, (3) organization of the environment, (4) provision of appropriate play materials, (5) parental involvement with the infant, and (6) opportunities for variety in daily stimulation.

The items included in the HOME Inventory are based on child developmental theory, research, and professional assessments (Bradley, Mundform, Whiteside, Casey, & Barrett, 1994). The quality of the home environment is measured by inventories that are designed for three distinct age groups: infants and toddlers, early childhood, and middle childhood. Each age group has specific items that, when measured, give an indication of the nature of the home ecology. Research using the HOME Inventory has demonstrated

sound psychometric properties, reliability and validity (Bradley, 1993; Bradley et al., 1994; Caldwell & Bradley, 2001). Significant associations between HOME Inventory scores and cognitive and language development, IQ, and school performance have been demonstrated (Shonkoff & Phillips, 2000). See Appendix A, Measures, for information regarding the HOME Inventory.

The presence of maternal depression was measured by The Center of Epidemiological Studies-Depression Scale (CES-D) (Radloff, 1977). The CES-D is a 20 item, self-reporting screening tool that is intended for use in the general population, but has also been used in the perinatal period (Beeghly et al., 2002; Bozoky & Corwin, 2002; Carter, Baker, & Brownell, 2000). The scale asks the respondents how they felt or behaved during the past week using a 4-point rating scale ranging from 0 (rarely or none of the time/less than one day) to 3 (most or all of the time/5 – 7 days). Items in the scale elicited information about feelings and behaviors such as feeling sad, lonely, having crying spells, and having optimism about the future. The score is obtained by summing of each the questions, yielding a range of possible scores of 0 – 60. A score of 16 or more is indicative of depressive symptoms. Internal consistency for the CES-D has been reported to be 0.85 for the general population (Radloff, 1997) and 0.89 for a group of cancer patients (Hann, Winter, & Jacobson, 1999). A sample of the CES-D is provided in Appendix A.

Developmental outcomes were measured by the Bayley Scales of Infant Development-II (BSID-II) are widely used, standardized scales that provide a comprehensive assessment of developmental functioning of infants and young children. The scales are not only a means of describing normal development in children aged 12 –

24 months, but they are useful for diagnosing abnormal development in infants who are at risk for developmental delay (Black & Matula, 2000; Nellis & Gridley, 1994; Niccols & Latchman, 2002). The original version of the BSID was piloted in 1958 (Nellis & Gridley, 1994) and was subsequently standardized in 1969 (Bayley, 1969). The currently used Bayley scales, the BSID-II, are the product of a 1993 revision (Bayley, 1993). The intent of the revision was to improve the instrument's utility by integrating changes such as extending the age range for testing subjects, updating normative data, reducing bias, and improving clinical utility, validity, and reliability (Black & Matula, 2000, Nellis & Gridley, 1994; Niccols & Latchman, 2002).

The BSID-II consists of three scales: the Mental Scale, which yields the Mental Development Index (MDI) score, the Motor Scale, which yields the Psychomotor Index (PDI) score, and the Behavior Rating Scale (BRS), which provides a qualitative assessment the infant's orientation towards the environment (Nellis & Gridley, 1994). Items in the MDI and PDI are organized by chronological age and increase in difficulty as they progress through each set of items. The Mental Scale has 178 items that measure constructs such as language, object permanence, and problem-solving skills that are scored according to the child's age. For example, items on the Mental Scale for a one-month-old will measure how the infant responds to the examiner's voice or the ability to habituate to the sound of a rattle; measurements for a 12-month-old include turning pages in a book and demonstrating the ability to jabber expressively. The Motor Scale has 111 gross motor and fine motor items which are also scored according to the child's age. The ability to thrust arms and legs in play is an expectation for a one-month-old; to walk with

help and throw a ball are expectations of a 12-month-old (Bayley, 1993; Black & Matula, 2000).

The MDI and PDI are interpreted as standardized scores. The mean for both the MDI and PDI is 100 (S.D. = 15), which is the average score of all infants in the standardization sample used in the revision of the BSID-II. Scores between 85 and 115 are within normal limits (Black & Matula, 2000); mildly delayed performance is reflected in a score of 70 to 84, and significantly delayed performance is reflected in a score of 69 and below (Nellis & Gridley, 1994). The BRS provides a description of the infant's observed behavioral traits, and is scored after the child leaves the testing area. The examiner bases the BRS score on observations of the infant that are made during the administration of the Mental and Motor scales. It consists of 30 items that are rated on a 5-point scale. Measurements include items such as the child's predominant state, the degree of social engagement, attention toward tasks, and the ability to be soothed when upset. Any score greater than 25 on the BRS scale is considered to be within normal limits (Black & Matula, 2000). The BRS provides information that is essential to the accurate interpretation of the MDI and PDI, because infant state, temperament, and orientation toward the environment will affect motor and mental abilities (Brazelton & Nugent, 1995) and thus MDI and PDI scores. The BRS may therefore provide some insight into variations of the infant's performance as measured by these scales. Reliability for the BSID-II is reflected in average coefficient alpha scores for MDI, PDI, and BRS as 0.88, 0.84, and 0.88 respectively (Nellis & Gridley, 1994).

Two recent investigations examining the stability of the BSID-II across repeat assessments report modest scores, however. Niccols & Latchman (2002) investigated the

stability of MDI scores with a high-risk population that was initially assessed at 4 – 10 months of age and then reassessed at 17 – 22 months of age. They reported a coefficient alpha of 0.65 for infants with Down Syndrome and 0.37 for medically fragile infants. Harris and colleagues (2005) examined the stability of MDI and PDI scores with a sample of low-risk and high-risk infants. Their first assessment was at an average age of 7 months for the low-risk group and 7.79 months for the high-risk group; the reassessment occurred at an average age of 18.5 months for the low-risk group and 18.9 months for the high-risk group. They combined their sample and reported a stability coefficient of 0.49 for the MDI and 0.48 for the PDI. These studies are an important reminder that decisions about development should not be based on a single evaluation, but on repeat measures. See Appendix A for information about the BSID-II.

Statistical Analysis

The statistical analyses included descriptive and inferential statistics. The following techniques were chosen based on the nature of the identified research aims and questions, the number of independent and dependent variables, and the level of measurement used with each of the identified variables. The statistical tests included: (a) univariate analysis of factors; examining cases across one variable at a time, (b) One-Way ANOVA with a Scheffé post hoc analysis to examine whether there are significant differences between identified variables, (c) bivariate correlations to measure the association between two quantitative variables without distinction between the independent and dependent variable, and (d) multiple linear regression technique to produce the best combination of predictors of the dependent variable. All data were

analyzed by using the software package *Statistical Package for Social Sciences*, version 17 (SPSS, 2008).

Descriptive statistics (means, standard deviations, percentages) were computed to summarize the profile variables of race/ethnicity, gestational age, birth weight, Apgar scores, infant gender, and maternal age; and the study variables of maternal depression, characteristics of the home environment, and parent-child interaction. To examine the reliability of the measures Cronbach's alpha coefficients were generated and compared to the original coefficients as described in the literature.

A One-Way ANOVA was conducted with a Scheffé post hoc analysis to examine whether there are significant mean differences in the level of neurodevelopment based upon the categorical variables of (1) race/ethnicity, (2) marital status, (3) infant gender, (4) neonatal risk index, (4) mother's educational level, and (5) baby's father in home. This analysis was conducted to determine potential factors for later model development. This analysis is often used as a hypothesis testing procedure and seeks to determine if a difference exists, and if the difference is due to chance or sampling error, or whether or not the differences represent real differences in the population (Mertler & Vannatta, 2005).

- Aim 1. Describe the level of neurodevelopment in this group of high risk infants. Descriptive statistics (means, standard deviations, percentages) were computed to summarize the scores of the three BSID-II subscales at year 1 and year 2 of life.
- Aim 2. Examine the relationship between, gestational age, birth weight, Apgar scores, infant gender, maternal age, the presence of maternal depression,

characteristics of the home environment, parent-child interaction, and motor, mental, and behavioral development at year 1 and year 2 of life.

To examine the relationships among the variables, first a correlation matrix was constructed to identify the potential for multicollinearity, which can occur when there are moderate to high correlations among predictor variables. Predictor variables scrutinized for moderate to high correlations can possibly be deleted and one variable will be reported, or variables may be combined to represent one measure of a construct to delete repetition (Mertler & Vannatta, 2005).

A correlation is a single number that describes the degree of relationship between two variables (Munro, 2005). In probability theory and statistics correlation, it is also known as the correlation coefficient, a numeric measure of the strength of linear relationship between two random variables (Munro, 2005). Pearson's r was calculated as a measure of the linear relationship between two quantitatively measured variables. The value range for r is -1 to +1. When the correlation result is 0, there is no relationship between the variables. If the correlation is positive, the two variables have a positive relationship, so that when the value of one variable increases, the value of the other variable also increases. Negative r values indicate an inverse relationship. The strength of relationship is measured by r^2 the coefficient of determination. This method of statistical analysis was selected because the researcher did not wish to imply causation but is interested in the relationship of contributing variables to the independent variables. Explanation of relationships among interrelated predictor and outcome variables have been reported. The established p value was set at $p \leq 0.05$.

- Aim 3. Examine the influence that gestational age, birth weight, Apgar scores, infant gender, maternal age, the presence of maternal depression, characteristics of the home environment, and parent-child interaction have on infant neurodevelopmental outcome.

In order to examine the influence of the variables on neurodevelopmental outcome, multiple regression was performed. Regression techniques make use of the correlation between variables and permit predictions to be made from some known evidence to future events (Munro, 2005). Simultaneous multivariable regressions were computed for the purposes of this study.

Human Subjects

All study procedures, including protocols for recruiting participants and obtaining informed consent were reviewed and approved by the appropriate institutional review boards, including Children's Hospital and Health Center - San Diego, San Diego State University, Sharp Mary Birch Hospital, University of San Diego, and the University of California San Diego, for the original investigators. The proposal was submitted with a letter of authorization for the use of the data by this investigator, from Dr. John Landsverk, Principal Investigator to the Institutional Review Board of the University of San Diego. See Appendix B.

De-identified data was provided on an external storage device for review and analysis purposes. The data collection tools were kept locked in a secure location by the original investigators, and made available to this researcher. All participants were coded by numbers rather than by names, and the original investigators kept the names separately from the coded data tools to maintain anonymity. There were no potential physical,

psychological, or social risks to the subjects in this secondary analysis. A copy of the University of San Diego Institutional Review Board Project Action Summary is provided in Appendix C.

Chapter IV

Results

The purpose of this study was to examine factors that predict neurodevelopmental outcomes of infants who are at risk for altered development. Predictor variables that were examined include: gestational age, birth weight, Apgar scores, infant gender, maternal age at the time of the child's birth, the presence of maternal depression, characteristics of the home environment, and parent-child interaction. This chapter presents the study findings. First a descriptive profile of the sample, scale reliabilities, scores on the independent measures of parent child interaction, maternal depression, and home environment, and selected demographics are presented. Following this, the results related to the specific research aims will be presented.

Study Profile

Maternal Profile

The sample was diverse in terms of race and ethnicity. Approximately half (46.3%) identified themselves as Hispanic: 27% Hispanic/English speaking and 19.3% Hispanic/Spanish speaking; 24.2% were Caucasian, 19.5% were African American, and

10.2% identified as Asian or belonging to another ethnic group. The mothers' age at the time of birth ranged from 14 to 42 years of age, with a mean age of 23.52 (SD = 6.01). Almost half (49%) had a CESD score greater than 16 at baseline. Although almost everyone in the sample had some level of formal education, the overall educational level in this sample is relatively low. The majority of the sample had some primary education (76%), and 21.5% stated that they either graduated from high school or obtained a GED. Twenty-four percent had attended college; however, just 17% had earned either an associate or bachelor's degree. The vast majority of the mothers in this sample identified themselves as single (77.3%), although half (50.8%) stated that the father of the baby was in the home (Table 3).

Table 3. Characteristics of the Sample: Maternal (N = 488)

Characteristic	N	%	M (SD)
Age (at time of birth)	488		23.52 (6.01)
Race/ethnicity			
Hispanic/English speaking	131	26.8	
Hispanic/Spanish speaking	94	19.3	
Caucasian	118	24.2	
African American	95	19.5	
Asian/other ethnic group	50	10.2	
CESD (baseline)			
< 16	249	51	
≥ 16	239	49	
Education			
None	2	0.4	
Nursery – 8 th	63	12.9	
9 th – 12 th	200	41	
HS Graduate/GED	105	21.5	
Some college/No degree	98	20.1	
AA degree	13	2.7	
Bachelor's degree	7	1.4	
Marital Status			
Married	71	14.5	
Single	377	77.3	
Divorced	24	4.9	
Separated	11	2.3	
Widowed	2	0.4	
Unknown	3	0.6	
Father of baby in home			
Yes	244	50.8	
No	236	49.2	

Infant Profile

Forty-nine percent of the infants in the sample were male. Gestational age showed a fairly wide range of 26 weeks to 42 weeks, with a mean gestational age of 38.74 weeks ($SD = 2.04$). There was a large variation in birth weight, which ranged from 1030 g to 5216 g. The mean birth weight was 3299.52 g ($SD = 555.23$). Mean 1 minute Apgar was 8.18 ($SD = 1.17$) and 8.92 ($SD = 0.39$) at 5 minutes, indicating that most of the infants did not have great difficulty transitioning from intrauterine to extrauterine life. Thirteen were transferred to the NICU. Infants were also described in terms of a Neonatal Risk Index, which is a composite variable where biological risk indicators were grouped for statistical control in data analysis. The variables in the index include birth weight of less than 2,500 g, gestational age of less than 37 completed weeks' gestation, an Apgar score of less than 7, and admission to NICU. Infants were given a score from 0 – 4, depending on how many of these risk factors the infant had. The vast majority (92%) of these babies had no biological risk factors as defined by this risk index (Table 4).

Table 4. Characteristics of the Sample: Infant (N = 488)

Characteristic	N	%	M (SD)
Gender			
Male		49	
Female		51	
Gestational age (weeks)	482		38.74 (2.04)
Birth weight (g)	482		3299.52 (555.23)
Apgar score			
1 minute	481		8.18 (1.17)
5 minutes	482		8.92 (0.39)
NICU Admit			
Yes	13	2.7	
Neonatal Risk Index 0 – 4			
0 risk factors	450	92.2	
1 risk factor	22	4.5	
2 risk factors	13	2.7	
3 risk factors	2	0.4	
4 risk factors	1	0.2	

Reliability of Measurements

For a measurement to be useful in clinical research, it is essential that the measurement generates data that is an accurate indicator of the behavior or attribute that is being measured. A measurement is reliable when it is consistent and free from error (Portney & Watkins, 2000). In order to assess reliability, Cronbach's Alpha coefficient was calculated for all measurements used in this study. A coefficient below .50 represents poor reliability, coefficients from .50 – .75 represent moderate reliability, and coefficients above .75 indicate good reliability. Cohen (1988) argues Cronbach alpha reliability < .70 indicates lack of consistency of responses and low reliability. Portney and Watkins (2000) assert the general principle that measurements utilized for decision making or diagnosis should demonstrate higher reliability than measurements that are used for descriptive purposes. As detailed in the Cronbach's alpha values listed in Table 5, all of the scales demonstrated moderate to good reliability.

Table 5. Measure Reliabilities

<i>Measure</i>	<i>Mean (SD)</i>	<i>Alpha</i>
CESD		
Baseline	17.1 (9.92)	0.68
Year 1	15 (9.9)	0.84
Year 2	14.3 (9.6)	0.79
NCAST		
Year 1	53.79 (8.86)	0.87
Year 2	54.46 (6.97)	0.79
HOME		
Year 1	35.42 (6.35)	0.86
Year 2	34.61 (5.18)	0.76
BSID-II BRS		
Year 1	110.35 (12.40)	0.93
Year 2	109.34 (13.17)	0.92
BSID-II MDI		
Year 1	103.98 (10.85)	0.92
Year 2	91.31 (11.62)	0.92
BSID-II PDI		
Year 1	113.10 (12.38)	0.89
Year 2	97.98 (13.75)	0.93

The following analyses were conducted to determine potential factors for model development.

Analysis of Variance (ANOVA)

One-way analysis of variance (ANOVA) was conducted to examine whether there were statistically significant differences in the dependent variable mean scores by race/ethnicity, marital status, mother's education, child's gender, and neonatal risk index. ANOVAs resulting in significant F values were followed by Scheffé post hoc comparisons for more than two groups to determine which specific conditions were significantly different.

Statistically significant differences in mean scores of Y2 BRS $F(4, 351) = 2.65, p < .05$, Y2 PDI $F(4, 368) = 3.73, p < .01$, Y2 MDI $F(4, 368) = 6.74, p < .01$ by race/ethnicity were found. Scheffé post hoc comparisons revealed none of the categories were significantly different.

Statistically significant differences in mean scores of Y2 BRS $F(5, 350) = 2.18, p < .05$ and a trend toward significance in Y2 PDI $F(5, 367) = 2.14, p = .06$ by marital status was found. Post hoc test revealed none of the groups were significantly different.

Statistically significant differences in mean scores of Y2 BRS $F(1, 354) = 11.39, p < .01$, and Y2 MDI $F(1, 371) = 22.23, p < .01$ by child gender was found. Female children had higher mean behavior ($M = 111.64, SD = 11.89$) and MDI scores ($M = 93.89, SD = 10.79$) than males ($M = 106.99, SD = 14.02$); ($M = 88.39, SD = 11.73$) respectively. There were no statistically significant differences on any of the Y1 or Y2 BSID-II mean scores by neonatal risk or mother's education status.

Correlations

A correlation matrix was computed to (1) check for multicollinearity and to (2) identify relationships between predictors and outcome variables. The degree of intercorrelation between

predictor variables is important to determine, because if these variables are highly correlated they are essentially measuring much of the same phenomenon. This would limit the ability of these variables to predict the true relationship to the outcome variables (Mertler & Vannatta, 2005).

Multicollinearity was not demonstrated in this group of variables (Table 6).

Table 6. Correlations of Child Development Subscales

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Y2BRS	-														
Y2MDI	.49**	-													
Y2PDI	.44**	.35**	-												
Y1BRS	.14**	.23**	.19**	-											
Y1MDI	.24**	.37**	.12*	.34**	-										
Y1PDI	.05	.16**	.11**	.20**	.50**	-									
BLCESD	.00	-.09	.01	-.08	-.12*	-.01	-								
Y1CESD	.01	-.08	-.01	-.05	-.03	.00	.45**	-							
Y2CESD	-.02	-.01	.00	-.04	-.09	-.00	.32**	.47**	-						
MAGE	.01	.03	.10*	.02	-.04	.02	.00	-.06	.06	-					
Y1NCAST	.13*	.24**	-.02	.08	.24**	.00	-.12*	-.09	-.07	.07	-				
Y2NCAST	.29**	.29**	.10	.16**	.23**	.09	-.04**	-.00	-.07	.06	.22**	-			
Y1HOME	.07	.23**	-.05	.11*	.12*	.03	-.12*	-.19**	-.11**	.14**	.48**	.24**	-		
Y2HOME	.24**	.30**	.11*	.10	.22**	.11*	-.19**	-.13**	-.13**	.11*	.31**	.33**	.48**	-	
BW	-.02	.00	-.06	.00	.10*	.14**	-.06	-.07	.00	.08	.00	.01	.06	.06	-
GEST	.09	.05	.05	-.00	.16**	.16**	-.10*	-.09	-.02	.04	.05	.04	.05	.11*	.65**

Note: * $p \leq .05$ ** $p \leq .01$ Y1 = measurement at 1st year of life Y2 = measurement at 2nd year of life MAGE = Mother's age at delivery

Significant correlations were found between Y2 BSID-II BRS scores and Y2 NCAST ($r = .16, p < .01$), Y1 HOME scores ($r = .11, p \leq .01$), Y1 BRS scores ($r = .14, p < .05$), Y1 MDI ($r = .34, p < .01$), Y1 PDI ($r = .20, p < .01$), and infant gender ($r = .22, p < .01$). Y2 BSID-II

MDI scores were significantly correlated with Y1 NCAST scores ($r = .24, p < .01$), Y2 NCAST scores ($r = .29, p < .01$), Y1 HOME scores ($r = .23, p < .01$), Y2 HOME scores ($r = .30, p < .01$), Y1 BRS scores ($r = .23, p < .01$), Y1 MDI scores ($r = .37, p < .01$), Y1 PDI scores ($r = .20, p < .01$), and infant gender ($r = .33, p < .01$). Y2 BSID-II PDI scores were significantly correlated with Y2 HOME ($r = .11, p < .05$), Y1 MDI scores ($r = .12, p < .05$), Y1 PDI scores ($r = .11, p < .05$), infant gender ($r = .13, p < .05$), and mother's age at delivery ($r = .10, p < .05$). These correlation results are summarized in Table 7.

Table 7. Intercorrelations Between Predictor and Outcome Variables

	Y2 BRS	Y2 MDI	Y2 PDI
Y1 NCAST	NS	.24**	NS
Y2 NCAST	.16**	.29**	NS
Y1 HOME	.11**	.23**	NS
Y2 HOME	NS	.30**	.11*
BL CESD	NS	NS	NS
Y1CESD	NS	NS	NS
Y2CESD	NS	NS	NS
Y1 BRS	.14*	.23**	NS
Y1 MDI	.34**	.37**	.12*
Y1 PDI	.20**	.16**	.11*
Gestational Age	NS	NS	NS
Birth Weight	NS	NS	NS
Apgar	NS	NS	NS
NICU Admit	NS	NS	NS
Infant Gender	.22**	.33**	NS
MAGE	NS	NS	.10*

Note: * $p \leq .05$ ** $p \leq .01$

Y1 = measurement at 1st year of life
 Y2 = measurement at 2nd year of life
 MAGE = mother's age at delivery

Regression Analysis

Simultaneous multiple regression was conducted to determine the degree to which the independent variables of maternal depression, maternal age at birth, parent-infant interaction, home environment, infant gender, gestational age, birth weight, and BSID-II developmental outcomes measured at year 1 predict neurodevelopmental outcomes. Regression results indicate that the model significantly predicted all three BSID-II developmental outcomes measured at year 2 (Table 8).

Mental Development

The model explained 34% of variance in the Y2 BSID-II MDI: $R^2 = .343$, $R^2 \text{ adj} = .299$, $F(14, 208) = 7.751$, $p = .000$. Y1 MDI scores, Y2 NCAST scores, and infant gender significantly contributed to the model. A summary of regression coefficients for Y2 BSID-II MDI is presented in Table 8.

Motor Development

The model explained 16% of variance in the Y2 BSID-II PDI: $R^2 = .163$, $R^2 \text{ adj} = .107$, $F(14, 208) = 2.896$, $p = .001$. Y1 PDI scores, Y1 BRS scores, birth weight, and infant gender significantly contributed to the model. A summary of regression coefficients for Y2 BSID-II PDI is presented in Table 8.

Behavioral Development

The model explained 20% of variance in the Y2 BSID-II BRS: $R^2 = .201$, $R^2 \text{ adj} = .144$, $F(14, 198) = 3.548$, $p = .000$. Y2 NCAST scores, Y2 HOME scores, birth weight, gestational age, and infant gender significantly contributed to the model. A summary of regression coefficients for Y2 BSID-II PDI is presented in Table 8.

Table 8. Regression Models for Child Development Subscales

	Year 2 BRS		Year 2 MDI		Year 2 PDI	
	<i>r</i>	Beta	<i>r</i>	Beta	<i>r</i>	Beta
Y1 BRS	.14**	.04	.23**	.09	.19**	.21**
Y1 MDI	.24**	.05	.37**	.16*	.12**	-.13
Y1 PDI	.05	-.01	.16**	.11	.11**	.17*
CESD Baseline	.00	.06	-.09	-.02	.01	.01
Y1 CESD	.00	-.06	-.08	-.00	-.01	-.03
Y2 CESD	-.02	.11	-.01	.03	.00	.06
MAGE	-.01	-.01	.03	.02	.10*	.11
Y1 NCAST	.13*	-.00	.24**	.02	-.02	-.05
Y2 NCAST	.29**	.22**	.29**	.18**	.10	.08
Y1 HOME	.07	-.03	.23**	.13	-.05	-.05
Y2 HOME	.24**	.19**	.30**	.12	.11*	.05
Birth Weight	-.02	-.20	.00	-.06	-.06	-.23**
Gestational Age	.09	.20*	.05	.04	.05	.17
Child Gender	.22**	.14*	.33**	.25**	.13*	.16*
	N = 212		N = 223		N = 223	
	R ²	.20	.34	.16		
	Adjusted R ²	.14	.30	.11		
	F	3.55**	7.75**	2.90**		
Note:	* p ≤ .05		** p ≤ .01			
	MAGE = Mother's age at delivery					
	Y1 = measurement at 1 st year of life					
	Y2 = measurement at 2 nd year of life					

Chapter V

Discussion

The purpose of this descriptive, correlational study was to examine the influence of selected predictor variables on neurodevelopmental outcomes of infants who are at risk for altered development. Guided by the Synactive Theory of Development (Als, 1982), this study sought to identify the degree to which the forces of nature, nurture, and niche shape developmental outcomes. This chapter presents the significance of the study to society and to the nursing profession, the strengths and limitations of the study, and suggestions for future research.

Significance of Research Findings

The ontogenetic journey of a new life is fascinating, yet it remains partially shrouded in mystery. Continued efforts to uncover the secrets of early development have resulted in an ever-growing knowledge base that has informed current best practices in the care of infants, young children, and their families. Critical gaps in this knowledge base still exist, however. Areas that require further clarification include issues such as: Which social and biological risk factors should be the primary focus of prevention and intervention for children and families at risk? Which children are best served by

interventions that support development, and at what point during development would prevention and intervention be most effective? How can areas of resilience be identified and supported? How are developmental outcomes best measured and interpreted for each child? What is the most useful framework for understanding the complex interplay between risk factors, protective factors, cumulative burdens, individual vulnerability and resilience, and the heterogeneity of children and families? What role do genomics and epigenetics play in determining developmental trajectories?

This study sought to further clarify which social and biological risk factors are most predictive of neurodevelopmental outcomes. These factors would then serve as focal points for preventative and interventional strategies to support child development. It is this researcher's conviction that refining knowledge of infant development in this way can provide the basis for enabling families to effectively nurture their infants and young children. This will support the healthy development of each individual child, enhance the quality of family life, and contribute to the health and sustainability of society at large. Further, the ability to identify and eradicate risks to child development can decrease human suffering and decrease societal burdens of reduced productivity and increased cost of special services needed to support impaired families and their children.

The discussion that follows describes the significance of each of the research aims. Following this, suggestions for further research and the relevance to the profession of nursing will be discussed.

Aim 1

The first aim of the study was to describe the level of neurodevelopment in this group of high risk infants. Mean scores of all three scales that compose the BSID-II

indicated that at year 1 of life this particular group of infants was functioning within normal limits in terms of mental, motor, and behavioral performance: Y1 PDI = 113.10 ($SD = 12.38$); Y2 PDI = 97.13 ($SD = 13.75$); Y1 MDI = 103.98 ($SD = 10.85$); Y2 MDI = 91.31 ($SD = 11.62$); Y1 BRS = 110.35 ($SD = 12.40$); Y2 BRS = 109.34 ($SD = 13.17$). There were statistically significant changes in the PDI $t(353) = 17.19, p < .001$ and MDI $t(353) = 18.86, p < .001$, scores between year one and year two of life but not for the BRS. This is important to note. Some of the risk factors demonstrated the ability to produce variance in infant functioning, but these factors did not generate a significant degree of impairment in infant functioning as measured by the BSID-II. As discussed in detail below in relation to other study aims, this is an unexpected finding. Based on current knowledge of child developmental risk factors, it could be expected that the children of the families in the study who were identified as high risk for altered parenting would not score within normal limits on the BSID-II.

Aim 2

This study also sought to describe the relationship between gestational age, birth weight, Apgar scores, infant gender, maternal age, the presence of maternal depression, characteristics of the home environment, parent-child interaction, and motor, mental, and behavioral development. A correlation matrix was computed to identify relationships between all pairs of variables (Table 6). Although there are no strict cut-off points, as a general rule correlations that range from .00 to .25 suggest that there is little or no relationship; correlations ranging from .25 to .50 indicate a fair degree of relationship; correlations ranging from .50 to .75 suggest a moderate to good relationship, and correlations above .75 indicate a good to excellent relationship (Portney & Watkins,

2000). Intercorrelations between predictor and outcome variables showed significant correlations ranging from .1 to .37. Although these correlations are relatively small, most were significant at the level of $p \leq .01$. Portney & Watkins (2000) suggest that studies examining social and behavioral phenomena accept lower correlation values as evidence of functionally useful relationships.

There were significant positive relationships between Y2 BRS scores and the Y1 BRS, MDI, and PDI scores. It would be expected that neurodevelopmental scores at the first year of life would be related to behavioral scores at the second year of life. In addition, Y2 NCAST, Y1 HOME, and child gender demonstrated significant positive relationships to Y2 BRS scores. Based on current literature, this is not a surprising result. As detailed below, each of these variables have clear associations with child developmental outcomes (see Aim 3 discussion).

There were significant positive relationships between Y2 MDI scores and the Y1 BRS, MDI, and PDI scores. Again, it would be expected that neurodevelopment at the first year of life would be related to mental scores at the second year of life. In addition, Y1 and Y2 NCAST, Y1 and Y2 HOME, and child gender demonstrated significant positive relationships to Y2 MDI scores. The literature clearly supports associations between these variables and child developmental outcomes (see Aim 3 discussion).

There were significant positive relationships between Y2 PDI scores and Y1 MDI, PDI, and BRS scores. In addition, Y2 HOME the mother's age at delivery, and infant gender demonstrated a significant positive relationship to Y2 PDI scores. It is also surprising that maternal age at delivery was positively correlated with the PDI scale and not the MDI or BRS scales at year one or year two. Maternal age at delivery was

significantly and positively correlated with Y1 HOME and Y2 HOME. Associations between increased maternal age and an enhanced child-rearing environment are supported in the literature (Fergusson & Woodward, 1999; Viau, Padula, & Eddy, 2002).

It is not surprising that 49% of this sample reported depressive symptomatology, given that depressive disorders are surprisingly common (Lepine, 2001; Moussavi et al., 2007). Although maternal depression was not directly correlated with the outcome variables, baseline CESD scores at baseline, Y1, and Y2 were significantly inversely correlated with Y1 and Y2 HOME scores. Baseline CESD scores were significantly inversely correlated with Y1 and Y2 NCAST scores. These associations are supported in current literature. Depressive symptomatology creates the potential for deleterious effects on family functioning and infant growth and development. Negative maternal affect, irritability, and social withdrawal can inhibit maternal sensitivity and responsiveness, which are essential elements in healthy mother-infant interaction and a supportive home environment (NICHD Early Child Care Research Network, 1999; Sohr-Preston & Scaramella, 2006).

Aim 3

The final aim of this study was to describe the influence that gestational age, birth weight, Apgar scores, infant gender, maternal age, the presence of maternal depression, characteristics of the home environment, and parent-child interaction have on infant neurodevelopmental outcome. Simultaneous multiple regression was conducted to determine the degree to which these independent variables predict neurodevelopmental outcomes. Regression results indicate that the model significantly predicted all three BSID-II developmental outcomes measured at year 2, explaining the variance in BSID-II

scores. The level of variance differs between scales. Infant gender significantly contributed to variance in all three scales.

Mental Development

The model explained 34% of variance in the Y2 BSID-II MDI: $R^2 = .343$, $R^2 \text{ adj} = .299$, $F(14, 208) = 7.751$, $p = 0.000$. Y1 MDI scores, Y2 NCAST scores, and infant gender significantly contributed to the model. Scores for Y1 MDI, Y2 NCAST, and infant gender significantly contributed to the model. It would be expected that Y1 MDI scores would contribute to Y2 MDI scores. Also, it would be expected that Y2 NCAST scores would contribute to mental development. The NCAST measures the characteristics interactions between the caregiver and child. Parenting behaviors set the tone for the developmental environment and for the parent-infant relationships that are nurtured within that environment (Collins et al., 2000; Kelly & Barnard, 2000). Ideally, parent-infant interactions are characterized by parental emotional availability and responsiveness as well as reciprocal and synchronous interchanges between parent and child. During this process, cortical cytoarchitecture and neuronal wiring is shaped by this social environment, giving rise to mental developmental processes (Westrup, 2005).

The fact that infant gender contributed significantly to mental development is also not unexpected. There is an ever-increasing body of evidence that points to gender as a key contributor to the processes of early childhood development. Numerous gender differences have been found in such clinical data as mortality rates functional outcomes (Tioseco et al., 2006; Vohr et al., 2000; Wood et al., 2005). Current evidence points to gender-specific pathways to neuronal growth and death (Du et al., 2004), suggesting that growth and risk pathways are initiated differently in boys than in girls. These discrete

elements may also have significance to how the child interacts with the environment (Carter et al., 2001). The mysteries of these gender differences are still being uncovered.

This study identified certain factors that made a significant contribution to 34% of observed variance in neurodevelopmental outcomes. Yet, much of the phenomenon of mental development remained unexplained. One explanation is that there are other variables that were not measured in this study that would have greater explanatory power and would therefore add to the variance in BSID-II scores. An additional explanation has to do with the innate complexity of human development and behavior. The developing child both shapes and is shaped by numerous factors over the course of time. Numerous risk factors from various domains may occur either consecutively or simultaneously. These risk factors may be either exacerbated or ameliorated by innate child characteristics as well as elements of the family system (Zenah, 1997). Identification of risk factors provides useful information, but the information has limitations. A more complete picture would be produced if one could determine exactly how these individual factors interact among themselves and with the unique attributes of each child and family. This is a knowledge gap that is a challenge to bridge. This present study did not attempt to unravel the specifics of this particular mystery.

Motor Development

The model explained 16% of variance in the Y2 BSID-II PDI: $R^2 = .163$, $R^2 \text{ adj} = .107$, $F(14, 208) = 2.896$, $p = 001$. Y1 PDI scores, Y1 BRS scores, birth weight, and infant gender significantly contributed to the model. It is not surprising that Y1 PDI scores and Y1 BRS scores contributed to motor development at year 2 of life. Also, as previously discussed, evolving research on the topic of gender differences is beginning to

establish gender as a key contributor to early developmental patterns. It appears that at least some of these gender differences occur at the cellular level, thus contributing to how the young child interacts with the world around him or her.

Birth weight was a significant contributor to motor development. This is supported by evidence that demonstrates that infants whose intrauterine growth patterns are outside normal limits are at risk for a broad spectrum of short-term and long-term negative sequelae (Bukowski, 2004; Das & Sysyn, 2004; Jarvis et al., 2003). Since birth weight and gestational age usually have a parallel relationship, it is surprising that gestational age did not also contribute to motor developmental outcomes.

Y1 PDI scores, Y1 BRS scores, birth weight, and infant gender significantly contributed to the model, but only explained 16% of the variance observed in neurodevelopmental outcomes. This leaves 84% of the variance unexplained. As with mental development, this analysis suggests that there are other variables that were not measured in this study that would have greater explanatory power and would therefore add to the variance in Y2 PDI scores. Another important factor is the challenge that human development and behavior presents. Numerous risk factors from various domains may occur either consecutively or simultaneously, which are altered by unique attributes of each child and family. This study did not attempt to measure this complex phenomenon.

Behavioral Development

The model explained 20% of variance in the Y2 BSID-II BRS: $R^2 = .201$, $R^2 \text{ adj} = .144$, $F(14, 198) = 3.548$, $p = .000$. Y2 NCAST scores, Y2 HOME scores, birth weight, gestational age, and infant gender significantly contributed to the model. Unlike mental

and motor development, none of the BSID-II scales measured at year 1 significantly contributed to behavioral development at year 2. This is an unexpected finding, especially when considering the BRS scoring process. In contrast to the BRS, both the MDI and PDI scales are scored by the examiner using specific age-appropriate items. The MDI has 178 items that measure constructs such as language and problem-solving skills, and the PDI has 111 gross and fine motor items. The MDI and PDI scores provide a quantitative index which is interpreted as standardized scores. The BRS has 30 items that provide a qualitative assessment of the infant's orientation toward the environment, based on descriptions of behavioral traits observed during the administration of the MDI and PDI scales. The examiner scores these items after the child leaves the testing area. Knowing this, it might be expected that the MDI and PDI would contribute to the BRS in this analysis. This expectation, however, was not observed.

Both gestational age and birth weight significantly contributed to behavioral development. This is not a surprising result in light of the predictable parallel relationship between gestational age and birth weight.

Y2 NCAST and Y2 HOME scores significantly contributed to behavioral development, a finding that is supported by previous research. The NCAST measures the characteristics of caregiver interactions with the child, which includes parental responsiveness to the child. The HOME measures the degree of structure, stimulation, and support that is available in the home environment. Although these scales measure diverse constructs, both of these scales measure emotional and verbal responsiveness of the caregiver. Parental responsiveness denotes the parent's ability to recognize infant cues and to consistently respond to them (Karl, 1995). This particular construct builds

reciprocal and synchronous processes that help the developing child understand self and others, which is a necessary ingredient for social interaction and behavior (Lamb, Bornstein, & Teti, 2002). In addition, the HOME is a measure of the socio-cultural milieu where early development and socialization takes place (Bronfenbrenner & Ceci, 1994). This social environment is a powerful predictor of neurodevelopmental outcome, including behavioral traits (Miceli, 2000; Msall & Park, 2008).

Infant gender significantly contributed to the model for all three scales, an expected finding supported by an ever-increasing body of evidence. Gender is a complex trait that is deeply embedded in biological and socio-cultural phenomena. Gender-specific pathways to growth and development are currently fascinating and highly relevant topics of research.

The model explained 20% of variance in the Y2 BSID-II BRS, leaving 80% of the variance unexplained. As with the MDI and PDI scales, where a portion of the variance was explained, one must consider that there are other variables that were not measured in this study that would have greater explanatory power. Also relevant is the complexity of human development and behavior that dictates a large degree of heterogeneity in how individual infants, children, and families experience these specific factors.

It was somewhat surprising that CESD scores did not directly affect BSID-II scores. However, one can posit that because CESD scores were significantly correlated with Y1 and Y2 NCAST scores and with Y1 and Y2 HOME scores, that the effects of depression may have been manifested in parent-infant interactions and the quality of the home environment – variables which did directly contribute to the regression models. Another explanation may be that the CESD scale did not completely measure depression

in this group. The statistical outcome may have been different if an alternative depression scale was utilized.

Strengths and Limitations of the Study

The large, ethnically diverse data base gave this study two important strengths: (1) sufficient statistical power to uncover significant phenomena if they do exist, and (2) the ability to generalize the study findings to larger populations (Kerlinger & Lee, 2000). Another significant strength of this study is that the outcome data was derived from a longitudinal investigation, which allows this researcher the ability to utilize data that reflects growth and change of the same individuals over time. Because the cumulative effects of factors are potent determinants of outcomes (Institute of Medicine, 2000b), data from a longitudinal study offers a distinct advantage to answer questions relating to neurodevelopmental outcomes. Additionally, a longitudinal study is typically a time-consuming and expensive research design. Using this data base allowed this researcher the opportunity to uncover relevant facts about the population without the expenditure of additional time and expense.

Certain limitations of the study should also be noted. Although the data base provided the study with significant strengths, using an existing data base for secondary analysis has certain limitations, as described previously.

An additional limitation to this study is one that is fundamental to studies examining phenomena as complex as human development and human behavior. This study looked at neurodevelopmental outcomes at two years of age. Saigal & Rosebaum (2007) make the assertion that more subtle impairments may emerge later in life when at risk children are presented with a more complex assortment of demands that may be

found in diverse academic and social settings. The study findings should be appreciated as relevant for children at year two of life, with the understanding that there is a likelihood of continued change over time.

Future Research

The findings from this study provide the basis for additional research relating to the forces that shape developmental outcomes. Future research may focus on the factors in this study that were shown to be most predictive of neurodevelopmental outcome. Research efforts could focus on determining which of these risk factors are most amenable to preventative and interventional strategies, and identifying the stage of development where these strategies would be most effective. In addition, research that clarifies factors related to maternal role attainment and family vulnerability and resilience would serve this population well.

This study identified several factors that were predictive of neurodevelopmental outcomes in this group of high risk infants. However, much of the effects were unexplained by the variables tested in this study. Although the inclusion of these variables in the model was supported by current evidence, future research should attempt to develop a more complete model with greater explanatory power in predicting neurodevelopmental outcomes. In addition, this population would be well-served by a deeper understanding of the process by which numerous risk factors from various domains interact with each other over time, and how they are either exacerbated or ameliorated by unique attributes of the individual child and the family system.

Infant gender significantly contributed to variance in all three scales. Further research is required to more fully appreciate how gender differences interact with innate

biological characteristics as well as the social system in which the young child is nurtured. Clarification of the role of genomics and epigenetics vis-à-vis developmental trajectories, gender, and other relevant factors would provide a useful evidence base on which to build best practices for the childbearing family.

This study utilized BSID-II to measure neurodevelopmental outcome. The BSID-II is a widely used standardized scale that provides a comprehensive assessment of developmental functioning in infants and young children. The scale measures mental, motor, and behavioral attributes, which are valid measures of child competence. Current thought advocates that, in addition to evaluation of these traditional competencies, assessment of self-regulation and early relationships be evaluated in greater detail. This would entail a focus on such elements as feeding, sleep, crying, and attachment to the primary caregiver (Institute of Medicine, 2000b). Future research should focus on the most effective way to measure and interpret a wide array of developmental outcomes.

Implications for Nursing Practice

Nurses have intimate contact with infants, young children, and their families so are able to positively influence developmental health in numerous ways. The findings of this study identified factors that have a significant impact on developmental trajectories of infants. This knowledge can be integrated into daily bedside practice, advocacy for policy and program development on all levels, and the education of interdisciplinary professionals, new nursing graduates, and nursing students.

Parent-child interaction significantly contributed to both motor and mental development. Promoting early infant-parent contact as soon as possible after birth is an effective means to support bonding and attachment processes, which can positively affect

the future parent-child relationship. Hospital routines are often disruptive to early parental contact with their newborns. Nurses can use current evidence to advocate for a change in hospital routines when dealing with the birth of healthy infants, thereby keeping the mother and her newborn together as much as possible. The simple practice of placing mother and baby skin-to-skin after delivery can result in numerous positive effects, including increased infant neurophysiological organization, increased likelihood of breastfeeding, and feelings of increased parental competence. Skin-to-skin contact can also be utilized in the NICU once infants have been stabilized. Until this practice can be utilized, the nurse can encourage parents of sick infants to see and touch their newborns. In this situation, it is also important for the nurse encourage the mother to provide breast milk for her baby. Encouraging breastfeeding can not only support the mother to take on the maternal role, but it can decrease maternal anxiety and is protective against depression (Díaz-Rossello & Ferreira-Castro, 2008; Martínez, 2007).

Nurses can model best practice in parent-infant care, and can advocate for policy change at the level of the facility where the nurse is employed. On a broader scale, the nursing profession can advocate for social policy and legislation at the local, state, and federal level that protects the integrity of the mother-baby dyad and the family unit as a whole. It should be recognized that nurturing children is a shared responsibility of the family, health care professionals, the community, and governmental agencies (Gomes-Pedro, 2002; Institute of Medicine, 2000a).

Nurses can advocate for the support of women as they meet multiple family and professional demands. Women, whether with a partner or single, are most often the primary caregivers of children. At the same time, 56% of women with children under the

age of 3 are employed outside the home (U.S. Department of Labor, 2007). Maternal employment can result in enhanced sense of self-worth for the mother, while at the same time creating internal conflict as the woman redefines her professional goals in the context of motherhood (Nelson, 2003). Flexible work scheduling, on-site child care, and employer support for lactation are examples of ways to support mothers and their young children. In addition, nurses should advocate for the availability of affordable, safe, and developmentally appropriate child care.

Funding for public health infrastructure, child protection, and child education initiatives should be supported by the nursing profession. Nurses can advocate for health care reform that would ensure coverage of family counseling and mental health services. Nurses involved in primary care can screen for maladaptive family dynamics. Screening for domestic violence for all women and postpartum depression at well-baby visits and obstetric follow-up visits are just two examples of where nurses can promote family integrity.

In sum, nurses are in an excellent position to meet the moral imperative of creating a benevolent and supportive society for infants, young children, and their families. Informed by the findings of this and other studies relating to child health, nurses can advocate for a professional and societal commitment to the health and stability of families. By doing so, the profession can positively impact infant developmental processes, enhancing the quality of life for all.

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APPENDIX A: MEASURES

Information regarding the Nursing Child Assessment Satellite Training (NCAST) scale is available at:

NCAST Programs
University of Washington
Box 357920
Seattle, WA 98185-7920
Phone: (206) 543-8528
FAX (206) 685-3284
www.ncast.org

APPENDIX A: MEASURES, continued

Information regarding the Home Observation for Measurement of the Environment

(HOME) Inventory is available at:

HOME Inventory LLC, Distribution Center

2627 Winsor Drive

Eau Claire, WI 54703

Phone: (715) 835-4393

www.ualr.edu/crtldept/home4.htm

APPENDIX A: MEASURES, continued

Center for Epidemiologic Studies Depression Scale
(CES-D)

During the Past Week:		Rarely or none of the time (< 1day)	Some or a little of the time (1 – 2 days)	Occasionally or a moderate amount of the time (3 – 4 days)	Most or all of the time (5 – 7 days)
1.	I was bothered by things that usually don't bother me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.	I did not feel like eating; my appetite was poor.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.	I felt that I could not shake off the blues even with the help of my family or friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.	I felt that I was just as good as other people.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.	I had trouble keeping my mind on what I was doing.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.	I felt depressed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.	I felt that everything I did was an effort.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8.	I felt hopeful about the future.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9.	I thought my life had been a failure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10.	I felt fearful.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11.	My sleep was restless.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12.	I was happy.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13.	I talked less than usual.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14.	I felt lonely.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15.	People were unfriendly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16.	I enjoyed life.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17.	I had crying spells.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18.	I felt sad.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19.	I felt that people dislike me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20.	I could not get "going."	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Scoring: zero for answers in the first column; 1 for answers in the second column; 3 for answers in the fourth column. The scoring of positive items is reversed. Possible range of scores is zero to 60, with higher scores indicating the presence of more symptomatology.

APPENDIX A: MEASURES, continued

Information regarding the BSID-II is available at:

Pearson Assessments

19500 Bulverde Rd.

San Antonio, TX 78259-3701

Phone: 800-627-7271

FAX: 800-232-1223

<http://psychcorp.pearsonassessment.com>

APPENDIX B:**Child & Adolescent Services Research Center**

3020 Children's Way • MC 5033 • San Diego, California 92123-4282
(858) 966-7703 • FAX (858) 966-7704 • www.casrc.org

October 1, 2008

Institutional Review Board
University of San Diego
5998 Alcalá Park
San Diego, CA
92110

To Whom It May Concern:

I am writing to indicate that Ms. Lisa Miklush has permission to utilize data from the study entitled "Healthy Families San Diego Clinical Trial" for her doctoral dissertation chaired by Cynthia D. Connelly, PhD.

If you have any questions, please do not hesitate to contact me at (858) 966-7703 or at JLANDSVERK@aol.com.

Sincerely,

John Landsverk, PhD
Principal Investigator

*A National Institute of Mental Health funded Center
in collaboration with:*

- San Diego State University • The University of California, San Diego
- San Diego County Probation Department • San Diego Health and Human Services Agency