BREASTFEEDING AND KANGAROO CARE: BIOBEHAVIORAL MEASURES OF DYADIC BONDING, INFANT CORTICAL MATURATION, AND INFANT HPA REACTIVITY

by

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This dissertation was prepared under the direction of the candidate's dissertation advisor, Dr. Nancy Aaron Jones, Department of Psychology, and has been approved by the members of her supervisory committee. It was submitted to the faculty of the Charles E. Schmidt College of Science and was accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Thank you to all of the moms and babies who participated in this research. I appreciate you all! Melannie, thanks for all your help. Couldn’t have done this without you.
The current study examined the effects of kangaroo care on breastfeeding practices, infant stress reactivity, and biobehavioral measures of mother-infant bonding across the first 3 months postpartum. Additionally, the role of breastfeeding in infant cortical maturation in the frontal lobe was examined. Thirty-two mother-infant dyads participated in the current study; 16 mother-infant dyads were randomly assigned to the kangaroo care group and 17 mother-infant dyads were assigned to the control group. Mothers in the kangaroo care group received training on proper kangaroo care procedures by a trained administrator during the first 1-2 weeks postpartum. Mothers in the kangaroo care group were asked to use the kangaroo care procedure for 1 hour per day for 6 weeks.
Maternal perceptions of fetal attachment, mood, feeding intentions, and urinary oxytocin measurements were assessed prenatally. At a newborn visit, infant neurobehavioral functioning and urinary oxytocin measurements were assessed. Maternal mood and feeding practices were also assessed at the newborn visit. At 3 months postpartum, mother-infant dyads were assessed on urinary oxytocin measurements. Mother-infant dyads were recorded during a play session and feeding session. Infant baseline EEG recordings were taken over a 5 minute period. Infant cortisol measurements were collected from infant saliva before and after a mild behavioral stressor, an infant arm restraint procedure. Maternal perceptions of postpartum bonding, mood, infant temperament, and feeding practices were also assessed. Results indicate that kangaroo care produced medium to large effects on cortisol reactivity, dyadic bonding, and breastfeeding practices if kangaroo care was practiced for the recommended amount of time. Kangaroo care produced medium to large effects on oxytocin levels in mother-infant dyads regardless of use. Cortical measures of infant frontal activity indicated that all infants in the samples displayed functional maturity of the frontal lobe. Kangaroo care can be used a viable, low-cost tactile procedure that can be implemented after birth to aid in breastfeeding practices, mother-infant bonding, and lower infant stress reactivity. Infants in the study who received at least one breastfeeding session displayed advanced patterns of frontal activation. Further study is needed to determine if peripheral oxytocin measurements are 1) reliable and 2) are indicative of dyadic bonding behaviors.
DEDICATION

For my mom, Marianne, and for my daughter, Averie—because motherhood is love incarnate.

And for Darius, may you live through all the good I do in life.
BREASTFEEDING AND KANGAROO CARE: BIOBEHAVIORAL MEASURES OF DYADIC BONDING, INFANT CORTICAL MATURATION, AND INFANT HPA REACTIVITY

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I. INTRODUCTION

Breastfeeding Practices

For many new mothers, pregnancy begins the time of important caretaking decisions which will impact the subsequent development of her child. One of the first decisions a new mother makes is regarding the type of feeding method she will employ after the arrival of her child. It is estimated that 74.6% of women in the United States attempt to breastfeed their child, however, this number drops to 35% by 3 months of age and 14.8% by 6 months of age (Centers for Disease Control and Prevention, 2011). Common reasons for early cessation of breastfeeding are maternal employment, lack of education on proper breastfeeding practices, and lack of social support from family and healthcare providers/educators (American Academy of Pediatrics, 2005).

Feeding method, although seemingly inconsequential, has been shown to impact both infant behavior and development. In fact, because of the nutritional and developmental benefits breastfeeding provides, the American Academy of Pediatrics (AAP; 2005) recommends mothers breastfeed their infants exclusively until 6 months of age. The current study aims to demonstrate the physiological and behavioral benefits of breastfeeding as well as investigate a method intended to successfully increase breastfeeding stability and duration and positively impact dyadic bonding. The study will
follow 30 mother-infant dyads from 28-38 weeks gestation until the infant is 3 months of age. The primary goal of the current study is to examine the effectiveness of a naturalistic intervention intended to promote dyadic bonding behaviors, breastfeeding length and stability, and optimal infant neurodevelopment.

A review of the literature pertaining to development in relation to feeding method follows. First, the nutritional, cognitive, and emotional benefits of breastfeeding are detailed, followed by an overview of brain maturation with special attention to frontal lobe development. Next, the role of oxytocin and cortisol are reviewed in order to illustrate the underlying physiological mechanisms of breastfeeding. Last, a tactile procedure capitalizing upon the physiological mechanisms underlying the mother-infant bond, called kangaroo care (KC) is proposed.

**Nutritional Benefits of Breastfeeding**

The bulk of breastfeeding literature entails the many health benefits breastfeeding has on both the infant and the mother. For instance, breastfeeding decreases the risk of the mother developing breast (Newcomb et al., 1994), uterine, and endometrial cancer (Cramer, 2012). For the infant, breastfeeding is viewed as the optimal feeding method in part because of the nutritional advantages conferred upon the infant. Previous studies have linked breast milk to the reduction of a host of diseases as well as increased autoimmune functioning (Krebs, 2011; Lawrence & Pane, 2007; Walker, 2010). Breast milk contains antibiotic properties which boost infant immune functioning (Rivera & Manera, 1989). The antimicrobial properties of human milk are uniquely effective at
preventing illness because of antimicrobial lipids which work both individually and synergistically to ward off infection (Isaacs, 2005). Not surprisingly, breastfed infants require less medical visits than formula-fed infants (Ball & Wright, 1999), and the AAP (2005) estimates that an annual $3.6 billion in health care costs would be saved if U.S. mothers breast-fed exclusively for the first 6 months. For instance, infants who are breast-fed exclusively during the first 6 months of life are less likely to develop ear and respiratory illnesses over the first two years of life (Philipsen Hetzner, Razza, Malone & Brooks-Gunn, 2008). Breast milk also appears to combat exposure to high insulin levels in utero. Infants whose mothers suffered from gestational diabetes are often at-risk for developing hypoglycemia shortly after birth. Infants who are breast-fed, however, are less likely to develop hypoglycemia and demonstrate higher blood glucose levels than formula-fed infants (Chertok, Raz, Shoham, Haddad, & Wiznitzer, 2009).

Among other advantages, breastfeeding is associated with decreased incidences of childhood lymphoma (Rudant et al., 2011), Chron’s disease and ulcerative colitis (Scholz, 2011), SIDS (Ford et al., 1993), asthma (Silvers et al., 2012), and bacterial meningitis (Hylander, Strobino, & Dhanireddy, 1998; Silfverdal & Bodin, 1999). Furthermore, breastfeeding enhances vaccine effectiveness (Hahn-Zoric et al., 1990), and is also associated with proper physical development such as jaw and dental development (Montaldo, Montaldo, Cuccaro, Caramico, & Minervini, 2011) and hand-eye coordination (Baumgartner, 1989). Tanoue and Oda (1989) suggest breastfeeding may protect against autism disorders through a mechanism which has yet to be empirically
tested. Formula-fed infants, however, demonstrate increased rates of autism when compared to breastfed infants (Schultz et al., 2006).

Conversely, formula feeding has been linked to increased risks in the development of certain diseases and nutritional disadvantages such as reduced appetite regulation (Disantis, Collins, Fisher, & Davey, 2011) obesity (Lindberg, Adams, & Prince, 2012), and type 2 diabetes (Moore, 2010). Breastfed infants are less likely to exceed normative weight guidelines (Li, Fein, Grummer-Strawn, 2008). Researchers believe this may be due, in part, to the self-regulatory eating patterns to which breastfed infants become accustomed (Li, Fein, & Grummer-Strawn, 2010). Bottle-feedings, however, are controlled by the caregiver rather than the infant, preventing the infant from learning to conclude feedings when satiated. Li and colleagues (2008) found that bottle-fed infants were more likely to be at-risk for excess weight during infancy than infants who were breastfed ≥80% of the time. According to the American Academy of Pediatrics policy statement on breastfeeding, “human milk is species-specific, and all substitute feeding preparations differ markedly from it, making human milk uniquely superior for infant feeding” (p. 496, 2005). Thus, the benefits of human milk discussed above are unique to breast milk and cannot be reproduced or manufactured in infant formula.

**Cognitive benefits of Breastfeeding**

It is believed that infants who are breastfed have cognitive advantages over bottle-fed babies. Whether breastfeeding directly propels cognitive development or whether the behaviors associated with breastfeeding aid in the developing cognitive skills, the
advantages have been consistently demonstrated in the literature. By 1 week of age, breastfed infants demonstrate superior neurobehavioral functioning compared to formula-fed infants (Hart, Boylan, Carroll, Musick, & Lampe, 2003). By 3 months of age, breastfed infants exhibit an advantage in language processing and increased sensory memory relative to formula-fed infants, an effect which persists through 6 months of age (Pivik, Andres, & Badger, 2011). By 12 months of age, breastfed infants surpass formula-fed infants on measures of fine motor control, communication skills, and sociability (Oddy et al., 2011). Furthermore, 12-month-old breast-fed infants outperform formula-fed infants on measures of general cognitive development (Sloane, Stewart, & Dunne, 2010).

A main criticism of the finding that breastfed infants possess cognitive advantages is that feeding studies poorly control for confounding variables, such as socioeconomic status and parental involvement and stimulation; variables which may influence development (Sloane, Stewart, & Dunne, 2010). However, even when controlling for these factors, 1-year-old infants still demonstrated more advanced cognitive development than formula-fed infants. Moreover, this relationship was dose dependent, infants who breastfed the longest demonstrated the most advanced cognitive skills.

The advantages of breastfeeding are not limited to infancy. In fact, developmental advantages appear to extend throughout childhood as well. Children who were breastfed demonstrate higher IQ scores (Horwood & Fergusson, 1998), lower incidences of childhood conduct disorders (Shelton, Collishaw, Rice, Harold, & Thapar, 2011), and
superior performance on educational tests (McCrory & Layte, 2011). In addition to long-lasting cognitive advantages to breastfed infants, there exist emotional benefits to the initiation and maintenance of stable breastfeeding practices. The psychological benefits of breastfeeding affect both the mother and the infant. However, it is important to note that the psychological benefits conferred upon the mother consequently impact her infant’s psychological and physiological functioning as well.

**Cognitive Advantages of Breastfeeding: Direct or Indirect Benefit?**

Until recently, research focused on the nutritional aspects of breastfeeding contributing to the cognitive “edge” of breastfed infants. However, contemporary research carried out by psychologists has elucidated the contribution of the behavioral aspects of breastfeeding in infant cognitive development. Moreover, the highly synchronous interactive behaviors of the breastfeeding dyad may aid in infant brain development (Jones, McFall, & Diego, 2004; Sader, Jones & Mize, in preparation; Hardin, Barrera, Jones, & Mize, 2012). Mother-infant interactions of breastfeeding dyads are also positively associated with infant neurodevelopment (Jones, McFall, & Diego, 2004). Mothers who breastfeed exclusively spend longer amounts of time interacting with their infants in comparison to formula feeding dyads (Smith & Ellwood, 2011). Furthermore, the same study found mothers who breastfeed exclusively spend more time providing emotional care to their infants than mixed-feeding (in which both breast and formula was given) or formula-fed groups.
Maternal sensitivity to infant distress increases after birth in breastfeeding mothers only (Pearson, Lightman, & Evans, 2011), providing evidence that an underlying mechanism for maternal behavior exists in breastfeeding mothers. Thus, breastfeeding mothers respond to their infants in a differential manner than formula feeding mothers. Parental sensitivity and optimal emotional care have also been linked to infant neurological functioning (Parsons, Young, Murray, Stein, & Kringelbach, 2010). Smith and Ellwood (2011) posit that the cognitive advantages conferred upon breastfed infants do not stem solely from the nutritive properties of breastfeeding, but also from maternal nurturance. In sum, breastfeeding drives maternal behaviors which in turn impact infant development. This is an especially important sentiment because it suggests that all dyads could equally benefit from stable breastfeeding practices.

*Emotional Benefits of Breastfeeding*

Breastfeeding creates an opportunity for intimacy between the mother and infant and, as outlined above, breastfeeding dyads display longer interactions than formula-feeding dyads. Furthermore, the behaviors of breastfeeding dyads are more optimal when compared to formula-feeding dyads. For instance, breastfeeding dyads exhibit more mutual gaze and touch than formula-feeding dyads (Lavelli & Poli, 1998). Breastfeeding enhances the mother-infant bond through physical contact and affectionate interactions (Feldman & Eidelman, 2003) and studies have demonstrated that breastfeeding dyads display more positive interactive behaviors than formula-feeding dyads (Lavelli & Poli, 1998; Kuzela, Stifter, & Worobey, 1990). Moreover, breastfeeding enhances maternal
perceived mood and decreases maternal perceived negative stress (Mezzacappa & Katkin, 2002).

Breastfeeding also provides a buffer for depressed maternal mood. Postpartum depression is common, affecting about 13% of new mothers in westernized regions (O’Hara & Swain, 1992). Depressed mothers typically display impaired mother-infant bonding evidenced through lower levels of dyadic interaction (Field, Hernandez-Reif, & Feijo, 2002). However, breastfeeding studies have reliably demonstrated that breastfeeding attenuates maternal depressive symptoms and maternal perception of negative infant temperament (Field, Diego, Hernandez-Reif, Figueiredo, Ezell, & Siblanlingappa, 2010; Field, Hernandez-Reif, & Feijo, 2002; Jones, McFall, & Diego, 2004). For instance, depressed breastfeeding mothers express greater confidence in feeding and perceive their infants as less irritable than depressed formula-feeding mothers (Field, Hernandez-Reif, & Feijo, 2002). Moreover, Jones and colleagues (2004) found that breastfeeding was related to positive dyadic interactions in depressed dyads. We (Jones, Mize, & Sader, 2010) also found that breastfeeding dyads engage in more affectionate touch than formula-fed infants. Taken together, the findings indicate that breastfeeding protects against impaired mother-infant interactions through the optimal dyadic behaviors and maternal perceptions associated with breastfeeding. The emotional benefits provided by breastfeeding are not solely attributed to behavioral differences in feeding method. Rather, there are distinct underlying physiological mechanisms which impact behavior, mood, and regulatory capacities. Thus, breastfeeding can be viewed as a regulator of a range of dyadic behaviors as well as neurophysiological functioning.
Moreover, the touch procedure used in the current study, kangaroo care, mimics the physical contact of breastfeeding providing benefits typically associated with breastfeeding.

**Neurophysiology of Breastfeeding**

The optimal patterns of behavior in breastfeeding dyads can be, in part, explained by the underlying physiological mechanisms of breastfeeding. Two hormones implicated in breastfeeding behaviors, oxytocin and cortisol, will be examined in the current study. Specifically, in the framework of our study oxytocin and cortisol will be used as measures of bonding behaviors and stress reactivity, respectively. These neuropeptides are believed to underlie the formation and maintenance of social bonds and maternal behavior (Henry & Wang, 1998; Depue & Morrone-Strupinsky, 2005; Carter & Porges, 2011) as well as the attenuation of the stress response system (Uvnäs-Moberg, 1998). The functions and mechanisms of the hormones are discussed below.

*The Oxytocinergic Bonding System and Maternal Behavior*

Oxytocin originates from two areas of the brain, the supraoptic nucleus (SON) and the paraventricular nucleus (PVN) of the hypothalamus (Uvnäs-Moberg, 1998). Somatosensory stimulation is the main proponent of oxytocin release within the brain. Oxytocin is also released peripherally by the pituitary gland and the neurohypophyseal terminal in the blood stream (Herbert, 1994; Neumann, 2008). Oxytocin literature is heavily concentrated on the behavioral effects oxytocin has on maternal behaviors because oxytocin has been demonstrated as a key hormone in the initiation and
maintenance of maternal behaviors (Lee et al., 2009). In fact, increases in oxytocin levels are exhibited in mothers immediately following birth (Matthiesen, Ransjö-Arvidson, Nissen, & Uvnäs-Moberg, 2001). The increase in oxytocin postnatally is related to another effect oxytocin has on new mothers, the initiation of milk “let-down” to allow for lactation (Uvnäs-Moberg, Johansson, Lupoli, & Svennersten-Sjaunja, 2001). However, perhaps the chief reason why oxytocin earned the nickname “the cuddle hormone” is due to its activity during the bond formation. Oxytocin is released primarily in response to interpersonal skin-to-skin contact and subsequent bonding occurs in response to oxytocin activity. Oxytocin is involved not only in maternal behaviors critical for care, but also in the establishment of the mother-infant bond. Because of oxytocin’s role in bonding, researchers have theorized bonding facilitated by touch may serve to form and strengthen secure attachment relationships (Šešo-Šimać, Sedmak, Hof, & Šimać, 2010).

Mother-infant touch and contact have been shown to enhance neurochemical regulation by stimulating oxytocin release. In one study, newborn infants placed on their mother’s chest initiated oxytocin release through hand movements and suckling (Matthiesen, Ransjo-Arvidson, Nissen, & Uvnäs-Moberg, 2001), and in another study mother-infant skin-to-skin contact immediately after birth elevated maternal oxytocin levels (Nissen, Lilja, Widstrom, & Uvnäs-Moberg, 1995). Oxytocin also was found to increase following breast massage in lactating women (Yokoyama, Ueda, Irahara, & Aono, 1994), and a similar increase in oxytocin was found following breast pumping and during breastfeeding (Zinaman, Hughes, Queenan Labobok, & Albertson, 1992), suggesting that both expressing breast milk and breastfeeding initiates the
"oxytocinergic" bonding system even when contact is unavailable. Touch and oxytocin, therefore, function as a feedback loop: with touch leading to oxytocin release which further increases the mother's tendency to provide more touch and contact.

Kim and colleagues (2011) conducted a study to provide a neurological explanation of the differences in maternal behaviors of formula- and breastfeeding mothers. The researchers discovered that breastfeeding mothers had greater levels of brain activation in response to own-infant cries including areas implicated in the emergence of maternal behavior. In addition, the breastfeeding mothers displayed higher levels of maternal sensitivity at 3-4 months postpartum than the formula-feeding mothers, providing evidence that breastfeeding may facilitate changes in neurological functioning which support maternal sensitivity and affectionate dyadic interactions. Febo, Numan, and Ferris (2005) demonstrated, using rat models, that brain areas activated by oxytocin are also activated during mother-pup suckling.

Breastfeeding mother-infant dyads attain hormonal benefits upon oxytocin release and perhaps differ in brain activation relative to bottle-feeding dyads, providing psychological benefits to dyads who exclusively breastfeed. Breastfed infants exhibit fewer signs of depressive and withdrawal behaviors when compared to bottle-fed infants (Hart, Boylan, Carroll, Musick, & Lampe, 2003). Enhanced maternal mood as a by-product of breastfeeding (Mezzacappa & Katkin, 2002) may be due to the proximity of mother and infant, facilitation of tactile interactions and transmission of warmth – all of which stimulate bonding behavior through oxytocin release (Uvnäs-Moberg, 1998).

Taken together, the findings of the studies indicate that oxytocin release as a by-product
of breastfeeding leads to the mother-infant relationship forming a sense of trust, affiliation, and an interpersonal bond. The social relationship between mother and infant is critical for the survival of the human and other mammals, but it also affords the infant its first opportunity to bond and establish a secure relationship with its primary caretaker.

Researchers Carter and Porges (2011) believe the mother-infant bond in mammals is so dependent on lactation both in modern society and over the course of evolutionary history, they contend that mother-infant “attachments shaped the infrastructure of the mammalian nervous system and ultimately the structure of families and more generally societies.” (p. 1). Breastfeeding creates two mechanisms which enhance the mother-infant bond, through mother-infant interactions and also through the activation of neurophysiological processes. These two mechanisms impact one another in a bidirectional manner, with breastfeeding physiology impacting dyadic interactions and dyadic interactions impacting breastfeeding physiology. The current study will elucidate the physiological synchronization of mother-infant bonding behaviors by measuring oxytocin levels in mother and infant at two time periods, prenatally/neonatally and when the infant is 3 months of age.

*Cortisol & Stress*

Stress is a physiological reaction as much as it is a behavioral one. The hypothalamic-pituitary-adrenocortical axis (HPA) is one of two stress response systems responsible for the physiological effects of stress. The HPA axis is associated with neuroendocrine functioning and the release of neuropeptides and glucocorticoids
The hypothalamic-pituitary-adrenal (HPA) axis is responsible for modulating behavioral and physiological responses to stress. Thus, cortisol levels are commonly used as a measure of HPA reactivity (Laurent, Ablow, & Measelle, 2012). Cortisol is an important hormone for survival; secreted by the hypothalamus, it is essential for threat detection and response (Gunnar & Quevedo, 2007) and elicits an anti-inflammatory response throughout the body (Black, 2002). However, excess levels of glucocorticoids are known to be neurotoxic (Black; Starkman, Gebarski, Berent, & Schteingart, 1992) and are associated with development of psychopathology (Checkley, 1996) and illicit drug use (Wisniewski et al., 2006). High levels of cortisol are also associated with health issues such as hypertension (Hammer & Stewart, 2006) and cardiovascular disease (Whitworth, Mangos, & Kelly, 2000).

Stress vulnerability in individuals is highly variable, though, and environmental factors play a large role in shaping the activation and functioning of the HPA axis. Early experiences, both in utero and neonatally, influence the infant’s reaction to stressful stimuli. Prenatally, the HPA axis develops, however not fully. While there exists a predisposition for stress reactivity, experiences in infancy further develop the HPA axis. The in utero experience has important implications for the calibration of the infant’s HPA axis and neuroendocrine functioning (de Weerth & Buitelaar, 2005). For example, prenatal maternal anxiety and/or depression impact the fetus’s postnatal HPA functioning. Lundy and colleagues (1999) found that depressed mothers exhibit elevated levels of cortisol and norepinephrine during pregnancy and infants of depressed mothers are also likely to display elevated cortisol and norepinephrine levels (Diego, Field,
Findings of another study linked maternal anxiety to heightened infant HPA axis functioning measured by cortisol reactivity (O’Connor et al., 2005). The findings suggest the fetal programming of the infant’s nervous system is influenced by maternal prenatal HPA functioning. The developing fetus is exposed to cortisol secreted by its mother. Repeated exposure to maternal cortisol in utero deleteriously affects the development of the fetal nervous system and the fetal brain (O’Connor et al.).

Seymour Levine, one of the first psychologists to research the physiological effects of extended contact and maternal deprivation, devoted much of his career in psychological research to the development and modulation of the HPA axis in response to stress. In particular, he emphasized the importance of infant stimulation as a buffer for stress (Levine, 1957, 1962). For example, mice taken from their mothers prior to the weaning period exhibit poorly modulated HPA axes (as measured by corticosteroid increases) in response to stressors (Levine, 1960). Levine proposed that early handling, specifically touch, influences postnatal development of the HPA axis. Uvnäs-Moberg (2003) extended Levine’s idea by proposing a neural pathway which functions in response to somatosensory stimulation, in particular skin-to-skin contact, and subsequently releases oxytocin. The oxytocin release creates a feeling of overall well-being and also blunts HPA reactivity so that stressors elicit a weaker reaction.

Indeed, previous studies examining kangaroo care and skin-to-skin contact have demonstrated that skin-to-skin contact reduces maternal and infant cortisol levels (Gitau
et al., 2002; Modi & Glover, 1998; Swinth et al., 2003), reduces maternal and infant behavioral displays of stress (Harrison et al., 2004), and increases maternal and infant oxytocin levels (Uvnäs-Moberg, 2003). Thus, we hypothesize that early extended contact in mother-infant dyads increases maternal perceptions of bonding, decreases cortisol levels, and increases oxytocin levels.

**Attenuation of the HPA axis**

Social bonds appear to have an attenuating effect on cortisol release, as a previous study demonstrated that social support diminishes cortisol reactivity in individuals (Eisenberger, Taylor, Gable, Hilmert, & Lieberman, 2007). Conversely, a suboptimal prenatal environment is associated with the presence of stress hormones such as norepinephrine and cortisol in mothers and their neonates (Lundy et al., 1999). Somatosensory stimulation and maternal presence are such potent buffers to stressors that even the odor of its mother’s breast milk blunts the stress response system in 5-day-old neonates (Nishitani et al., 2009). Maternal touch may even function as an analgesic. Blass and Ciamataro (1994) found that the presence of maternal touch blunts infant pain reactivity during inoculation.

The current study will examine, in addition to HPA axis functioning, the attenuation of the stress response system as a product of a dyadic touch procedure. Both breastfeeding and interpersonal touch have been demonstrated as effective methods of diminishing stress responses, both behavioral and physiological (Gray, Miller, Phillip, & Blass, 2002; Mooncey, Giannakoulopoulos, Glover, Acolet, & Modi, 1997; Feldman,
Singer, & Zagoory, 2010) specifically through the release of oxytocin, a neuropeptide implicated in maternal behavior (Feldman, Gordon, & Zagoory-Sharon, 2011), mother-infant bonding (Mogi, Nagasawa, & Kikusui, 2011), and affiliative behavior (Ross & Young, 2009). Taken together, the oxytocin and cortisol research suggests that affectionate maternal behaviors and interpersonal touch have the potential to down regulate cortisol reactivity through anxiolytic pathways in infants.

Gene X Environment Interactions: Considerations to Individual and Group Differences

Differential responses to stress may be partially modulated by genes. Infants possessing the same gene alleles may express differential stress responses relative to environmental conditions. For example, Lujik and colleagues (2011) found that infants carrying the same gene allele exhibited both the highest and lowest forms of maternal attachment relative to levels of maternal sensitivity and responsiveness. Ellis and Boyce (2005) proposed that genes are differentially expressed as a product of environmental conditions. Thus, infants who are extremely susceptible to ecological conditions experience either the best or worst developmental outcomes based upon the environment at an individual level. In the current study, infants who receive kangaroo care may benefit differentially. For dyads highly susceptible to environmental influences, kangaroo care may not only provide immediate benefits to bonding, feeding, and development, but long-lasting benefits to stress reactivity and neural development. Thus, baseline cortisol
levels of some individuals are expected to be higher. However, baseline levels of cortisol are not sufficient indicators of HPA functioning.

For example, a study conducted by Cao and colleagues (2009) found that salivary cortisol of infants 12 months and under was 40% higher in breast-fed infants than formula-fed infants. However, interleukin-6, a marker for inflammatory response was higher, but not significantly higher, in breast-fed infants relative to formula-fed infants. The authors concluded that this extra increase in cortisol may actually benefit the infant, as cortisol is implicated in analgesic effects produced in the human body. They further propose that the increased cortisol levels of breast-fed infants may actually positively benefit HPA development, making the infant more resilient to stressors. The study, however, took baseline measurements of cortisol levels.

Breast-fed infants may indeed have higher baseline cortisol levels and the author’s conclusions are entirely plausible, but it should be presupposed that inter-individual differences in basal cortisol reflect HPA reactivity and modulation. The current study focuses on the baseline-to-task difference in cortisol levels. Infants who display the greatest increases in cortisol levels are those most highly reactive to stressors, whereas low increases in cortisol levels from baseline-to-task is indicative of infants who possess blunted HPA axes. Taking into account these individual and group differences by using a baseline-to-task measurement of cortisol allows us to make conclusions about the HPA functioning of infants relative to feeding method and extended contact experiences.
It should be noted that although cortisol is released in response to stress, there exist normative, expected patterns of cortisol release in response to stress. That is not to imply that any level of cortisol release within the body is deleterious to human health. Rather, it is chronic stress which impacts proper HPA functioning and neuroinflammation. The bulk of cortisol literature centers on HPA functioning in negative environmental contexts. Accordingly, there exists a gap in the literature: HPA functioning as a result of positive environmental factors. The current study will address this by examining HPA functioning in relation to extended contact and optimal feeding practices.

Despite the deleterious effects of maternal prenatal cortisol on the infant, the developing infant’s brain neurophysiology is highly plastic (Greenough & Black, 1987) and early neonatal experience is believed to override prenatal programming effects (Loman & Gunnar, 2010; Weinberg, Smotherman, & Levine, 1980). For example, rat pups of mothers low in grooming behaviors typically display low grooming behaviors with their own offspring (Champagne & Meaney, 2007). However, when the LG rat pups are placed with rat mothers high in grooming behaviors, the LG pups are more likely to display HG behaviors with their own rat pups. Transmission of predisposition from mother to offspring is not limited to behavior. Rat pups separated from mothers at birth display changes in prelimbic prefrontal brain areas (Poeggel, Lange, Hase, Metzger, Gulyaeva, & Braun, 1999). Therefore, the current study focuses not only on the attenuation of the HPA axis as a function of extended contact, but also the functioning and maturation of the frontal lobes.
The Frontal Lobe and Electrophysiological Indices of Neurodevelopment

The frontal lobes are, quite arguably, the most unique defining feature of the human species. With the evolution of the frontal lobes, the human brain diverged markedly from that of our ape ancestors (Ardila, 2008). The frontal lobes are primarily responsible for executive functions, such as affective and cognitive processing and self-regulatory behavior (Fox & Calkins, 2003). Although it has been argued that subcortical regions of the brain are capable of producing emotional responses, animals that have been cortically-lesioned display extreme, uninhibited displays of emotion suggesting the frontal lobe regulates emotion (Dawson, 1994). Furthermore, the maturation of the frontal lobe coincides with the development of regulatory abilities (Dawson, Panagiotides, Klinger, & Hill, 1992).

The frontal lobe of infants is strikingly similar to that of adults, but with less gyrification (Rilling, 2006) and less cortical folding (Hill et al., 2010). In particular, areas marked by high expansion postnatally, such as the frontal lobes, are less mature at term (Hill et al.) allowing the fetal brain to devote prenatal resources to the developmental of brain regions necessary for survival upon birth. Regions less mature at birth tend to mature more slowly and encompass the greatest dendritic density (Hill et al). Not surprisingly, much of the maturation of the frontal lobe takes place postnatally because of its role in executive functioning. Researchers (Weiner, Monge, & Mann, 2008) have surmised that this may be due to an evolutionary process which selected for a head shape suitable for passage through the birth canal. Hill and colleagues contend that the postnatal
development of the frontal lobe leaves the infant brain vulnerable to postnatal experience and insult. Because experiential factors influence brain development and frontal lobe development in particular, electrophysiological measures of brain development can elucidate the contribution of experience on neurodevelopment. Few studies directly address maturational differences in response to environmental manipulations. For the current study, we assume infant brains are highly plastic and thus we will examine an environmental context, infant feeding method, and its impact on brain development.

The current study will not focus on specific cognitive or affective tasks, but rather we will collect a baseline measurement of brain electrical activity with the intent of measuring brain activation across hemispheres and specific frequencies. Since previous studies have demonstrated shifts to higher frequency bands as reflective of cognitive advances and cortical maturation (Bell, 2002), a baseline recording of brain activation in the absence of stimuli will serve to demonstrate whether infants differ in brain development across feeding methods and as a product of experiential factors. Similarly, left frontal asymmetry is considered, in infants, an indicator of neuromaturation as the left frontal hemisphere is implicated in higher order cognitive and emotional processing (Zhu et al., 2011). Thus, in the current study infant EEG patterns will be used to assess overall brain maturation.

As cognition and emotion are inextricable and because development in these domains largely occurs in the frontal lobe, the literature reviewed below focuses on indices of cortical maturation in the cognitive and emotional domains. Researchers
acknowledge the interplay between emotion and cognition and many believe their
development to be dependent on one another. Dunbar (2009) metaphorically describes
the “bricks and mortar of cognition (perceptual processing, memory, causal reasoning,
executive function competencies)” (p. 1119) as the building materials for structures of
social cognition, namely emotion. As skills in the cognitive domain increase and become
refined, so too does the emotional domain. For instance, the development of theory of
mind is positively related to the development of prosocial behavior (Eggum et al., 2011)
and emotion regulation is a significant predictor of kindergarten academic success
(Graziano, Reavis, Keane, & Calkins, 2007). Under other developmental conditions,
emotional and cognitive skills emerge simultaneously. For instance, the ability to produce
emotionally appropriate responses coincides with the development of self-locomotion
(Uchiyama et al., 2008). Self-locomotion in the infant has been linked with the
emergence of a variety of cognitive abilities such as attention, working memory, and
planning of goal-directed behavior (Bell & Wolfe, 2004). The following reviews research
demonstrating the EEG as a reliable measure of 1) cognitive development, 2) emotional
development, and 3) overall cortical maturation.

Physiological measures of brain electrical infant brain electrical activity have
become a common tool to inform researchers of cognitive development and brain
maturation (Bell & Fox, 1992; Bell & Wolfe, 2007; Cuevas & Bell, 2010; West & Bell,
1997; Wolfe & Bell, 2007). EEG studies of infant brain maturation rely on power
changes (3-6 Hz to 6-9 Hz) over the course of infancy as reflective of neuro-maturation.
Increased activity within specific bands is thought to reflect age-related brain maturation
or individual differences in cognitive abilities as a result of experiential factors. For example, EEG data distinguished between successful and unsuccessful infant performance on the A-not-B task, with greater frontal power bands exhibited at baseline for capable infants (Bell & Fox, 1997) suggesting that maturation of EEG power is linked with the maturation of early developmental skills/cognitive abilities. The current study will examine general brain activity across power bands. Activity clustered around the 6-9 Hz power bands is reflective of more advanced brain maturation than activity clustered around 3-6 Hz bands. The power bands will be examined according to feeding method.

In infancy, the processing, expression, and regulation of emotion are rudimentary due to immature frontal lobes. The development of emotions begins in the right frontal hemisphere, the area of the frontal lobe devoted to primitive behaviors, such as disgust, withdrawal, and fear (Fox, 1991). These behaviors are suitable, and essential, to early development as they are necessary for survival. Logically, the development of the brain follows a pattern appropriate to the corresponding developmental stage. Later brain maturation is devoted to the left frontal hemisphere, the area responsible for the expression and modulation of higher order emotions, approach emotions, and positive affect (Coan & Allen, 2003).

Greater activity in the left frontal lobe indicates advanced brain maturation in comparison to greater activity in the right frontal lobe. The divergent development across the two frontal hemispheres during infancy makes electrocortical measures using EEG a reliable index of brain maturation. The comparison of brain activity in the left and right
frontal lobe using EEG recordings is referred to as frontal asymmetry (Fox, 1991). Thus, relative left frontal asymmetry suggests greater activation in the left frontal hemisphere and relative right frontal asymmetry indicates greater activation in the right frontal hemisphere.

During childhood and across adulthood, patterns of frontal EEG asymmetry reflect stable predispositions for greater relative right frontal asymmetry or greater relative left frontal asymmetry (Calkins, Fox, & Marshall, 1996). Individual differences of brain functioning in later development are indicative of personality, temperament, and psychopathology (Dawson, 1994) however, in infancy a right to left switch in frontal activation is a typical developmental trajectory. Greater left frontal asymmetry is also generally accepted as a marker for overall brain maturation, in addition to emotional development (Bell & Fox, 2003; Zhu et al., 2011). Asymmetry patterns in certain populations, such as children with Down syndrome and infants of depressed mothers, differ from the asymmetry patterns of typically developing infants and children (Conrad et al., 2007; Jones, McFall, & Diego, 2004) suggesting patterns of EEG asymmetry can be utilized as an indicator of normative or atypical cortical development.

The Influence of Skin-to-Skin Contact on Neurodevelopment, Mother-Infant Bonding and Breastfeeding Practices

Kangaroo care (KC) developed out of necessity in Colombia as a means to care for medically stable pre-term infants in extremely low-income areas (Neu, 1999). As the skin-to-skin procedure proved effective in stabilizing pre-term infants, stimulating
development, and facilitating maternal lactation and mother-infant bonding, other countries began implementing the procedure in their neonatal units. Kangaroo care is a practice which goes by different names and definitions. Kangaroo care, under the framework of the current study, is defined as skin-to-skin, chest-to-chest contact between infant and mother for at least one infant sleep cycle (approximately 60-90 minutes). Ludington-Hoe (2012) contends that skin-to-skin, chest-to-chest contact within the dyad is necessary to promote the full benefits of kangaroo care as the ventral area of the skin (stimulated during KC) stimulates the vagus nerve thereby facilitation vagal-induced hormonal cascades (implicating both oxytocin and cortisol) which downregulates physiological stress responses such as cardiovascular reactivity and cortisol production.

Kangaroo care was not always looked at as a safe option for regulating infant physiology because infants, if unmonitored, are at-risk for apparent life-threatening events. Thus, kangaroo care must always be practiced properly; with the infant’s nostrils unobstructed, neck and spine aligned, head turned to one side, neck is neutral not flexed, and arms, legs, and feet flexed. However, many studies have demonstrated that kangaroo care does not increase mortality and morbidity rates (Cerezo, de Leon, & Gonzalez, 1992; Nagai et al., 2010). Use of kangaroo care in a study of Colombian pre-term infants did not increase mortality or morbidity rates relative to pre-term infants receiving standard care (Charpak, Ruiz-Pelaez, Figueroa de Calume, & Charpak, 1997; Sloan et al., 1994). Moreover, kangaroo care appears to reduce morbidity rates (Conde-Agudelo, 2003). Agencies such as the World Health Organization (1996) and Centers for Disease Control and Prevention in the United States (2009) have released policy statements in favor of
birth KC for full-term, placing the infant in kangaroo care within five minutes of birth and up until, at least, the infant’s very first feeding.

The use of kangaroo care in hospitals has cautiously persisted with primarily preterm infants as a method to increase contact between the mother and infant, often when the infant is ventilated or predominantly kept in an incubator (Ludington-Hoe, 2012). Pre-term infants greatly benefit from skin-to-skin contact, although traditionally neonatal intensive care units have limited parent-infant holding and touching because of the fragility of the pre-term infant (Johnson, 2005). Furthermore, it is now know that the introduction of KC bolsters the infant’s immune system (Ludington-Hoe, 2012). Pathogens have the ability to transfer to the infant through skin, air, and mucus membranes. The pathogens are passed on to the mother during skin-to-skin contact. Since the mother presumably possesses a fully developed, fully functioning immune system, the antigens are combated through the production of antibodies. These antibodies are passed on to her infant during breastfeeding (as outlined previously), bolstering her infant’s immune functioning and allowing the infant’s immune system to also combat the antigens. Therefore, kangaroo care, in addition to breastfeeding, may bolster the infant’s immune functioning.

**KC and Maternal Stress**

Maternal stress is reduced with as little as 1.5 hours of kangaroo care (Engler, in preparation) and maternal anxiety is lower in mothers who practice KC relative to mothers who do not (Lai et al., 2006; Lee & Shin, 2007; Neu et al., 2004). These findings
are of particular importance to infant stress levels and development because mother-infant glucocorticoid release is coordinated (Middlemiss, Granger, Goldberg & Nathans, 2012) and infants of mothers with high levels of anxiety exhibit higher levels of cortisol relative to infants of mothers with low anxiety (O’Connor, Shlomo, Heron, Golding, & Glover, 2005).

**KC and Infant Outcomes**

Under circumstances of stress, infants exhibit distinct behavioral displays such as squirming, crying, gaze aversion, back arching, and startle. Physiological displays of infant stress include an increase in cortisol levels, heart rate, high frequency heart rate variability (HRV), and a decrease in oxygen saturation levels (Ludington-Hoe, 2012). Previous studies have demonstrated that kangaroo care positively influences physiological functioning of pre-term infants (Feldman & Eidelman, 2003). For example, kangaroo care has been demonstrated to reduce cortisol levels in full-term infants (Takahashi et al., 2010) and pre-term infants (Modi & Glover, 1998; Mooncey et al., 1997; Tornhag et al., 2010). Kangaroo care is also associated with increased weight gain in low birthweight infants (Conde-Agudelo, Diaz-Rossello, & Belizan, 2003). Oxygen saturation levels (Hunt, 2008), thermoregulation (American Academy of Pediatrics & American Heart Association, 2006; Bystrova, 2007) suckling behaviors (Widström et al., 2011) and pain tolerance (Anand, 2008) in pre-term infants.

Pre-term infants exposed to kangaroo care also display enhanced neuromaturation (Feldman & Eidelman, 2003; Scher et al., 2009) and their mothers display increased
maternal sensitivity relative to dyads not receiving kangaroo care (Feldman, Weller, Sirota, & Eidelman, 2003). Mothers of pre-term infants who practice kangaroo mother care experience a decrease in stress levels and increase in exclusive breastfeeding practices (Feldman et al., 2002). However, given its many documented benefits, virtually no studies examine the effects of kangaroo care on neurological maturation and modulation of the HPA axis in full-term infants, creating a gap in the literature. The current study fills that void by addressing infant outcomes at 3 months of age after a 6 week kangaroo mother care trial. The current study tests the kangaroo care method for two purposes; first, to examine indirect contributions of KC to optimal infant outcomes (i.e. dyadic behaviors, brain development, and HPA functioning, addressed above), and second, to influence the stability and success of breastfeeding (addressed below).

It is logical to surmise that full-term infants may benefit from the procedure as well, specifically in regards to breastfeeding duration and exclusivity. Kangaroo mother care is known to increase milk supply and let-down (Uvnäs-Moberg, Johansson, Lupoli, & Svennersten-Sjaunja, 2001) and the effects of skin-to-skin contact activate the oxytocinergic system in much the same way as breastfeeding and interpersonal touch. Thus, implementing the procedure in full-term infants and their mothers may influence exclusive breastfeeding practices of the dyads in a country where only 14.8% of mothers breastfeed exclusively for the recommended 6 months (Li, Ogden, Ballew, Gillespie, & Grummer-Strawn, 2002).

In a review of the hospital stays of over 21,000 mother-infant dyads, it was found that mothers with greater levels of skin-to-skin contact in the hours following birth
were more likely to breastfeed exclusively, and mothers who intended to breastfeed were more likely to maintain skin-to-skin contact with their infants (Bramson, 2010). Unfortunately, the results of the study hint at an important factor influencing mother-infant dyads at risk for impaired bonding: at-risk mothers are less likely to breastfeed and maintain affectionate contact with their infants (Dennis & McQueen, 2007; Hart, Jackson, & Boylan, 2011) although they are arguably the mothers who may benefit most from exclusive breastfeeding practices.

For instance, mothers who are depressed are more likely to discontinue breastfeeding (Nishioka et al., 2011) and thus fail to experience the benefits conferred upon breastfeeding dyads. This includes the hormonal benefits which blunt the stress response system and enhance mood, and also the behavioral benefits such as the close affectionate contact critical for dyadic bonding (Uvnäs-Moberg, 1998). Kangaroo care is an intervention which has the potential to attenuate the deleterious effects of impaired bonding while also providing the infant optimal feeding method. The KC method is also easily implemented; the mother need only expose her bare chest to the infant’s bare chest by wearing an infant sling specially designed for kangaroo care procedures.

**The Current Study**

Despite the vast amount of literature which reviews the many benefits of breastfeeding, cessation of breastfeeding commonly occurs. In addition to the many nutritive, health, developmental, and cognitive advantages, breastfeeding may also serve as a buffer against potentially damaging effects of maternal depressive mood, disrupted
bonding behaviors, maternal insensitivity, and asynchronous behaviors of the mother and infant (Feldman, 2007). Furthermore, few studies have examined neurodevelopment, HPA functioning, and the oxytocinergic bonding system in full-term infants as a consequence of kangaroo care using a randomized, controlled trial.

The current study examined the effects of skin-to-skin contact in full-term infants through the first six weeks of life and measured developmental outcomes at 3 months of age as well as neuroendocrine functioning prenatally and neonatally. The mother-infant dyads were assigned to one of two groups: one group received kangaroo care training and subsequently used the skin-to-skin procedure one hour per day for six weeks (although actual use varied; discussed further in results section); the second group served as a control group and did not receive any instructions regarding physical contact. Underlying neuroendocrine activity involved in mother-infant bonding was investigated through the collection of oxytocin and cortisol using urine and saliva samples of mother and infant. Mother and infant oxytocin were measured at a prenatal (mother), neonatal (infant), and 3-month visit (mother and infant). Oxytocin was used a physiological measure of dyadic bonding and maternal affectionate care. Through measurement of infant cortisol we attempted to demonstrate breastfeeding patterns increase bonding behaviors and oxytocin levels, thereby increasing threshold activation of stress responses and consequently decreasing cortisol levels. Breastfeeding also provides cognitive benefits to the infant, positively impacting neurodevelopment; the current study attempted to demonstrate this through the use of electroencephalograph (EEG) recordings, specifically EEG asymmetry scores and frequency band activity. Results are expected to demonstrate
that touch training can be used as a viable, low-cost option to facilitate mother-infant bonding, promote breastfeeding stability and positively impact infant neurophysiological development.

**Hypothesis 1: Exclusive breastfeeding practice will positively impact infant neurodevelopment.**

*Predictions:* Infants who are breast-fed exclusively will demonstrate more mature brain development than the infants who are not breast-fed exclusively through the use of electroencephalograph (EEG) recordings, specifically EEG asymmetry scores and frequency bands. Specifically, infants who are exclusively breast-fed will exhibit greater relative left asymmetry and activity in higher frequency bands during a baseline EEG than the formula-fed group.

*Rationale:* Previous studies have demonstrated a developmental advantage for infants who are breastfed exclusively (Hart, Boylan, Carroll, Musick, & Lampe, 2003). A shift to higher EEG frequency bands over the course of infancy is commonly accepted as an indicator of neurological maturation (Bell, 2002). Similarly, left frontal asymmetry is considered, in infants, an indicator of neuromaturation as the left frontal hemisphere is implicated in higher order processing (Zhu et al., 2011).

**Hypothesis 2: Kangaroo mother care will positively impact breastfeeding practices.**

*Predictions:* Mothers assigned to the touch intervention group will be more likely to breastfeed their infants exclusively at 3 months of age. In the current study exclusive breastfeeding is defined as follows: infants who feed at the breast 80% of the time and receive only breast milk at feedings. In addition, it is expected that through measures of
self-report, specifically the breastfeeding self-efficacy scale, kangaroo care mothers will report greater levels of breastfeeding confidence and perceived breast milk production than the control group.

Rationale: Kangaroo care facilitates milk production and let-down because of the increased skin-to-skin contact and associated oxytocin release. Oxytocin released as a product of tactile interaction increases bonding behaviors of the mother and infant, and dyadic bonding behaviors are known to aid in the establishment of successful breastfeeding practices (Nissen, Lilja, Widstrom, & Uvnäs-Moberg, 1995; Uvnäs-Moberg, 1998).

**Hypothesis 3: Mother-infant oxytocin levels will be related to quality of maternal affectionate care**

Predictions: Similar to Feldman et al. (2010), mothers will be classified as high in affectionate care (HAC) and low in affectionate care (LAC) using a composite variable consisting of frequency of affectionate maternal touch behaviors, maternal affectionate vocalizations, and maternal gaze during a sampling of infant feeding and interaction. It is expected that the HAC group will demonstrate greater levels of oxytocin than the LAC group. Furthermore, more HAC mothers will exist in the KC group than the control group.

Rationale: Oxytocin is responsible for the initiation and maintenance of maternal behavior and is critical to the bonding of the dyad (Numan & Woodside, 2010; Feldman, Gordon, & Zagoory-Sharon, 2010). Affectionate care is an important component of maternal behavior in both humans and animals as it facilitates bonding of the mother and
infant, fostering attachment thereby increasing the chances of infant survival (Mogi, Nagasawa, & Kikusui, 2011).

**Hypothesis 4: Oxytocin levels of mother-infant dyads will be highly interrelated.**

*Predictions:* Maternal and infant oxytocin levels will be positively correlated at both the prenatal/newborn and 3 month measurement. Previous studies have demonstrated maternal and infant oxytocin to be related (Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010).


**Hypothesis 5: Kangaroo Care will impact the individual stability of mother-infant oxytocin levels.**

*Predictions:* Oxytocin levels of the kangaroo mother care group will remain highly stable for individuals across the pregnancy and postpartum measurements. In addition, mothers labeled as highly affectionate (as defined by verbal, tactile, and affect behaviors) and their infants will exhibit stable oxytocin levels at both the prenatal/newborn and 3 month measurements.

*Rationale:* Previous studies have demonstrated that suboptimal dyadic environments can create disordered levels of maternal oxytocin (Cyranowski, Hofkens, Frank, Seltman, Cai, & Amico, 2008). Maternal oxytocin levels should be interrelated to infant oxytocin levels, thus variable maternal oxytocin levels should be indicative of variable infant
oxytocin levels. Furthermore, mothers who display stable levels of oxytocin are not only more likely to exhibit maternal affectionate bonding behaviors, but their offspring are also more likely to display affectionate bonding behaviors as well (Feldman, Gordon, & Zagoory-Sharon, 2010).

**Hypothesis 6: Maternal perceptions of bonding will be related to infant cortisol levels.**

*Predictions:* The prenatal and postnatal environments have a pivotal role in shaping infant stress reactivity. The current study focuses on the neonatal environment at 3 months, specifically the mother’s role in the rearing environment. It is expected that infant cortisol levels will be demonstrate a higher baseline-to-task increase for infants of mothers whom perceive bonding difficulty.

*Rationale:* Mothers at risk for impaired bonding are low in maternal sensitivity (Field et al., 2010) and demonstrate inappropriate responses to infant distress (Kiel, Gratz, Moore, Latzman, & Tull, 2011) leaving the infant to attempt to self-regulate at an age when self-regulatory capacities are poorly developed. Infants of at-risk mothers are also exposed to increased levels of maternal cortisol in utero (Lundy et al., 1999) creating a neurophysiological sensitivity to stressors in the infant.

**Hypothesis 7: Kangaroo care will impact infant stress regulation**

*Predictions:* Kangaroo mother care infants are expected to exhibit less stress reactivity in the presence of a mild stressor. Specifically, a maternal still-face procedure in which the infant’s arms are restrained by the mother for 90 seconds will be used as the infant stressor. Kangaroo care infants will display lower levels of stress reactivity.
**Rationale:** Skin-to-skin contact facilitates the development of the infant’s nervous system as well as the calibration of the infant’s stress response systems (Feldman & Eidelman, 2003). Early experiences impact the functioning of the HPA axis and its associated behavioral effects, such as stress reactivity. Activating the oxytocinergic pathway, the so-called “antithesis” of the HPA axis, through skin-to-skin contact not only creates an anxiolytic effect for the infant, but also downregulates the infant’s stress response system (Uvnäs-Moberg, 1998). Thus, the stressor used in the current study will create higher levels of cortisol reactivity subsequent to the arm restraint procedure in infants not receiving kangaroo care.

**Hypothesis 8: Kangaroo care will increase maternal feelings of bonding**

**Predictions:** Utilizing kangaroo mother care will stimulate physiological mechanisms associated with bonding behaviors. Thus, KC dyads will be more likely to display affectionate bonding behaviors when compared to the dyads receiving no KC.

Furthermore, it is expected maternal perceptions of dyadic bonding will exhibit a greater increase over the infants’ first three months for the KC group relative to the control group.

**Rationale:** Because of oxytocin’s role in bonding, researchers have theorized bonding facilitated by touch may serve to form and strengthen secure attachment relationships (Šešo-Šimać, Sedmak, Hof, & Šimać, 2010). Since the oxytocinergic bonding system is implicated in the development of dyadic bonding, it is expected that kangaroo mother care will provide a buffer against impaired bonding and serve to increase maternal perceptions of dyadic bonding. Increased bonding as a by-product of kangaroo care may be due to the proximity of mother and infant, facilitation of tactile interactions and
transmission of warmth – all of which stimulate bonding behavior through oxytocin release (Uvnäs-Moberg, 1998).
II. METHOD

Participants

Data were collected from 33 mother-infant dyads. Pregnant mothers between 29-38 weeks gestation were recruited from local hospitals, breastfeeding coalition meetings, and through lactation consultants. The pregnant mothers were assigned to one of two groups: the kangaroo care (KC) group or the control group (CG). The KC group included 16 mothers and the CG included 17 mothers. Mothers assigned to the kangaroo care group were taught proper kangaroo care procedures by a certified kangaroo caregiver and were given a kangaroo care wrap (Nurtured by Design, The Kangaroo Zak). Mothers assigned to the control group were given infant feeding pillows (Boppy). Chi-square ($\chi^2$) analyses were conducted to ensure homogeneity of the sample between the kangaroo and control group on measures of SES, parity, ethnicity, maternal age, method of infant delivery, infant gender, depression status, and fetal attachment. Mothers recruited for the study did not use drugs or alcohol during the pregnancy and were not prescribed medications for mood disorders.

The control group consisted of 17 mother-infant dyads, mainly Caucasian (N Caucasian = 9, N Hispanic = 2, N African-American = 1, N Unknown ethnicity = 5) first- or second-time (first child = 8, second child = 5, third child = 4) mothers. The kangaroo care group consisted of 16 mother-infant dyads, mainly Caucasian (N
Caucasian = 13, N Unknown ethnicity = 3) first- or second- time (first child = 8, second child = 6, third child = 2) mothers. Average maternal age was 30 years old (MKC = 30.13, MCG = 32.17). Nine female and 8 male infants were assigned to the control group and 6 female and 10 male infants were assigned to the kangaroo care group.

**Materials and Procedure**

*Prenatal, Neonatal, and 6-week, and 3-month Visits*

The prenatal and neonatal visits took place in the participants’ homes; the 6-week maternal interview was conducted over the phone; the 3-month visit was conducted in our Infant Development Lab at Florida Atlantic University. The feeding and interaction session, arm restraint procedure, and infant EEG were recorded during the 3-month visit. Refer to Table 1 for a comprehensive overview of questionnaires, behavioral procedures, and physiological measures administered at each visit.

*CES-D and EPDS: Maternal Depression Screening*

The Center for Epidemiological Studies Depression Scale (CES-D) is used to prescreen participants for depression. The CES-D is 20 item questionnaire in which scores range from 0 to 60. A score of 12 or below is defined as "non-depressed" and a score of 16 or above is defined as "depressed." The CES-D has been shown to be a reliable questionnaire in terms of measuring depression (Radloff, 1977). The CES-D was administered to the mothers at the prenatal, neonatal, 6-week, and 3-month visits. Additionally, the Edinburgh Postnatal Depression Scale (EPDS) was administered at the neonatal and 3-month visit as a depression screening tool. The EPDS has similar
psychometric properties as the CES-D (Logsdon, Usui, & Nearing 2009) and has
demonstrated good construct validity and internal reliability (Logsdon, Usui, & Nearing,
2009; Bunevicius, Kusminskas, & Buneviskas, 2009). A score of 7 or greater of the
EPDS indicates the presence of depressive symptoms. The CES-D and EPDS were
correlated across visits. Refer to Table 2 for exact correlations. Two mothers reported
depressive symptoms prenatally, five at 6 weeks postpartum, and two at the 3 month
visit. No significant differences in depressive symptoms existed between the kangaroo
care and control groups and the breastfeeding and formula-feeding groups.

Breastfeeding Intentions and Status: BAPT, BSES, and MBFES

The Breastfeeding Attrition Prediction Tool was developed by Janke (1994) to
predict early weaning of the infant. The BAPT includes questions which measure
maternal perceptions of breast- and formula-feeding norms and maternal attitudes about
breast- and bottle-feeding. The BAPT was administered at the prenatal visit. At the
neonatal, 6-week, and 3-month visit, the Breastfeeding Self-Efficacy Scale (BSES) was
administered to the mothers. The BSES (Dennis & Faux, 1999) includes questions about
maternal breastfeeding confidence and experience. The Maternal Breastfeeding
Evaluation Scale (MBFES) was developed by Leff, Jeffris, & Gagne (1994). It includes
items linked to breastfeeding satisfaction and addresses both maternal and infant
behaviors in relation to feeding practice. The MBFES was administered at the 3-month
visit. The BAPT, BSES, and MBFES all demonstrate acceptable reliability and validity
(Ho & McGrath, 2010). The BSES and MBFES were correlated across visits.
Perceptions of Bonding: MFAS, MAAS, PBQ, and IBQ-R: Infant Temperament

Maternal fetal attachment was measured using two questionnaires, the Maternal Fetal Attachment Scale (MFAS; Cranley, 1981) and the Maternal Antenatal Attachment Scale (MAAS; Condon, 1993). Both scales demonstrate acceptable reliability and validity (Cranley, 1981; Condon, 1993). The MFAS and MAAS were administered to the mother at the prenatal visit. Scores of the MFAS and MAAS were not correlated. The Postpartum Bonding Questionnaire (PBQ; Brockington et al., 2001) was administered at the 6-week and 3-month visit and is intended to reflect the quality of bonding behaviors. It contains 4 subscales: impaired bonding, rejection and anger, anxiety about care, and risk for abuse. The PBQ impaired bonding subscale demonstrates acceptable reliability and validity (Wittowski, Wieck, & Mann, 2007). The total PBQ score was used for analyses. Lower scores on the PBQ indicate more optimal levels of bonding; the total PBQ score was reverse scored so that higher scores reflected more optimal levels of bonding. The PBQ was not correlated with the prenatal attachment questionnaires.

Infant temperament was reported by mothers using the Infant Behavior Questionnaire-Revised (IBQ-R) (Gartstein & Rothbart, 2003). The IBQ demonstrates good reliability and is applicable to neonates as early as 2 weeks (Worobey and Blajda, 1989). The IBQ-R is a 191 item questionnaire which measures maternal perceptions of infant activity level, pleasure, arousal, distress to limitations, rate of recovery from distress, fear, smiling, laughing, cuddliness, sadness approach, and vocal reactivity. The IBQ-R was administered to the mothers at the 3-month visit.
The Brazelton Neonatal Behavioral Assessment Scale (BNBAS; Brazelton, 1977; 1995) was administered to infants at the neonatal visit by a trained researcher. The BNBAS measures infant neurobehavioral functioning using dimensions such as orientation, motor, range of state, and state regulation. No differences in neonatal neurobehavioral functioning were found between between the kangaroo care group and control group.

**Behavioral Recordings**

Mothers in the kangaroo care group were given journals and asked to record frequency of kangaroo care use. Mothers were asked to use kangaroo care for 1 hour per day for 6 weeks. Mothers in the control group were given journals as well and asked to record infant feeding behavior for 6 weeks.

A feeding interaction was recorded at the newborn and 3-month visit. Mothers are instructed to feed their infants as they normally would. The dyads were left alone in a room to feed their infants. The session concluded when the mother was finished breast- or bottle-feeding the infant. A 5-minute sampling of each dyad’s feeding session was used for behavioral coding of the feeding session. The feeding session was coded for maternal touch, affect, and vocalizations. Following the feeding session at the 3 month visit, mothers and infants engaged in a 3-minute play interaction. The mother and infant face each other, with the infant placed in an infant seat. Mothers were instructed to interact with their infants as they would at home. Dyadic interactions were coded on a
second-by-second basis for affect, touch, and vocalization. The quality of interactions were assessed by combining affective coding into variables such as high in affectionate care and low in affectionate care. The behavioral coding of each behavior, and also for mother and infant, were coded separately. After the initial play session, mothers were asked to administer an arm restraint task to their infant. The arm restraint task has been used to assess temperamental reactivity and frustration (Stifter & Jain, 1996; Jones McFall, & Diego, 2004). The infant was placed in an infant seat and the mother was instructed to hold down the arms of her infant for a 3 minute period. Mothers were asked to maintain a neutral facial expression and remain silent during the procedure. Prior to and following this mild stressor, infant’s saliva was collected through passive drooling for subsequent cortisol analysis (further outlined in cortisol and oxytocin analysis).

Behavioral Coding

Mother-infant feedings and interactions were coded on a second-by-second basis using behavioral coding scales described by Jones and colleagues (2004) (adapted from Kuzela et al., 1990; Stifter & Jain, 1996, respectively). Refer to Appendix 1 for behavioral coding states. The mother-infant feeding measures behaviors of maternal attention such as touch, vocalizations, and gaze. The behavioral coding demonstrated Kappa scores ranging from .87 to .93 (feeding) and .83 to .87 (interaction). The scale used to code the mother-infant feeding session will also be used for the mother-infant play session. The behaviors are coded on a seven-point scale, with higher scores reflecting more optimal behaviors and lower scores reflecting suboptimal behaviors.
Physiological Recordings

EEG data was collected from the infant at the beginning of the visit while the infant is in a quiet and alert state. The baseline recording was sampled for 5-6 minutes. A stretch lycra cap (Electro Cap, Inc.) with the international 10-20 system was used to measure the EEG recordings. Impedances were brought below 5K ohms. The sites used are as follows: mid frontal (F3 and F4), lateral frontal (F7 & F8), central (C3 and C4), parietal (P3 and P4) and occipital (O1 and O2). All sites were referenced to the vertex (Cz). The vertex was used as a site of reference as previous infant EEG research almost exclusively utilizes Cz as the site of reference (for review Field & Diego, 2008a). The EEG electrical signal was amplified using SA Instrumentation Bioamps and bandpassed from 1-100 Hz. The EEG activity from each lead was streamed onto a computer screen. The EEG sampling rate on-line rate was 512 samples per second. The EEG recordings were saved to a computer hard drive using Snapstream v. 3.21 (HEM Data Corp, 1991).

Although there is no universally accepted criterion for frequency bands used for infants, typically the 3-6 Hz frequency bands are used for young infants and the 6-9 Hz range is used for older infants (Cuevas & Bell, 2010; Jones, Field, Fox, Lundy, & Davalos, 1997). Thus, this study will examine the 3-6 Hz, 6-9 Hz, and 3-12 Hz (broadband) range at 3 months of age. The EEG data was scored for artifacts from eye and motor movements (Cohen’s $\kappa = .82$ for inter-rater reliability).

Cortisol analysis
As suggested by Jansen and colleagues (2010) HPA reactivity was defined as the “pre- to post-stressor difference in concentrations of salivary cortisol, expressed in units of pre-stressor deviation (effect size)” (p.2). Cortisol reactivity appears to decrease with age and the effect sizes of acute stressors diminish after 6 months of age (Jansen, Beijers, Riksen-Walraven, de Weerth, 2010). Thus, measurement of cortisol reactivity in response to a mild stressor at 3 months of age is feasible. Salivary cortisol levels were measured at the pre-test phase (before the arm restraint procedure) and 20-25 minutes after the test phase, the elapsed time for cortisol levels to peak following a stimulus (Gunnar & Quevedo, 2007). By 3 months of age, infant salivary cortisol concentrations generally peak in the morning and subsequently decline over the course of a day (Mantagos et al., 1998), all but one saliva measurements were taken between 10:30 A.M. and 12 P.M.

Cortisol was measured by collecting infant saliva samples using a nalgene cryogenic vial (Thermo Scientific, NY, USA). The researcher allowed the infant to passively drool into the vial. We collected a baseline saliva sample as soon as the mother and infant arrived for the visit and again 20-25 minutes post-stressor. The samples were immediately moved to a -20°C freezer. Following the visit, samples were moved to an ultra-low temperature freezer at -80°C and subsequently assayed using a commercial cortisol EIA kit (Salimetrics, PA, USA). The test uses 25 μl of saliva per determination, has a lower sensitivity of 0.003 μg/dl, and average intra- and inter-assay coefficients of variation 3.5% and 5.1 %, respectively. Method accuracy, determined by spike and recovery, and linearity, determined by serial dilution, are 100.8% and 91.7%. Values from matched serum and saliva samples showed the expected strong linear relationship r(63) = .89, p < .0001. Saliva samples brought to room temperature and samples were
subsequently centrifuged according to the assay protocol to remove any particulates. All assayed samples contained 25 μl of saliva. Samples from two participants were discarded as there was not enough saliva to pipette. Samples were assessed for pH all were found to be within normal range, as there were no acidic or alkaline saliva samples.

*Oxytocin Analysis*

Oxytocin was measured by collecting maternal and infant urine. Samples were collected over 4 consecutive days to establish average individual levels of oxytocin. Mothers provided urine samples at the prenatal and 3-month visit. Mothers collected infant urine using pediatric urine bags (Thermo Fisher Scientific Inc., PA, USA) at the neonatal and 3-month visit. Peripheral oxytocin levels are typically correlated with other measures of oxytocin such as blood plasma and saliva (Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010) making urine collection a viable measure of oxytocin release. Mothers stored samples in their freezers until they were done collecting samples at which point, we transported the samples to an ultra-low temperature freezer using coolers filled with ice. Urine samples were stored in an ultra-low temperature freezer at -80 °C. Oxytocin samples were assayed and analyzed at the University of Wisconsin, Primate Lab by Dr. Toni Ziegler. Tables 3 and 4 include means and standard deviations of outcome measures in the study based on group assignment and groups based on frequency of kangaroo care use, respectively.
III. RESULTS

Null Hypothesis Significance Testing v. Effect Sizes

Reporting p-values and statistical significance is common in research. However, statistical significance is influenced by the sample sizes, with smaller samples less likely to be considered statistically significant. The American Psychological Association (2010) suggests that researchers report effect sizes even when results are not statistically significant. Further, statistical significance can be less informative when interpreting the practical significance of the results when using smaller/clinical samples. Use of effect sizes for reporting results with smaller samples can be one remedy as effect sizes are not sensitive to small sample sizes and are useful in interpreting the relative effectiveness of treatments and their clinical implications. The current study tested hypotheses with common null hypothesis significance testing (NHST) and also explored the strength of the relationship between kangaroo care and other variables using effect sizes in order to assess the practical significance of kangaroo care use. Specifically, because we are interested in the effectiveness of kangaroo care it is appropriate to use effect sizes because of its potential clinical and practical implications. Thus, the effect sizes and confidence intervals reported are specific to kangaroo care analyses. Further, due to variation in maternal use of kangaroo care (see Table 5), the kangaroo care was split into two separate groups based on maternal compliance with task demands, decreasing chances of finding statistical significance with traditional NHST.
Cohen (1988) suggests using the values .2 (small), .5 (medium), and .8 (large) for standardized mean difference tests of effect sizes. Cohen’s $d$ was calculated using the following formula: $M_1 - M_2 / S_{pool}$. Cohen’s $d$ reports the standardized means for effect size, allowing ease of comparability between studies. Further, the corresponding confidence intervals were calculated using the formula: $ES_{smd} + - 1.96SE_{smd}$ where $ES$ is effect size and standardized mean difference is the square root of the variance of the standardized mean difference.

**Statistical Analyses**

**H1: Exclusive breastfeeding practice will positively impact neurodevelopment.**

In order to determine if differences in brain activation existed across regions, an omnibus group (breastfeeding v formula feeding) X region (mid frontal v. lateral frontal v. central v. parietal v. occipital) X hemisphere (left v. right) test was conducted. Additionally, a MANOVA was conducted to examine differences in brain region and frontal hemispheric activation by feeding group. Paired samples $t$-tests were used to compare hemispheric and EEG frequency band activation differences in frontal EEG electrical activity across and within the alpha 1 (3-6 Hz), alpha 2 (6-9 Hz), and broadband (3-12 Hz).

Asymmetry scores at the alpha 1 band, alpha 2 band, and broadband were computed to examine differences in hemispheric activation between breast- and formula-fed infants. In order to analyze infant asymmetry scores, all recordings were normalized using a
natural log transformation and asymmetry scores were computed (ln(right)- ln(left)) so that negative scores reflect relative right hemispheric activity and positive scores reflect relative left hemispheric activity. A MANOVA was conducted to investigate feeding group effects on frontal (mid and lateral) EEG asymmetry.

**H2: Kangaroo Care will positively impact breastfeeding practices.**

In order to determine if mothers who practiced kangaroo care would display higher levels of breastfeeding self-efficacy relative to the control group, a one-way ANOVA was conducted. Effect size estimates using Cohen’s $d$ and corresponding CI’s were calculated to better determine clinical relevance of kangaroo care upon breastfeeding practice. Furthermore, the maternal breastfeeding evaluation scale was also examined for differences between the kangaroo care group and control group.

**H3: Quality of maternal affectionate care will be related to mother-infant oxytocin levels.**

A composite variable was created to reflect mothers who are high in affectionate care (HAC) and mothers who are low in affectionate care (LAC). The composite variable included percentage of affectionate maternal touch, vocalization, and gaze during infant feeding (behavioral coding states 6 and 7; Appendix A) and interaction (behavioral coding states 6 and 7; Appendix A) when the infant is 3 months of age, in which high scores reflect more positive maternal care and lower scores reflect lower levels of maternal affectionate care. The maternal affectionate care composite variable allowed us to classify mothers as high in affectionate contact (HAC) or low in affectionate contact.
(LAC) groups based on their scores. Similar to Feldman and colleagues (2010) we
classified mothers and high or low in affectionate care in an attempt to replicate their
finding that high in affectionate care mothers exhibited higher oxytocin levels relative to
low in affectionate care mothers. A mother exhibiting 60% (of affectionate care
throughout the coded behavioral session) was classified as a HAC mother and mothers
exhibiting affectionate care 40% of the behavioral sessions were classified as LAC
mothers. Mothers whose scores fell between 41% and 59% were excluded from the
present analysis. A total of 10 mothers were assigned to the LAC group and a total of 9
mothers were assigned to the HAC group.

Furthermore, all oxytocin measurements (of mothers and infants) were
normalized by taking the natural log of the raw oxytocin scores. Correlational analyses,
independent samples t-tests (comparing KC v CG and ANOVA (KC>1 hr, v. KC < 1 hr.
v. CG) were used to determine if mother-infant dyads differed in oxytocin levels as a
result of maternal affectionate care. A repeated measures ANOVA was conducted to
determine if high in affectionate care mothers and low in affectionate care mothers
differed in oxytocin levels from the prenatal to 3 month measurements. A one-way
ANOVA was used to determine if mothers who used kangaroo care were more likely to
display higher levels of affectionate care relative to the control group.

**H4: Oxytocin levels of mother and infant will be interrelated across age.**

Correlational analyses were used to assess the dyadic relationship of OT levels at
the newborn/prenatal visits and the 3 month visit.
**H5: Kangaroo Care will impact the individual stability of mother-infant oxytocin levels**

Correlational analyses and repeated measures ANOVAs were conducted to determine differences in OT levels of mothers and infants during pregnancy and 3 months postpartum based on group assignment. The analyses were conducted separately for mother and infant.

**H6: Maternal perceptions of bonding will be related to infant cortisol levels.**

Infant salivary cortisol levels are correlated pre- and post-stressor, and the two cortisol measurements are correlated with the computed baseline to task difference in cortisol levels (Table 6). Correlational analyses examined if maternal perceptions of bonding are correlated to infant cortisol levels. Further, a linear regression was used to assess the relationship of maternal fetal attachment and infant cortisol reactivity at 3 months of age.

**H7: Kangaroo Care experience will impact stress reactivity**

A one-way ANOVA examined differences in cortisol reactivity between the KC and CG groups. Effect size estimates and odds ratio calculations were used to determine clinical relevance of kangaroo care effects on cortisol reactivity (Tables 7 and 8).

**H8: Kangaroo Care will increase maternal feelings of bonding.**

The PBQ is scored so that lower scores reflect higher levels of bonding, thus we reverse scored the PBQ so that higher scores reflected higher levels of dyadic bonding. One-way ANOVAs were used to assess differences of bonding behaviors by group. A repeated measures ANOVA was also conducted to determine if kangaroo care practice
increased maternal feelings of dyadic bonding from 6 weeks postpartum to 3 months postpartum.

**Results**

**H1: Exclusive breastfeeding practice will positively impact neurodevelopment.**

A region (mid frontal v. lateral frontal v. central v. parietal v. occipital) X hemisphere (left v. right) MANOVA conducted to assess overall differences in EEG activation across the alpha 1 band revealed a main effect for region, $F(4,18) = 3.563, p = .026, \eta^2 = .44$ ($p = .069, \eta^2 = .36$ in alpha 2; $p = .032, \eta^2 = .42$ in broadband) indicating differential functioning in infant brain regions at 3 months of age. All infants displayed regional differences in brain activation, indicating that cortical activity differed by brain region. Further analyses were limited to the frontal regions because it was hypothesized that the advantages of breastfeeding in infancy are specifically manifested through enhanced functional growth of the left frontal region. Thus, the frontal lobe was examined separately from the other brain regions.

In order to further examine hemispheric differences in frontal activation between feeding groups, we conducted a MANOVA to assess differences in mid-frontal EEG asymmetry in the 3-6, 6-9, and 3-12 Hz frequency ranges; feeding method was used as the grouping variable. Formula-fed infants displayed a trend for greater left frontal EEG asymmetry relative to the breast-fed infants at the 3-6 Hz range, $F(1,20) = 4.08, p = .057, \eta^2 = .17$ and the 3-12 Hz range, $F(1,20) = 4.08, p = .057, \eta^2 = .17$. The asymmetry
analysis was not significant in the 6-9 Hz bands, $\eta^2 = .13$. Asymmetry scores of infants at the different power bands were correlated with their respective regions (Table 9). No significant differences or effects ($\eta^2 = .052-.057$) were found for asymmetry scores in the lateral frontal area.

A MANOVA was conducted to assess group (breast v. formula/mixed feed) differences in overall frontal (mid and lateral) hemispheric (left v. right) activity (3-12 Hz broadband) revealed a trend for a hemisphere X feeding method effect, $F(1,20) = 3.432, p = .079, \eta^2 = .15$ (the same trend was found in the 3-6 Hz band, $F(1,20) = 3.432, p = .079, \eta^2 = .15$). Breastfed infants displayed less activation in the right frontal hemisphere relative to formula fed infants (breastfed $MF4 = 4.295$, $MF8 = 4.966$; formula/mixed feed $MF4 = 4.741$, $MF8 = 5.678$). Table 7 displays mean power scores for the 3 frequency bands and 2 feeding groups. This effect was not evident in an analysis using the 6-9Hz frequency bands ($\eta^2 = .05$). Paired t-tests indicated the most frontal activity in the infants was clustered at the 6-9 Hz frequency bands and although not significant, breastfed infants exhibited greater mean activity in the left frontal hemisphere within the 6-9 Hz frequency band (mid frontal $d = -.06$, 95% CI [-1.07, .93]; lateral frontal $d = -.15$, 95% CI [-1.15, .84]; See also Tables 10 and 11).

A within frontal (mid and lateral frontal) region effect existed across groups, $F(1,20) = 7.7143, p = .015, \eta^2 = .267$, indicating that the mid and lateral frontal sites function differently within and between hemispheres. The effect was further examined by conducting follow-up tests to determine which frontal sites exhibited differential functioning. Paired t-tests conducted independently of feeding method revealed that
within the alpha 1 band, all frontal regions exhibited significantly different power (F3/F4 \( d = .17, 95\% \text{ CI [-.36, .71]} \); F3/F8 \( d = .56, 95\% \text{ CI [-.03, 1.15]} \); F4/F7 \( d = -.56, 95\% \text{ CI [-1.15, .03]} \); F3/F7 \( d = -.36, 95\% \text{ CI [-.94, .22]} \); F4/F8 \( d = .47, 95\% \text{ CI [-.12, 1.05]} \); See Table 12 for Ms, SDs, and p-values) except for F7/F8 (\( p = .432, d = .81, 95\% \text{ CI [.20, 1.43]} \)), indicating that the lateral frontal areas exhibit similar power values. Paired t-tests of the alpha 2 band revealed all infants exhibited differences in power values (Table 12) at all frontal sites (F4/F7 \( d = -.48, 95\% \text{ CI [-1.06, .11]} \); F3/F7 \( d = -.36, 95\% \text{ CI [-.94, .23]} \); F4/F8 \( d = -.93, 95\% \text{ CI [-1.54, -.33]} \)) except for F3/F4 (\( p = .10, d = .11, 95\% \text{ CI [-.42, .64]} \)), F7/F8 (\( p = .56, d = -.47, 95\% \text{ CI [-1.07, .13]} \)), and F3/F8 (\( p = .06, d = -.7037, 95\% \text{ CI [-1.07, .13]} \)), indicating that the mid frontal sites displayed similar power values, the lateral frontal sites displayed similar power values (similar to the alpha 1 band), and the right hemisphere frontal leads exhibited similar power values. Paired t-tests of the broadband revealed significant differences (Table 12) in the frontal regions at all sites (F3/F4 \( d = .06, 95\% \text{ CI [-.47, .59]} \); F3/F8 \( d = -.35, 95\% \text{ CI [-.93, .23]} \); F4/F7 \( d = -.45, 95\% \text{ CI [-1.03, .14]} \); F3/F7 \( d = -.38, 95\% \text{ CI [-.96, .21]} \); F4/F8 \( d = -.41, 95\% \text{ CI [-.10, .17]} \)) but F7/F8 (\( p = .498, d = -.01, 95\% \text{ CI [-.60, .58]} \)). The results indicate that across all frequency bands mid frontal sites exhibit similar power values and lateral frontal sites exhibit similar power values. However, within the alpha 2 band, infants did not display differences between the right frontal leads. The finding may indicate greater synaptic connectivity in the right hemisphere as a function of maturity. Taken together, the EEG asymmetry and power results indicate that within the frontal lobes, differences in band activity, hemisphere, and frontal brain regions indicate normative developmental specialization of frontal lobe function.
H2: Kangaroo Care will positively impact breastfeeding practices.

A one-way ANOVA was conducted to assess the effect of kangaroo care on breastfeeding practices. We found a trend for the Maternal Breast Feeding Evaluation Scale-(MBFES) Maternal Body Image and Life style Feelings Subscale, $F(1, 21) = 3.375, p = .08$, indicating the kangaroo care group reported more positive feelings toward their maternal body image and lifestyle than the control group. Analyses of total BSES and MBFES failed to reveal differences in breastfeeding practice between the kangaroo care and control group.

Small effect sizes were found for kangaroo care use on maternal reports of breastfeeding self-efficacy at 3 months ($d = .3$). However, when the kangaroo care group was re-categorized into 2 separate groups based on kangaroo care actual use for a total of three groups: 1) kangaroo care > 1 hr per day for 6 weeks, 2) kangaroo care < 1 hour per day for 6 weeks, and 3) control group, a moderate effect size ($d = .426$) for breastfeeding self-efficacy was revealed. Refer to Table 7 for effect sizes and confidence intervals.

H3: Quality of maternal affectionate care will be related to mother-infant oxytocin levels.

Correlational analyses, independent samples t-test, and ANOVA failed to reveal differences in oxytocin levels of high in affectionate care versus low in affectionate care mother-infant dyads. A repeated measures ANOVA was conducted to compare prenatal and 3 month maternal oxytocin, using the HAC/LAC variable as the grouping variable. The ANOVA failed to reveal differences in oxytocin levels of the high in affectionate
care mothers and low in affectionate care mothers between the prenatal and 3 month measurements. A one-way ANOVA failed to reveal differences in total maternal affectionate care based on group (KC v. CG) assignment and actual kangaroo care use (KC > 1 hr v. KC < 1 hr. v. CG). Effect size estimates indicated high levels of maternal affectionate care had a moderate effect ($d = .48$), 95% CI[-.8896, .8478], on increasing infant oxytocin levels but not maternal oxytocin levels ($d = .09$). Further, kangaroo care had a moderate effect ($d = .51$) on increasing levels of maternal affectionate care, but the effect size was specific to dyads who practiced kangaroo care for the recommended amount of time (1 hour per day for 6 weeks), 95% CI[-.3656, 1.3897]. In order to further explore the effects of maternal affectionate care and oxytocin levels, an attempted mediation analysis in outlined in the exploratory analysis section.

**H4: Oxytocin levels of mother and infant will be related.**

No significant correlations existed for oxytocin scores of mother-infant dyads between the prenatal/newborn measurements ($r = .298$, $p = .263$) to 3 months postpartum ($r = .019$, $p = .947$). The hypothesis was not supported.

**H5: Kangaroo Care will impact the individual stability of mother-infant oxytocin levels.**

Overall, maternal OT levels were not correlated at prenatal and 3 months. Infant OT levels were not correlated at newborn and 3 months. Within the kangaroo care group, KC maternal OT levels were not correlated at prenatal and 3 months. KC infant OT levels were not correlated at newborn and 3 months. Within the control group, CG maternal OT
levels were not correlated at prenatal and 3 months. CG infant OT levels were not correlated at newborn and 3 months. A repeated measures ANOVA was conducted to determine differences in OT levels of mothers during pregnancy and 3 months postpartum based on KC group. No significant within-subjects effects or between-subjects effects were found. The same results were found when a repeated measures ANOVA was conducted for the infants.

However, effect size estimates revealed medium to large effects sizes for oxytocin increases in mother-infant dyads based on only one use of kangaroo care. Negligible and small effect sizes were found at the newborn ($d = .055$) and prenatal ($d = .244$) measurements, expected as the kangaroo care procedure had not yet been implemented. At the 3 month measurements, effect size estimates for oxytocin increases were .618 for infants and .836 for mothers. The effect size estimates indicate at least one session of kangaroo care increased oxytocin in both mothers and infants relative to the control group. Consistent use of kangaroo care produced large effect sizes for the mother-infant group practicing kangaroo care for the recommended 1 hour per day for 6 weeks relative to the mother-infant group that did not regularly practice kangaroo care and the mother-infant control group.

**H6: Maternal perceptions of bonding will be related to infant cortisol levels.**

Cortisol reactivity was not correlated with maternal reports of bonding at 6 weeks and 3 months postpartum. Effect size estimates using the kangaroo care and control group did not reveal effects for bonding. However, when effect size estimates were calculated using the 3 groups (KC > 1 hr., KC < 1hr., CG) we found a large effect size for 3 month
PBQ scores, indicating regular kangaroo care use over a 6 week period increased maternal feelings of bonding. A moderate effect size was found for kangaroo care decreasing cortisol reactivity \( (d = -0.45) \), but this effect was also specific to the dyads who used kangaroo care for the recommended amount of time (1 hour per day for 6 weeks). Results indicate that frequency kangaroo care use has the potential to lower cortisol reactivity and increase maternal feelings of dyadic bonding.

Mother-infant bonding begins prenatally and infant HPA functioning develops in utero, thus a linear regression was conducted to investigate if fetal attachment impacts postnatal functioning of the HPA axis. Maternal fetal attachment scores (MFAS scores) were used a predictor for infant cortisol reactivity at 3 months of age. The linear regression was significant, \( R^2 = 24.5 \), \( F(1, 28) = 8.415 \), \( p = .007 \). Maternal fetal attachment accounted for 24% of the variance in infant cortisol reactivity at 3 months of age. Figure 1 depicts the inverse linear relationship between maternal fetal attachment and infant cortisol reactivity.

**H7: Kangaroo Care experience will impact stress regulation.**

A one-way ANOVA comparing cortisol reactivity failed to reveal any group differences in infants who received kangaroo care relative to infants who did not receive kangaroo care. When the kangaroo care group was re-categorized into 2 separate groups based on kangaroo care use for a total of three groups: 1) kangaroo care > 1 hr per day for 6 weeks, 2) kangaroo care < 1 hour per day for 6 weeks, and 3) control group, we found a trend for cortisol reactivity across groups, \( F(2, 24) = 2.743 \), \( p = .085 \). The kangaroo care
group who received kangaroo care for 1 hour per day for 6 weeks had the lowest average for infant cortisol reactivity (\( M = -0.2830 \) micrograms/deciliter, the negative indicating an average decrease in cortisol from baseline to task) followed by the control group (\( M = 0.1176 \) micrograms/deciliter). The kangaroo care group who received kangaroo care < 1 hour per day displayed the highest average cortisol reactivity with a mean of 0.2176 micrograms/deciliter.

The kangaroo care < 1 hr group displayed the highest levels of cortisol reactivity. Thus, odds ratio calculations were conducted to determine if kangaroo care potentially increases cortisol reactivity. An odds ratio score of 1 indicates no associated risk of higher cortisol reactivity after kangaroo care use. A score higher than 1 indicates an increased risk of higher cortisol reactivity after kangaroo care use. A score less than 1 indicates a decrease in cortisol reactivity after kangaroo care use. Odds ratio calculations revealed skin-to-skin experience had no effect on elevating cortisol reactivity (Table 8). Moreover, effect size estimates using Cohen’s \( d \) indicate kangaroo care use at over an hour per day for 6 weeks had a moderate effect on lowering infant cortisol reactivity (\( d = -0.4547 \)).

**H8: Kangaroo Care will increase maternal feelings of bonding.**

A one-way ANOVA failed to reveal bonding differences between the kangaroo care and control group. A repeated measures ANOVA was conducted to examine differences in group bonding scores across the 6 week and 3 month measurements, but again the test failed to reveal group differences in bonding. However, further analyses
yielded an effect size of .083 for the kangaroo care-control group bonding differences and an effect size of .792 for the kangaroo care > 1 hour, kangaroo care < 1 hour, and control group category, indicating increased kangaroo care use is associated with increased maternal reports of dyadic bonding. Table 7 displays the corresponding CIs.

Exploratory Analyses

A 2 (breast v. formula/mixed feed) X 3 (maternal affectionate care total v. maternal affectionate care during play v. maternal affectionate care during feeding) MANOVA revealed group differences in overall maternal affectionate care, $F(1,26) = 4.534, p = .044$. Mothers who breastfed their infants displayed higher levels of overall (total) affectionate care than mothers who formula fed/mixed fed.

A mediation analysis was attempted to investigate whether maternal oxytocin levels mediated the relationship between breastfeeding and maternal affectionate care. Oxytocin is released in response to breastfeeding (Uvnäs-Moberg, Johansson, Lupoli, & Svennsten-Sjauna, 2001) and is also associated with maternal behaviors (Pedersen et al., 1982), thus it was reasonable to propose that oxytocin may mediate the relationship between maternal affectionate care and breastfeeding. Furthermore, previous mammalian studies have demonstrated oxytocin as a mediator of maternal behavior (Champagne & Meaney, 2007; Takayanagi et al., 2005).

In an exploratory analysis, it was found that maternal affectionate care was significantly higher in the breastfeeding group relative to the formula/mixed feed group. Furthermore, linear regressions to test the possible relationship between maternal
oxytocin, maternal affectionate care, and breastfeeding significantly predicted maternal affectionate care and maternal oxytocin levels at 3 months postpartum. A change decrease in the beta statistic of the HLM analysis when oxytocin was added to the second block indicated that oxytocin may serve as a partial mediating variable between breastfeeding and maternal affectionate care. We submitted the variables to a mediation analysis, but were unable to conclude that oxytocin is a mediating variable of breastfeeding and maternal affectionate care.
IV. DISCUSSION

The present study attempted to investigate underlying physiological mechanisms associated with mother-infant bonding. Further, we attempted to elucidate the relative contributions of breastfeeding and extended skin-to-skin contact experience on mother-infant outcomes as well as measures of bonding and infant neuromaturation. The study provides evidence that kangaroo care benefits full-term mother-infant dyads on measures of breastfeeding self-efficacy, oxytocin, and cortisol reactivity. The impact of breastfeeding on neurodevelopment was partially supported and several of the kangaroo care hypotheses were also partially supported. Further, when analyses were re-computed using a new variable accounting for frequency of kangaroo care use, we found several significant effects. Importantly, the study provides evidence that frequency of kangaroo care use differentially impacts behavioral and physiological indices of mother-infant bonding as well as maternal perceptions of breastfeeding confidence. The ability to use peripheral oxytocin as a biobehavioral index of dyadic bonding is discussed and the influence of the prenatal environment on postnatal infant HPA functioning is reviewed. Further, an attempted mediation analysis conducted to determine if maternal oxytocin mediates the relationship between breastfeeding and maternal affectionate care is considered. Finally, the clinical relevance of kangaroo care is discussed.
Electrophysiological Indices of Brain Development

Breastfeeding, Frontal EEG Asymmetry, and Frequency Band Activation

It was hypothesized that exclusively breastfed infants would display EEG patterns indicative of advanced neuro-maturation (Hypothesis 1) because of the plasticity associated with the neonatal period in which the infant’s brain and nervous system are still underdeveloped and vulnerable to environmental experiences, specifically breastfeeding. Thus, it was expected that breastfeeding would serve as an effective environmental experience to enhance neurofunction in infants. Specifically, it was expected that exclusively breastfed infants would display greater left frontal EEG asymmetry and greater levels of activity in the 6-9 Hz frequency bands.

The EEG results comparing resting frontal EEG asymmetry of the breast-fed and mixed-/formula-feeding groups were non-significant. Rather, a trend was found indicating the breastfed infants displayed greater relative right frontal EEG asymmetry and the formula/mixed feed infants displayed greater relative left frontal EEG asymmetry. Further, all infants exhibited greater activity in the 6-9Hz range relative to the 3-6 Hz range at 3 months of age, extending the findings of Jones, McFall, and Diego (2004) that demonstrated a switch to the frequency range of 6-9 Hz as early as 3 months of age. However, we did find a trend for the breastfed infants displaying less overall right frontal activity in the broadband (3-12 Hz), alpha 1 band (3-6 Hz), but not the alpha 2 band (6-9 Hz). Results of the current study suggest the frequency band activation shift may occur earlier in infancy for breastfeeding and partially breastfeeding infants than
previously believed (Jing, Gilchrist, Badger, & Pivik, 2010). Moreover, the role of breastfeeding and typical developmental trajectories in relation to frequency band shifts in infancy will be discussed.

Although the infants displayed overall differences in maturation, the results were not as expected. Breastfed infants exhibited a trend for greater relative right frontal asymmetry and the formula/mixed feed group displayed greater relative left frontal asymmetry. The EEG asymmetry pattern of greater relative left frontal asymmetry in the formula-feeding/mixed-feeding infants may be due to either greater left frontal hemispheric activation or lesser right frontal hemispheric activation. Previous findings have implicated the right frontal hemisphere as predominantly active in early infancy (Gabard-Durnam, Tierney, Vogel-Farley, Tager-Flusberg, & Nelson, 2013), and in later infancy predominant hemispheric activation switches to the left frontal hemisphere (Zhu et al., 2011). It was expected that because of the involvement of the frontal lobe in the cognitive and emotional domain (Bell & Fox, 2003) greater left frontal asymmetry would indicate greater maturation in these domains. However, at 3 months of age, infants may not yet exhibit stable patterns of hemispheric activation, contributing to our lack of findings. Further, our lack of findings could due to the small sample in which all infants received at least one breastfeeding session.

Jing and colleagues (2010) found that 6-month-old formula-fed infants displayed greater cortical activity in lower frequency bands (3-6 Hz range) relative to breastfed infants. The researchers postulate that the findings may reflect differences in brain maturation as a result of diet. EEG researchers use shifts in frequency band activation as physiological
markers of neuromaturation, as frequency band shifts to higher ranges occur as a function of age (Cuevas & Bell, 2010; Jones, Field, Fox, Lundy, & Davalos, 1997). The findings of Jing et al. relate to the asymmetry findings of the current study in that the formula-fed infants displayed less activity in the 6-9 Hz bands than the breastfeeding infants. The finding may indicate that the formula/mixed feeding infants display greater overall activity in the 3-6 Hz range. Although not significant, breastfed infants in the current study exhibited greater frontal activity in the 6-9 Hz band in comparison to the formula/mixed feeding infants.

The findings related to frequency band activation in the frontal lobes extend previous research indicating a shift in frequency band activity occurs between 1 and 3 months of age (Sader, 2011). The switch in brain activity between the 3-6 Hz frequency range to the 6-9Hz frequency range is believed to be a function of age and indicator of neuromaturation (Barry, Clarke, McCarthy, Selikowitz, Johnstone, & Rushby, 2004). Across frequency bands, infants in the current study displayed differences in activity between frontal leads. Several frontal regions functioned similarly and were also correlated (Table 9) which may indicate that these regions exhibit greater connectivity. Further examination of the data using coherence measurements will allow us to determine if this is in fact due to greater connectivity between these frontal regions.

The current findings related to EEG power scores across frontal sites are consistent with the work of Barry and colleagues (2004). The researchers found greater coherence values for frontal regions in close proximity in frontal EEG patterns of 8-10-year-old children, indicative of greater synaptic connectivity. The results of the current study may reflect greater synaptic connectivity occurring within the mid and lateral frontal regions across
all frequency bands. Importantly, no functional differences in activity of the right frontal hemisphere at the alpha 2 band may also indicate synaptic connectivity occurs in the right frontal hemisphere as a function of the maturational shift to higher frequency band functioning in infancy. The finding may also serve as preliminary evidence that the right to left frontal functioning shift has not yet occurred in 3 month old infants. Taken together, the results indicate that cortical maturation in infants, as measured by EEG, displays patterns of first shifts to higher frequency bands and perhaps secondarily a switch from right to left predominant frontal functioning.

**Considerations: A Neonatal Sensitive Period for Breastfeeding Benefits?**

Although a trend for the breast-feeding infants displaying greater left frontal activity relative to the formula-/mixed-feeding group was found, the significant power value findings of the current study were not specific to feeding group, indicating that the expected cortical switch to higher frequency band activation is not influenced by stability of feeding method. Previous research indicates neurological advances for breastfeeding (Pivik, Andres, & Badger, 2011) that persist through childhood (American Academy of Pediatrics, 2005), but there is no consistency in the literature for the minimum amount of breastfeeding exposure necessary to garner the associated neurological advantages. Almost all infants in the current study had exposure to breast milk. Furthermore, I hypothesized that the entire breastfeeding environment—both nutritive and behavioral—drives neurological maturation. Thus, infants who received both breast milk and formula were classified as “formula-fed” infants. Previous research indicates neurocognitive advantages demonstrated after as little as one week of breastfeeding (Hart, Boylan,
Caroll, Musick, & Lampe, 2003). The findings indicate that even short durations of breastfeeding produce advantages through the first 3 months of life. Further research is needed to determine if these effects persist into later infancy and toddlerhood.

Peripheral Oxytocin Measurements in Mother-Infant Dyads

It was hypothesized that mothers of the high in affectionate care group and their infants would exhibit higher oxytocin levels than the low in affectionate care mothers and infants (Hypothesis 3). Inconsistent with previous findings (Gordon, Zagoory-Sharon, Leckman, & Feldman, 2010), no differences existed in oxytocin levels as a function of maternal care variation. The findings were not expected, given that the infant’s nervous system matures as a function of tactile stimulation and nutrition provided by the mother (Hofer, 1987).

Very few studies have examined infant oxytocin levels (Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010; Feldman, Gordon, & Zagoory-Sharon, 2011) and no studies have used urine to measure newborn and 3-month infant oxytocin levels. Thus, there exist no established ranges of infant oxytocin levels making it hard to ascertain if the results are due to issues in measurement or differences in peripheral oxytocin release exist across development. Theories of the development of the oxytocinergic system are based on animal models, studies of plasma levels of older infants and children, and adults. However, the mature human oxytocinergic system may be vastly different in comparison to an infant’s immature oxytocinergic system. The development of the infant oxytocinergic system needs to be studied at length before
researchers can conclude whether infant oxytocin should, in fact, be related to oxytocin levels of the parent and how oxytocin levels relate to the interactive behaviors of a dyad. Further, samples of infant urine used to examine oxytocin levels needs to be further studied to determine if urine oxytocin levels are 1) a reliable measure and 2) reflective of infant oxytocin release.

A possible explanation for the findings of the current study is based on the research of Cyranowski and colleagues (2008). Cyranowski found that dysregulated oxytocin levels are related to maternal mood problems, thus it is possible that variations in mother-infant bonding are linked to dysregulated levels, rather than high or low levels. Further, because oxytocin is believed to have an anxiolytic effect, high levels of oxytocin could also be reflective of the body’s attempt to maintain homeostasis during times of stress or novelty.

For instance, mothers low in sensitivity experience higher levels of oxytocin after interacting with their infants compared to mothers high in sensitivity (Elmadih et al., 2014). The authors conclude that higher basal oxytocin levels may be a biomarker for heightened stress responsivity. Further, in a study of mothers who interacted with their own children and with unfamiliar children, maternal plasma oxytocin levels increased during the unfamiliar interaction (Bick & Dozier, 2009). The research provides evidence that oxytocin is released in order to facilitate social interaction. Once baseline behavior is established in a dyad, further oxytocin surges may not be necessary except in situations which necessitate increased social interaction or affiliation. Taken together, oxytocin
research indicates basal levels of oxytocin may not only reflect variations in maternal care but also reflect individual differences in stress reactivity.

In a separate study conducted by Feldman, Gordon, and Zagoory-Sharon (2011) salivary, plasma, and urine were collected and assayed for oxytocin levels. Plasma and salivary oxytocin levels were related but neither was related to urinary oxytocin levels. Importantly, plasma and salivary oxytocin levels were related to positive interactive behaviors and mother-child affect synchrony whereas urinary oxytocin levels were related to maternal stress and anxiety. The social environment of the mother-infant dyad is a complex interplay of emotions and behavior. Although most oxytocin research focuses only on demonstrating oxytocin as a biomarker for affiliative behavior, the role of oxytocin is more complex than previously theorized and not specific to positive behaviors. Oxytocin appears to also play a role in dampening the negative effects of stress and modulating fear and anxiety in mothers.

Moreover, researchers have posited that individual differences in maternal fear and aggression may modulate oxytocin release in animals and humans. Most studies focus on positive maternal social interactions with their infant because oxytocin regulates initiation and maintenance of maternal behavior. Yet oxytocin may also regulate patterns of maternal behavior specific to negative affect and behavior. Feldman, Gordon, and Zagoory-Sharon (2011) found that maternal oxytocin measured from urine samples was related to maternal stress and anxiety. Similar biobehavioral profiles are also evident in mammals.
For instance, most mothers of infant mammals display hostility or aggression toward unfamiliar intruders, a pattern of maternal behavior referred to as maternal aggression. One study (Bosch, Meddle, Beiderbeck, Douglas, & Neumann, 2005) found maternal aggression in rats was related to the location of inter-cerebral release of oxytocin and also the level of fear/anxiety of the dam. A maternal defense task, in which a virgin (non-mother rat) intruder was introduced in the dam’s cage, increased the release of oxytocin in the paraventricular nucleus (PVN) and amygdala of high-anxiety rats, but decreased release of oxytocin in the PVN of low-anxiety rats. The high-anxiety rats displayed significantly more aggressive behaviors toward the virgin intruder when compared to the low-anxiety rats. Furthermore, high-anxiety rats that were administered an oxytocin receptor antagonist exhibited reduced aggressive maternal behavior, implicating oxytocin release in the expression of aggression during high-anxiety or fear-inducing environments.

The key to the behavioral consequences of oxytocin release may lie within the amygdala. The Bosch et al. (2005) study demonstrated oxytocin release was highest in the amygdala of the dam who displayed the most aggressive behaviors. Another study found that participants who received oxytocin administration prior to viewing fearful stimuli displayed reduced amygdala activation when compared to participants who received a placebo (Kirsch et al., 2005). Brains of high-anxiety rats may release higher concentrations of oxytocin in the amygdala as a compensatory function because these rats are innately more fearful than low-anxiety rats; oxytocin not only creates a behavioral response, behavior necessitates the release of oxytocin within the amygdala, especially in
highly fearful rats. Although the expression of behavior varies upon the environmental context and genetic predispositions, researchers do agree that oxytocin modulates the amygdala in the manifestation of fear and aggression. Future studies may investigate if maternal fear and anxiety in humans mediates maternal oxytocin levels. If so, do the fearful/anxious mothers display higher or lower levels of oxytocin?

It was expected that mother-infant oxytocin would be correlated at the newborn-prenatal and 3 month measurements (Hypothesis 4). However, mother-infant oxytocin levels were not correlated at either measurement. Birth can be viewed as a stress-inducing experience for the mother and infant, both physically and psychologically, because of the demand placed upon the body’s physical and cognitive resources. Sippel et al. (1978) found that cortisol is elevated during birth and subsequently declines over the first day. Thus, birth may “reset” some of the neuroendocrine functioning in the infant body explaining differences in mother-infant oxytocin levels at the prenatal-newborn measurement. Further, during the hours and weeks following birth the mother and infant bond in a different manner than during pregnancy.

It may be during this time that the infant’s physiological functioning begins to synchronize with maternal physiological functioning. It is also possible that this process takes months or even years to occur, before dyadic behavior and physiology become synchronized. This would explain why a significant difference existed in oxytocin levels at the newborn-prenatal measurements but not the 3 month measurements. Tessier et al. (1998) found that pre-term infants who were the least physiologically stable experience the greatest reports of maternal competence and sensitivity, suggesting a dynamic
interplay between the infant’s vulnerable nervous system, impact of kangaroo care on the
infant’s physiological stability, and increases in maternal behavior. KC appears to have
the greatest effects on vulnerable infants, creating a demand to maintain homeostatic
functioning and perhaps greater capability for the environment to attenuate physiological
predispositions. Thus, moderate stress associated with birth may also make this time
period ideal for the implementation of kangaroo care in full-term infants.

Counter to Hypothesis 5, maternal oxytocin levels were not related across the
maternal prenatal-3 month measurements and infant oxytocin levels were not related at
the newborn-3 month time periods. Feldman and colleagues (2011) found that maternal
oxytocin levels were highly variable but also highly stable within individuals. The current
study failed to replicate the findings of Feldman. However, the current study used urine
samples to assess oxytocin levels, whereas Feldman used blood samples. Further, there
were no significant oxytocin correlations based on group assignment to the kangaroo care
or control group. Repeated measures ANOVAs conducted separately for mothers and
infants failed to reveal any within or between-group (kangaroo v. control) differences in
oxytocin levels.

Because of the lack of findings for the oxytocin measurements, odds ratios were
calculated based on the increase in oxytocin levels from the prenatal/newborn
measurement to the 3 month measurement for the control group and kangaroo care group.
The odds ratio calculations indicated that kangaroo care experience increased maternal
oxytocin levels relative to the control group (OR = 2.85; CI = .4215, 19.25). Further, the
odds ratio calculations revealed that the kangaroo care group infant experienced an
overall increase in oxytocin levels relative to the control group infants (OR = 4.07; CI = .3442, 48.24). However, it is difficult to conclude with certainty that kangaroo care increased mother-infant oxytocin levels because the corresponding confidence intervals are wide. Although the OR is high, wide confidence intervals, most likely due to the small sample size of the current study, decrease the precision of the measurement. Researchers have theorized a bio-mechanism exists between oxytocin increase and kangaroo care use in infants (Feldman, 2007). The current study extends this theory with evidence that kangaroo care accounts for increases in oxytocin in mothers and their full-term infants, regardless of feeding method. Yet, further research must be conducted to determine if this finding can be replicated due to the wide confidence intervals of the odds ratio calculations and also to determine if kangaroo care effects on peripheral oxytocin values can be replicated.

**Prenatal Calibration of the HPA Axis**

Maternal fetal attachment predicted infant cortisol reactivity at 3 months of age (Hypothesis 6). The relationship between fetal attachment and infant cortisol reactivity was an inverse relationship. Mothers who reported lower attachment to their fetus were also more likely to have an infant who displayed higher levels of cortisol reactivity at 3 months of age in response to a mild stressor. This finding bolsters existing research which claims the HPA axis develops prenatally (de Weerth & Buitelaar, 2005; Lundy, et al., 1999). The current findings were specific to prenatal reports of fetal bonding. Postnatal reports of mother-infant bonding were not predictive of infant cortisol reactivity at 3 months of age, indicating that the shared physiology of dyadic bonding during
gestation imparts different physiological consequences of infant physiological HPA function than postnatal bonding.

Prenatal contributors of postnatal development have long been of interest to researchers, specifically if and how prenatal environmental factors predict postnatal development across the first few months of life (Loman & Gunnar, 2010; Weinberg, Smotherman, & Levine, 1980). Prenatal calibration of postnatal predispositions would explain why pre-term infants, whose nervous systems and brains are highly underdeveloped and should in fact still be in utero, display heightened benefits from kangaroo care over full-term infants. Infant cortisol reactivity predicted from maternal fetal attachment scores, indicates that maternal bonding behaviors, and presumably underlying neuroendocrine functioning, influence the development of the infant’s HPA axis.

Glynn, Davis, and Sandman (2013) proposed a prenatal biomechanism which influences infant HPA functioning. Corticotrophin releasing hormone regulates (CRH) physiological response to stress and is increased during pregnancy in the placenta. The physiological consequences of the CRH surge during pregnancy include increased cortisol levels and a diminished HPA response. However, it is believed that pregnant women who do not display lowered HPA responses adversely impact the fetus. Chronic prenatal stress is believed to impact infant HPA functioning (de Weerth & Buitelaar, 2005). Dysregulation of the HPA axis during pregnancy is linked to pre-term delivery (Facchinetti & Ottolini, 2004), maternal depression (Field et al., 2004; Field et al., 2008), and postnatal interactive quality of the dyad (Brummelte, Grunnau, Zaidman-Zait,
Further, mothers and infants who may have dysregulated HPA functioning may especially benefit from kangaroo care as it has been demonstrated to decrease maternal depressive symptoms and increase interactive quality of mother-infants dyads. The current study provides evidence that prenatal factors predict postnatal physiological stress reactivity but also demonstrates that prenatal biological predispositions are, in part, amenable to environmental influences in early infancy. Infants exposed to kangaroo care displayed decreases in cortisol reactivity in response to an environmental stressor.

The findings of the current study indicate that prenatal bonding influences physiological development prenatally but postnatal implementation of heightened skin-to-skin contact has the ability to downregulate HPA reactivity. Champagne and Meaney (2007) found that licking and grooming behaviors in rats attenuates predispositional stress reactivity. Kangaroo care functions similarly in humans; enhancing maternal contact with the infant decreases infant stress reactivity and perhaps attenuates predispositional stress reactivity. Taken together, the findings indicate that postnatal development of the HPA axis is 1) in part attenuated by tactile stimulation in the form of kangaroo care, and 2) influenced by prenatal maternal bonding with the fetus.

Creating interventions during pregnancy may enhance postpartum effects of kangaroo care. It is possible that postpartum interventions may have effects on HPA functioning or even heighten effects of postnatal interventions. Although postpartum
procedures such as kangaroo care may decrease cortisol levels of mother and infant (Engler, in press; Takahashi et al., 2010), kangaroo care may not alter tonic functioning of the HPA axis. The findings of the regression provide evidence for the calibration of the HPA axis prenatally which in turn affects postnatal functioning.

Sensitive Periods: Timing Effects of Kangaroo Care and Breastfeeding

Kangaroo care had a moderate effect on breastfeeding confidence and experience, providing partial support for Hypothesis 2. The results indicate that kangaroo care use does, in fact, impact breastfeeding practices, but this effect increased based on longer kangaroo care use. Importantly, it appears that kangaroo care had effects on breastfeeding practice even after the first week of life. Previous research on kangaroo care implements kangaroo care immediately following birth in pre-term and full-term infants (Conde-Agudelo, Diaz-Rossello, & Belizan, 2003; Feldman & Eidelman, 2003; Takahashi et al., 2010). The current study provides preliminary evidence that kangaroo care impacts feeding practice after initial feeding patterns have already been established within the dyad.

Analyses of null hypothesis significance testing failed to reveal breastfeeding effects of kangaroo care when comparing the kangaroo care and control groups. Effect size estimates revealed moderate effects only when using three groups based on frequency of kangaroo care use: the control group, kangaroo care group < 1 hour (dyad assigned to the kangaroo care group but mother used kangaroo care less than the recommended 1 hour per day for 6 weeks), and kangaroo care > 1 hr (dyad assigned to
the kangaroo care group and mother used kangaroo care for the recommended 1 hour per day for 6 weeks). Previous studies have established links between kangaroo care use and increased breastfeeding duration and stability; however, this link is specific to pre-term infants (Feldman et al., 2002). The findings of the current study, though, were specific to mother-infant dyads that used kangaroo care for the recommended hour per day for 6 weeks. The current findings indicate that kangaroo care implemented as late as 1 week postpartum has positive effects on maternal reported breastfeeding confidence and experience. The results also indicate kangaroo care increases dyadic bonding. Kangaroo care may increase the interactive quality of mother-infant interactions and dyadic bonding during feedings making the mother feel more confident in her ability to breastfeed.

A large effect size estimate was found for the 3 month report of dyadic bonding when comparing kangaroo care use (KC>1 hour group, KC<1 hour group, and control group). The findings indicate that consistent use of kangaroo care produced effects on maternal reports of bonding at 3 months. Two important implications are taken from the finding: 1) bonding effects of kangaroo care persist even after kangaroo care is not practiced, and 2) the effects of kangaroo care on bonding are increase with frequency of KC use.

Infants in the kangaroo care group >1 hour per day exhibited a trend for lower cortisol reactivity relative to the KC< 1 hour group and the control group (Hypothesis 7). When comparing the KC and control groups, effect size estimates did not yield effects; however, when effect size estimates were calculated using the three groups (KC>1 hour,
the analysis yielded a medium effect size indicating that kangaroo care use impacts infant cortisol reactivity. It has been demonstrated in previous research that just one session of kangaroo care significantly decreases cortisol levels in pre-term infants (Mooncey et al., 1997). We were able to provide evidence that cortisol reactivity is also decreased in full-term infants who were given kangaroo care for 6 consecutive weeks. Full-term infants may benefit from kangaroo care after stressful procedures, such as inoculation, after maternal separation, or maternal unresponsiveness.

Kangaroo care use also has implications for infants who may experience dysregulated HPA functioning following birth, such as infants born to mothers with psychopathologies. The functioning of the stress response system (or HPA axis) in infancy is thought to have long-lasting effects on development, specifically impacting behavioral and physiological responses to stressors (Brummelte, Grunau, Zaidman-Zait, Weinberg, Nordstokke, & Cepeda, 2011; Laurent, Ablow, & Measelle, 2012). Implementing kangaroo care after birth may help to attenuate a predisposition for high HPA reactivity.

The breastfeeding hypothesis (Hypothesis 1) that was not supported and the effects found for kangaroo care use (Hypothesis 2; Hypothesis 8) may provide evidence of sensitive periods for garnering benefits from breastfeeding and kangaroo care. For instance, the current study provides evidence of an early sensitive period for breastfeeding effects because the breastfed infants did not display advances in neuromaturation over the formula and mixed feed infants. All of the infants in the sample received at least one session of breastfeeding suggesting that the colostrum expressed by
the mother over the first few days postpartum may provide protective neurological benefits. Infants who receive as little as one breastfeeding, in which the infant ingests colostrum, may account for the neurocognitive benefits of breastfeeding. Hart and colleagues (2003) found evidence of neurocognitive advantages of breastfeeding demonstrated as early as week postpartum (Hart, Boylan, Caroll, Musick, & Lampe, 2003).

Thus, it may be of importance for mothers who do not intend to breastfeed to attempt at least one breastfeeding session immediately after birth, or to express colostrum and feed it to the infant via a syringe. The timing effects of neurocognitive advantages associated with breastfeeding need to be further studied, as breastfeeding research often excludes the amount of time the infant was breastfed and definitions of breastfeeding differ by article (Petryk, Harris, & Jongbloed, 2007). Explicit operational definitions of breastfeeding and continuous variables of breastfeeding length will elucidate timing effects of breastfeeding on cortical development. The current study provides preliminary evidence that any amount of breastfeeding in infancy influences normative patterns of cortical development.

Timing effects were also found for kangaroo care. While previous research on pre-term infants has yielded effects for kangaroo care use on increasing oxytocin and decreasing cortisol with as little as 1.5 hours of use (Engler, in press), our cortisol results but not oxytocin results were revealed when we adjusted the kangaroo care variable based on kangaroo care use. For any amount of kangaroo care use, oxytocin levels of mother-infant dyads in the kangaroo care group were higher than the control group.
Feldman, Rosenthal, and Eidelman (2014) found that after 2 weeks of kangaroo care, pre-term infants showed increases in cognitive functioning and decreases in stress response activation from 6 months to 10 years of age relative to matched controls. However, in our study kangaroo care effects on decreasing cortisol reactivity were only found for the kangaroo care group that used kangaroo care for the recommended amount of time (6 weeks for at least one hour per day). On measures of breastfeeding confidence and practice as well as dyadic, effects were similar to the cortisol reactivity findings. Moderate effects for increased breastfeeding experience and confidence emerged as an effect of kangaroo care only when we looked at kangaroo care use. Large effects for increased dyadic bonding were found only if the mother-infant dyad practiced kangaroo care for the suggested amount of time (1 hour per day for 6 weeks).

Taken together, the findings indicate that kangaroo care use 1) differentially affects both the biology and behavior of mother-infant bonding and breastfeeding based on frequency of use and 2) just one session of kangaroo care appears to have long-lasting effects on biological indices but not maternal reports of dyadic bonding. Feldman and colleagues (2014) contend that in order for kangaroo care to work it must be implemented during a sensitive period. Based on this contention and the results of the present study, future research should focus on when, and if, a sensitive period for implementing kangaroo care exists in full-term infants.
Limitations

There exist several limitations regarding group assignment in the study including feeding method grouping, maternal compliance to recommended kangaroo use, and measurement of peripheral oxytocin. Because feeding method is a highly personal choice, mothers self-assigned into feeding groups. The study had low levels of exclusively formula-feeding mothers, presumably because all mothers who enrolled in the study intended to breastfeed. The levels of formula-feeding mothers at 3 months of age was not consistent with CDC estimates of U.S. breastfeeding rates at 3 months postpartum (35% for the U.S.; 52% for the current study). Upon group assignment two mothers refused to participate in kangaroo care.

Participants were asked to record their kangaroo care use (or feeding patterns) in a notebook provided through the study. The notebooks would have provided us with a continuous variable for kangaroo care, but only 3 mothers in the study returned the notebooks. Further, mothers then had to estimate their use of kangaroo care (“did you use it every day?”, “how long did you use it every day?”, “until when did you use it?”) in order for the researcher to estimate kangaroo care use. Future kangaroo care studies using full-term infants need to use a more regulated system for monitoring maternal kangaroo care. Effects for kangaroo care were found based on use, but mothers who used kangaroo care for the recommended amount of time may be inherently different than mothers who chose not to use kangaroo care for the recommended amount of time. For instance, the desire to practice kangaroo care may be related to quality of maternal caregiving
behaviors. The results of the study may merely dichotomize behaviors which would exist without the use of kangaroo care, but perhaps are exacerbated by the procedure.

The current study is the first to measure peripheral oxytocin release through human infant urine. Thus, because of the measure’s novelty there exist concerns in reliability of measurement, stability of these measurements and comparability of infant oxytocin levels to adult oxytocin levels. First, there exist no other studies for which to compare our infant oxytocin results, making it difficult to determine if our findings are consistent with other studies measuring plasma oxytocin (Feldman et al., 2012). Second, it is not known how variable peripheral oxytocin measured through infant urine is because of the lack of previous research. Lastly, the manner in which we understand oxytocin and its effects on mother-infant bonding and breastfeeding is limited and may not be correlated with infant levels of oxytocin. However, the current study provides evidence that collecting and subsequently analyzing infant urine for peripheral oxytocin levels is feasible.

Future studies may also utilize baseline-to-task measurements of oxytocin release from kangaroo care. Using this research paradigm, Kim and colleagues (2013) found that maternal plasma oxytocin was positively related to maternal behavior. Unlike the present study, oxytocin was measured before and after maternal interaction with her infant. OT collected before and directly following KC to estimate OT release, in comparison to an infant feeding, may provide researchers a better estimate of the oxytocin increase experienced in the dyad following kangaroo care. However, the ability to collect baseline-to-task measurement for urine collection may not prove feasible with infant
populations due to the indirect manner of collection. Plasma oxytocin measurements are collected more directly, but pose more risk to infants as the collection is done intravenously through blood or collection of cerebrospinal fluid. Maternal cortisol levels were not collected; however, collecting maternal cortisol samples may be useful in future studies in order to determine if oxytocin levels blunt HPA reactivity. Further, some researchers (Yuen et al., 2014) have found evidence that cortisol release functions independently of oxytocin release, whereas other researchers contend oxytocin has an anxiolytic effect on HPA reactivity (Hostinar, Sullivan, & Gunnar, 2014). Future studies investigating neurodevelopment should control for potential environmental effects of resting EEG asymmetry recordings by implementing a second measure of infant neurofunctioning. Habituation tests may be an appropriate measure of cognitive functioning in young infants, especially because previous studies have found correlations between infant habituation and later IQ scores (Kavšek, 2004).

Exploratory Analysis: Maternal Oxytocin as a Mediator of the Relationship between Breastfeeding and Maternal Affectionate Care

The lack of mediation between breastfeeding and maternal affectionate care may provide evidence that oxytocin influences the initiation of, but perhaps not the maintenance, maternal behaviors. DaCosta and colleagues (1996) found that once maternal care was established after birth, lesioning the paraventricular nucleus (PVN; the area of the brain where oxytocin is manufactured) in maternal sheep brains did not alter subsequent maternal behavior, leading the authors to conclude that oxytocin release mediates maternal care only immediately after birth. Thus, oxytocin may function as a
mediator of maternal care and breastfeeding immediately following birth. However, no significant results were found with the variables at the prenatal/newborn phase in the current. One possibility for the lack of findings in our study at the newborn/prenatal period may be due to variations in feeding method; in mammalian models there is no variation in feeding method, all offspring are fed from the lactating mother.

**Concluding Remarks**

Kangaroo Care is most often provided to pre-term infants in order to aid in roper development of a premature nervous system. However, the current study provides preliminary evidence that mothers and their full-term infants benefit from kangaroo care use on measures of physiology, breastfeeding practices, and bonding. Although traditional null hypothesis significance tests failed to reveal effects of kangaroo care of mother-infant physiological indices of bonding and breastfeeding practices, effect size estimates and odds ratio calculations yielded moderate to large effects for kangaroo care use.

The results of the study suggest that implementing late kangaroo care may impact bio-behavioral functioning of the mother-infant dyad in a similar manner as birth KC. Many organizations such as the American Association of Pediatrics (2005) and World Health Organization (1996) recommend kangaroo care use, but most hospitals fail to adopt KC procedure after birth. Educating mothers prenatally about the potential benefits of kangaroo care will serve to increase KC awareness and practice in the US. Further
studies are needed to determine the long-lasting effects of KC and the ideal window to implement and continue practice with full-term infants.
Table 1. Dependent Measures of Constructs Assessed at each Visit

<table>
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<th>Visit</th>
<th>Variable</th>
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<th>Neo-6 wk</th>
<th>natal</th>
<th>natal</th>
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<td>Maternal Mood</td>
<td>CES-D</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>EPDS</td>
</tr>
<tr>
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<td>Feeding (collected to control for covariate effects)</td>
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<td>Intentions</td>
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<td></td>
<td>BAPT M</td>
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<td>Demographic Interview M</td>
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<td>Status, experiences and stability</td>
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<tr>
<td></td>
<td>BSES MMM</td>
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<td>MBFES M</td>
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<td>Feeding interaction observation B</td>
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<tr>
<td></td>
<td>Perceptions of bonding/attachment (collected to control for covariate effects) and infant temperament</td>
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<tr>
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<td>MFAS M</td>
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<tr>
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<td>MAAS M</td>
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<td>PBQ MMIBQ-R mother-report of infant temperament</td>
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<td>Infant growth and development</td>
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<td>BNBAS I</td>
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<td>Ponderal Index – height/weight index I</td>
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<td>Face-to-face play and feeding interaction observations B</td>
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<td></td>
<td>Arm-restraint Procedure (frustration task) I</td>
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<td>I</td>
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<td></td>
<td>Oxytocin assay MIB Cortisol assay I</td>
<td>I</td>
<td>I</td>
<td>I</td>
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</tr>
<tr>
<td></td>
<td>EEG I</td>
<td>I</td>
<td>I</td>
<td>I</td>
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</tr>
</tbody>
</table>

Note. M = mother, I = infant, and B = data collected on both mother and infant. aBehavior patterns coded for mother, infant and the dyad include: attention, affect, touch; bPhysiological variables to be evaluated for mothers include: biochemical patterns; stability in biochemical patterns across time; and changes in biochemical regulation. Physiological variables to be evaluated for infants include: biochemical and EEG patterns; stability of physiological patterns across time; and changes in biochemical and physiological regulation. We also will evaluate the relationship between mother-infant bio-chemical patterns.
Table 2. Correlations of Maternal Depression Scales Across Visits

<table>
<thead>
<tr>
<th></th>
<th>PN CES-D</th>
<th>NB CES-D</th>
<th>NB EPDS</th>
<th>6 wk. CES-D</th>
<th>3 mo. CES-D</th>
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<tr>
<td>NB CES-D</td>
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<td>NB EPDS</td>
<td>112</td>
<td></td>
<td>.721**</td>
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<tr>
<td>6 wk. CES-D</td>
<td>602**</td>
<td>.580**</td>
<td></td>
<td>.382</td>
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<tr>
<td>3 mo. CES-D</td>
<td>697**</td>
<td>.679**</td>
<td>.385</td>
<td>.871**</td>
<td></td>
</tr>
<tr>
<td>3 mo. EPDS</td>
<td>639**</td>
<td>.447*</td>
<td>.218</td>
<td>.782**</td>
<td>.703**</td>
</tr>
</tbody>
</table>

* Indicates significant correlation at alpha level .05. ** Indicates significant correlation at alpha level .01. PN = prenatal visit, NB = newborn visit; 6 wk. = 6 week visit, 3 mo. = 3 month visit. CES-D = Center for Epidemiological Studies- Depression Scale. EPDS = Edinburgh Postnatal Depression Scale.
Table 3. Means and Standard Deviations of Outcome Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>KC</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Premetal</td>
<td>Newborn</td>
<td>6 week</td>
<td>3 month</td>
<td>Premetal</td>
<td>Newborn</td>
<td>6 week</td>
<td>3 month</td>
<td>Premetal</td>
<td>Newborn</td>
<td>6 week</td>
<td>3 month</td>
<td>Premetal</td>
<td>Newborn</td>
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<tr>
<td>MAAI</td>
<td>79.86(2.20)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>74.22(8.34)</td>
<td>—</td>
<td>—</td>
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<td>—</td>
<td>—</td>
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<td></td>
</tr>
<tr>
<td>MEAS</td>
<td>74.7(13.40)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>67.60(13.22)</td>
<td>—</td>
<td>—</td>
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</tr>
<tr>
<td>CES-D</td>
<td>10.13(7.48)</td>
<td>4.36(3.85)</td>
<td>12.00(12.02)</td>
<td>6.26(10.87)</td>
<td>7.48(3.87)</td>
<td>6.70(7.11)</td>
<td>0.26(3.20)</td>
<td>3.00(5.16)</td>
<td>—</td>
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</tr>
<tr>
<td>EPDS</td>
<td>—</td>
<td>4.36(3.40)</td>
<td>—</td>
<td>4.82(6.68)</td>
<td>—</td>
<td>5.14(2.29)</td>
<td>—</td>
<td>—</td>
<td>3.54(2.07)</td>
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</tr>
<tr>
<td>RAFT</td>
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<td>—</td>
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</tr>
<tr>
<td>Positive</td>
<td>469.4(68.02)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>571.78(89.64)</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Negative</td>
<td>123.46(59.04)</td>
<td>16.73(3.54)</td>
<td>—</td>
<td>—</td>
<td>173.59(16.59)</td>
<td>—</td>
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<td>—</td>
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</tr>
<tr>
<td>Control</td>
<td>163.0(68.02)</td>
<td>—</td>
<td>50.37(5.83)</td>
<td>—</td>
<td>43.17(8.73)</td>
<td>—</td>
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<td></td>
</tr>
<tr>
<td>BRES</td>
<td>—</td>
<td>50.41(19.25)</td>
<td>54.50(30.51)</td>
<td>46.00(28.71)</td>
<td>—</td>
<td>50.39(20.57)</td>
<td>46.69(25.80)</td>
<td>40.82(31.99)</td>
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<td>—</td>
<td>—</td>
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<td></td>
</tr>
<tr>
<td>MIFES</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>18(7.71)</td>
<td>30(7.73)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>116(145.14)</td>
<td>—</td>
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<tr>
<td>Infant OT</td>
<td>—</td>
<td>1.9(0.74)</td>
<td>—</td>
<td>1.9(0.51)</td>
<td>—</td>
<td>1.9(0.97)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1.9(0.97)</td>
<td>—</td>
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</tr>
<tr>
<td>Mother OT</td>
<td>2.23(0.87)</td>
<td>—</td>
<td>—</td>
<td>2.16(0.85)</td>
<td>—</td>
<td>2.18(0.72)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2.18(0.72)</td>
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<tr>
<td>PBQ</td>
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<td>—</td>
<td>-4.59(10.75)</td>
<td>-11.29(14.31)</td>
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<td>—</td>
<td>-7.82(15.17)</td>
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<td>—</td>
<td>-11.42(16.94)</td>
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<tr>
<td>MAC</td>
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<td>—</td>
<td>—</td>
<td>-4.23(20.76)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>-4.23(20.76)</td>
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</tbody>
</table>

MAAS = Maternal Antenatal Attachment Scale; MAAI = Maternal Affective Attachment Scale; CES-D = Center for Epidemiological Studies-Depression Scale; Edinburgh Postnatal Depression Scale; RAFT = Breastfeeding Attitudes Postnatal Tool; positive, negative, social, and control subscales; BRES = Breastfeeding Self-Efficacy Scale; MIFES = Maternal Breastfeeding Evaluation Scale; Infant OT = infant observer; Mother OT = mother observer; PBQ = Postpartum Bonding Questionnaire; MAC = Percentage of maternal affectionate care displayed by mother during a feeding session and play session; — indicates the measure was not affected by the intervention.
Table 4. Means and standard deviations of outcome measures of groups based on kangaroo care use.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Premature</th>
<th>Newborn</th>
<th>6 week</th>
<th>3 month</th>
<th>Premature</th>
<th>Newborn</th>
<th>6 week</th>
<th>3 month</th>
<th>Premature</th>
<th>Newborn</th>
<th>6 week</th>
<th>3 month</th>
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<tbody>
<tr>
<td>MAAM</td>
<td>0.65 ± 0.13</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.60 ± 0.14</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.60 ± 0.14</td>
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<tr>
<td>MTAS</td>
<td>7.4 ± 4.9</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>7.5 ± 4.9</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>7.5 ± 4.9</td>
<td>—</td>
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<tr>
<td>CBRD</td>
<td>6.0 ± 1.5</td>
<td>2.0 ± 1.2</td>
<td>5.5 ± 5.7</td>
<td>2.5 ± 3.4</td>
<td>5.5 ± 5.7</td>
<td>2.0 ± 1.2</td>
<td>5.5 ± 5.7</td>
<td>2.0 ± 1.2</td>
<td>5.5 ± 5.7</td>
<td>2.0 ± 1.2</td>
<td>5.5 ± 5.7</td>
<td>2.0 ± 1.2</td>
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<td>FMD</td>
<td>—</td>
<td>5.8 ± 1.8</td>
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<td>3.8 ± 1.8</td>
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<td>5.8 ± 1.8</td>
<td>—</td>
<td>3.8 ± 1.8</td>
<td>—</td>
<td>5.8 ± 1.8</td>
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<td>BAPTT</td>
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<td>56 ± 16.5</td>
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<td>56 ± 16.5</td>
<td>30 ± 16.5</td>
<td>56 ± 16.5</td>
<td>30 ± 16.5</td>
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<tr>
<td>BRSF</td>
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<td>56 ± 16.5</td>
<td>—</td>
<td>30 ± 16.5</td>
<td>—</td>
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<td>56 ± 16.5</td>
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<td>30 ± 16.5</td>
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<td>ASBEES</td>
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<td>120 ± 30.2</td>
<td>22 ± 4.2</td>
<td>—</td>
<td>—</td>
<td>120 ± 30.2</td>
<td>22 ± 4.2</td>
<td>—</td>
<td>—</td>
<td>120 ± 30.2</td>
<td>22 ± 4.2</td>
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<tr>
<td>Instant OT</td>
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<td>5.4 ± 1.3</td>
<td>—</td>
<td>3.9 ± 1.3</td>
<td>—</td>
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<td>5.4 ± 1.3</td>
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<td>3.9 ± 1.3</td>
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<td>Mother OT</td>
<td>2 ± 1.5</td>
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<td>2 ± 1.5</td>
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<td>2 ± 1.5</td>
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<td>14 ± 6.4</td>
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<td>14 ± 6.4</td>
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<td>14 ± 6.4</td>
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<td>14 ± 6.4</td>
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<td>5 ± 2.5</td>
<td>—</td>
<td>5 ± 2.5</td>
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</tr>
</tbody>
</table>

MAAM = Maternal Anxiety, Attachment Scale; MTAS = Maternal Toddlers, Attachment Scale; CBRD = Centre for Epidemiologic Studies Depression Scale; Edinburgh Postnatal Depression Scale; BAPTT = Birth-Adjusted Preterm Term; BRSF = Birth-Adjusted Preterm Scale; ASBEES = Asymmetrically Balanced Emotional Experience Scale; Mother's OT = Mother's Occupational Therapy; PZO = Postoperative Obstetric Scale; MAC = Percentage of maternal, affective, and mild anxiety; 95% CI: 95% confidence interval; **p < 0.01; ***p < 0.001.
Table 5. Number of participants assigned to the kangaroo care group and control group and the number of participants in groups based on frequency of kangaroo care use.

<table>
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<tr>
<th>Group Assignment</th>
<th>Groups Based on Task Compliance</th>
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<tr>
<td></td>
<td>KC &gt; 1 hr</td>
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<tr>
<td>KC</td>
<td>N</td>
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<tr>
<td>CG</td>
<td>8</td>
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</table>

(2 KC participants did not return for the 3 month visit)
Table 6. Cortisol Intercorrelations

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<tr>
<th></th>
<th>Cortisol Baseline</th>
<th>Cortisol Post-Test</th>
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<tbody>
<tr>
<td>Cortisol Baseline</td>
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<td></td>
</tr>
<tr>
<td>Cortisol Post-Test</td>
<td>.380*</td>
<td></td>
</tr>
<tr>
<td>Cortisol Baseline-to-Task</td>
<td>.667**</td>
<td>-.424*</td>
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</table>

*p < .05

**p < .01
Table 7. Effect sizes using Cohen’s $d$ and 95% confidence intervals estimating the effects of kangaroo care on neuroendocrine functioning, breastfeeding self-efficacy and mother-infant bonding.

<table>
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<tr>
<th></th>
<th>KC v. CG</th>
<th>KC &gt; 1 hr v. KC &lt; 1 hr v. CG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortisol Reactivity</td>
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<tr>
<td>(H7)</td>
<td>-1.837</td>
<td>-0.457</td>
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<tr>
<td>v = 1.442</td>
<td>(1.223, 31.4)</td>
<td>(1.158, 31.8)</td>
</tr>
<tr>
<td>OT prenatal</td>
<td>2.447</td>
<td></td>
</tr>
<tr>
<td>(4.71, 3.60)</td>
<td>(2.67, 6.12)</td>
<td>(V = 1.60)</td>
</tr>
<tr>
<td>v = 1.334</td>
<td>(V = 1.60)</td>
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</tr>
<tr>
<td>OT 3 mo. mother</td>
<td>8.369</td>
<td>5.948</td>
</tr>
<tr>
<td>(9.25, 6.99)</td>
<td>(3.49, 2.0)</td>
<td>(V = 2.3)</td>
</tr>
<tr>
<td>v = 4.834</td>
<td>(V = 2.3)</td>
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</tr>
<tr>
<td>OT newborn</td>
<td>0.55</td>
<td>0.111</td>
</tr>
<tr>
<td>(8.55, 6.59)</td>
<td>(5.41, 3.63)</td>
<td>(V = 2.36)</td>
</tr>
<tr>
<td>v = 2.16</td>
<td>(V = 2.36)</td>
<td></td>
</tr>
<tr>
<td>OT 3 mo. infant</td>
<td>0.811</td>
<td>0.428</td>
</tr>
<tr>
<td>(8.09, 5.36)</td>
<td>(2.56, 3.47)</td>
<td>(V = 2.56)</td>
</tr>
<tr>
<td>v = 5.239</td>
<td>(V = 2.56)</td>
<td></td>
</tr>
<tr>
<td>BSES 5 mo.</td>
<td>3.076</td>
<td>4.26</td>
</tr>
<tr>
<td>(4.55, 1.65)</td>
<td>(5.65, 1.71)</td>
<td>(V = 1.62)</td>
</tr>
<tr>
<td>v = 1.436</td>
<td>(V = 1.62)</td>
<td></td>
</tr>
<tr>
<td>Bonding</td>
<td>0.035</td>
<td>0.257</td>
</tr>
<tr>
<td>(0.65, 0.12)</td>
<td>(1.34, 1.78)</td>
<td>(V = 2.23)</td>
</tr>
<tr>
<td>v = 1.423</td>
<td>(V = 2.23)</td>
<td></td>
</tr>
</tbody>
</table>

*Analyses conducted separately by group assignment and kangaroo care use. Effect sizes (small = 2, moderate = 5, large = 8); KC 1 hr and CG were tested as the control groups when calculating effect sizes for the three groups. v = variance of the effect size.
Table 8. Odds ratio calculations and corresponding 95% confidence intervals estimating the likelihood of kangaroo care increasing oxytocin and cortisol reactivity.

<table>
<thead>
<tr>
<th></th>
<th>OT Increase Mother</th>
<th>OT Increase Infant (3 months)</th>
<th>Cortisol Reactivity Infant (3 months)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kangaroo Care</strong></td>
<td>2.8484</td>
<td>4.0747</td>
<td>7166</td>
</tr>
<tr>
<td><strong>Experience</strong></td>
<td>(.4215, 19.23)</td>
<td>(.3442, 48.2407)</td>
<td>(.1838, 2.7642)</td>
</tr>
</tbody>
</table>
Table 9. EEG asymmetry correlations between regions and frequency bands.

<table>
<thead>
<tr>
<th></th>
<th>Alpha 1 (3-6 Hz)</th>
<th>Alpha 2 (6-9 Hz)</th>
<th>Broadband (3-12 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lateral Frontal</td>
<td>Mid Frontal</td>
<td>Lateral Frontal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Central Parietal</td>
<td>Central Parietal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mid Lateral</td>
<td>Mid Lateral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frontal Parietal</td>
<td>Frontal Parietal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Central Parietal</td>
<td>Central Parietal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mid Lateral</td>
<td>Mid Lateral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frontal Parietal</td>
<td>Frontal Parietal</td>
</tr>
<tr>
<td>Alpha 1</td>
<td>.10</td>
<td>.91*</td>
<td>.998*</td>
</tr>
<tr>
<td>Lateral Frontal</td>
<td>.22</td>
<td>.98*</td>
<td>.12</td>
</tr>
<tr>
<td>Central</td>
<td>.01</td>
<td>-.27</td>
<td>.35</td>
</tr>
<tr>
<td>Parietal</td>
<td>-.2</td>
<td>-.06</td>
<td>.04</td>
</tr>
<tr>
<td>Occipital</td>
<td>.22</td>
<td>-.11</td>
<td>.22</td>
</tr>
<tr>
<td>Alpha 2</td>
<td>.91*</td>
<td>.22</td>
<td>.22</td>
</tr>
<tr>
<td>Mid Frontal</td>
<td>.98*</td>
<td>.11</td>
<td>.01</td>
</tr>
<tr>
<td>Lateral Frontal</td>
<td>.06</td>
<td>-.12</td>
<td>-.27</td>
</tr>
<tr>
<td>Central</td>
<td>.22</td>
<td>-.117</td>
<td>.21</td>
</tr>
<tr>
<td>Parietal</td>
<td>.06</td>
<td>.21</td>
<td>.965*</td>
</tr>
<tr>
<td>Occipital</td>
<td>.17</td>
<td>-.08</td>
<td>.03</td>
</tr>
<tr>
<td>Broadband</td>
<td>.998*</td>
<td>.12</td>
<td>.20</td>
</tr>
<tr>
<td>Mid Frontal</td>
<td>.09</td>
<td>.998*</td>
<td>-.1</td>
</tr>
<tr>
<td>Lateral Frontal</td>
<td>.2</td>
<td>.996*</td>
<td>.1</td>
</tr>
<tr>
<td>Central</td>
<td>-.01</td>
<td>.02</td>
<td>.09</td>
</tr>
<tr>
<td>Parietal</td>
<td>-.004</td>
<td>.2</td>
<td>.997*</td>
</tr>
<tr>
<td>Occipital</td>
<td>-.2</td>
<td>.06</td>
<td>.03</td>
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</table>

*Significant at p < 0.05
Table 10. Paired Samples T-tests of infant alpha 1 and alpha 2 frontal regions

<table>
<thead>
<tr>
<th></th>
<th>M(SD)</th>
<th>T-test Statistic</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Left mid frontal 6-9 Hz</strong></td>
<td>2.78(1.65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Left mid frontal 3-6 Hz</strong></td>
<td>4.06(1.47)</td>
<td>-31.011</td>
<td>26</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Right mid frontal 6-9 Hz</strong></td>
<td>2.62(1.62)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Right mid frontal 3-6 Hz</strong></td>
<td>4.06(1.47)</td>
<td>-25.861</td>
<td>22</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Left lateral frontal 6.9 Hz</strong></td>
<td>3.31(1.53)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Left lateral frontal 3-6 Hz</strong></td>
<td>4.78(1.45)</td>
<td>-19.959</td>
<td>23</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Right lateral frontal 6-9 Hz</strong></td>
<td>3.45(1.95)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Right lateral frontal 3-6 Hz</strong></td>
<td>4.95(1.88)</td>
<td>-23.688</td>
<td>23</td>
<td>.000</td>
</tr>
</tbody>
</table>
Table 11. Mean Power Scores across Frequency Band and Feeding Method

<table>
<thead>
<tr>
<th></th>
<th>Alpha 1</th>
<th></th>
<th>Alpha 2</th>
<th></th>
<th>Broadband</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BF</td>
<td>FF</td>
<td>BF</td>
<td>FF</td>
<td>BF</td>
<td>FF</td>
</tr>
<tr>
<td>F3</td>
<td>4.41</td>
<td>4.37</td>
<td>2.84</td>
<td>2.96</td>
<td>4.58</td>
<td>4.54</td>
</tr>
<tr>
<td></td>
<td>(1.83)</td>
<td>(.95)</td>
<td>(1.86)</td>
<td>(1.11)</td>
<td>(1.83)</td>
<td>(.973)</td>
</tr>
<tr>
<td>F4</td>
<td>4.12</td>
<td>4.56</td>
<td>2.64</td>
<td>3.16</td>
<td>4.36</td>
<td>4.74</td>
</tr>
<tr>
<td></td>
<td>(1.73)</td>
<td>(.85)</td>
<td>(1.90)</td>
<td>(.96)</td>
<td>(1.75)</td>
<td>(.86)</td>
</tr>
<tr>
<td>F7</td>
<td>4.75(1.60)</td>
<td>4.94</td>
<td>3.25</td>
<td>3.49</td>
<td>4.95</td>
<td>5.11</td>
</tr>
<tr>
<td></td>
<td>(.82)</td>
<td>(1.70)</td>
<td>(1.84)</td>
<td>(1.63)</td>
<td>(1.94)</td>
<td>(1.81)</td>
</tr>
<tr>
<td>F8</td>
<td>4.79</td>
<td>5.48</td>
<td>3.25</td>
<td>4.13</td>
<td>4.97</td>
<td>5.68</td>
</tr>
<tr>
<td></td>
<td>(1.93)</td>
<td>(1.82)</td>
<td>(1.97)</td>
<td>(1.93)</td>
<td>(1.94)</td>
<td>(1.86)</td>
</tr>
<tr>
<td>C3</td>
<td>4.29(2.00)</td>
<td>4.21</td>
<td>2.70</td>
<td>2.72</td>
<td>4.39</td>
<td>4.37</td>
</tr>
<tr>
<td></td>
<td>(.99)</td>
<td>(2.18)</td>
<td>(1.08)</td>
<td>(2.06)</td>
<td>(1.01)</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>4.11</td>
<td>4.31</td>
<td>2.55</td>
<td>2.85</td>
<td>4.29</td>
<td>4.48</td>
</tr>
<tr>
<td></td>
<td>(2.05)</td>
<td>(.93)</td>
<td>(2.22)</td>
<td>(1.07)</td>
<td>(2.10)</td>
<td>(.95)</td>
</tr>
<tr>
<td>P3</td>
<td>4.51</td>
<td>3.97</td>
<td>2.93</td>
<td>2.33</td>
<td>4.76</td>
<td>4.12</td>
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<tr>
<td></td>
<td>(2.39)</td>
<td>(2.07)</td>
<td>(2.29)</td>
<td>(2.00)</td>
<td>(2.32)</td>
<td>(2.05)</td>
</tr>
<tr>
<td>P4</td>
<td>4.46</td>
<td>4.30</td>
<td>2.84</td>
<td>2.68</td>
<td>4.63</td>
<td>4.45</td>
</tr>
<tr>
<td></td>
<td>(1.99)</td>
<td>(.89)</td>
<td>(2.06)</td>
<td>(1.10)</td>
<td>(2.06)</td>
<td>(.92)</td>
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<tr>
<td>O1</td>
<td>5.44</td>
<td>5.17</td>
<td>3.76</td>
<td>3.49</td>
<td>5.66</td>
<td>5.32</td>
</tr>
<tr>
<td></td>
<td>(2.08)</td>
<td>(1.08)</td>
<td>(2.10)</td>
<td>(1.05)</td>
<td>(2.07)</td>
<td>(1.08)</td>
</tr>
<tr>
<td>O2</td>
<td>4.77</td>
<td>4.92</td>
<td>3.06</td>
<td>3.17</td>
<td>4.94</td>
<td>5.06</td>
</tr>
<tr>
<td></td>
<td>(3.18)</td>
<td>(.83)</td>
<td>(2.94)</td>
<td>(.88)</td>
<td>(3.01)</td>
<td>(.83)</td>
</tr>
</tbody>
</table>

BF = Exclusively breastfed; FF = formula-feeding or mixed-feeding; a1 = alpha (3-6 Hz); a2 = alpha 2 (6-9 Hz); br = broadband (3-12 Hz); F3 = left mid frontal site; F4 = right mid frontal site; F7 = left lateral frontal site; F8 = right lateral frontal site; C3 = left central site; C4 = right central site; P3 = left parietal site; P4 = right parietal site; O1 = left occipital site; O2 = right occipital site.
Table 12. Means, Standard Deviations, Paired t-tests P-values, and Correlations of Frontal Region Power

<table>
<thead>
<tr>
<th></th>
<th>Alpha 1</th>
<th></th>
<th>Alpha 2</th>
<th></th>
<th>Broadband</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M(SD)</td>
<td>T-test</td>
<td>r</td>
<td>M(SD)</td>
<td>T-test</td>
<td>r</td>
</tr>
<tr>
<td>F3</td>
<td>4.32(1.64)</td>
<td>.051</td>
<td>.910*</td>
<td>2.78(1.65)</td>
<td>.096</td>
<td>.946*</td>
</tr>
<tr>
<td>F4</td>
<td>4.06(1.47)</td>
<td></td>
<td></td>
<td>2.62(1.62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.49(1.64)</td>
<td></td>
<td></td>
<td>4.24(1.49)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F7</td>
<td>4.78(1.45)</td>
<td>.432</td>
<td>.877*</td>
<td>3.31(1.53)</td>
<td>.563</td>
<td>.809*</td>
</tr>
<tr>
<td>F8</td>
<td>4.95(1.88)</td>
<td></td>
<td></td>
<td>3.45(1.95)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.98(1.47)</td>
<td></td>
<td></td>
<td>5.13(1.90)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F3</td>
<td>4.32(1.64)</td>
<td>.025</td>
<td>.768*</td>
<td>2.78(1.65)</td>
<td>.047</td>
<td>.719*</td>
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<td>F7</td>
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<td></td>
<td></td>
<td>3.31(1.53)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.98(1.47)</td>
<td></td>
<td></td>
<td>5.13(1.90)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F8</td>
<td>4.95(1.88)</td>
<td>.050</td>
<td>.791*</td>
<td>3.45(1.95)</td>
<td>.062</td>
<td>.808*</td>
</tr>
<tr>
<td></td>
<td>4.98(1.47)</td>
<td></td>
<td></td>
<td>5.13(1.90)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Indicates a significant correlation at alpha level of .05; r = correlation statistic between frontal regions; F3 = left mid frontal; F4 = right mid frontal; F7 = left lateral frontal; F8 = right lateral frontal
Figure 1. The inverse linear relationship between the Maternal Antenatal Attachment Scale and infant cortisol reactivity at 3 months of age.
Appendix 1. Maternal attentiveness, physical and verbal affect for feeding and interaction session

<table>
<thead>
<tr>
<th>Coded Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Strong interest, smiling, positive intonation of vocalizations, and positive touch</td>
</tr>
<tr>
<td>6</td>
<td>Moderate show of interest, pleasant positive attitude, positive intonation of vocalizations, and positive touch</td>
</tr>
<tr>
<td>5</td>
<td>Some interest but no variability in intonation of vocalizations, variable stimulation, little touch or heightened physical activity or physical contact. Participant is reactive but with little facial affect</td>
</tr>
<tr>
<td>4</td>
<td>Varied positive, no, and/or negative affect, no consistency in responsiveness or attention. Mother’s touch is for grooming rather than stimulating. Infant is non-reactive or neutral</td>
</tr>
<tr>
<td>3</td>
<td>Mother speaks to child but her face and voice are flat in affect, directs conversation without being responsive.</td>
</tr>
<tr>
<td>2</td>
<td>Mother losing interest, shows some self-interest (i.e., self-grooming), touches infant infrequently or not at all</td>
</tr>
<tr>
<td>1</td>
<td>Mother shows varied interest in infant, possibly negative facial expressions or vocalizations.</td>
</tr>
</tbody>
</table>
Appendix 2. Maternal Antenatal Attachment Scale

MAAS

Directions: Please check one box only in answer to each question.

1. Over the past two weeks I have thought about, or been preoccupied with the baby inside me:
   - [ ] Almost all the time
   - [ ] Very frequently
   - [ ] Frequently
   - [ ] Occasionally
   - [ ] Not at all

2. Over the past two weeks when I have spoken about, or thought about the baby inside me I got emotional feelings which were:
   - [ ] Very weak or non-existent
   - [ ] Fairly weak
   - [ ] In between strong and weak
   - [ ] Fairly strong
   - [ ] Very strong

3. Over the past two weeks my feelings about the baby inside me have been:
   - [ ] Very positive
   - [ ] Mainly positive
Mixed positive and negative

Mainly negative

Very negative

4. Over the past two weeks I have had the desire to read about or get information about the developing baby. This desire is:

Very weak or non-existent

Fairly weak

Neither strong nor weak

Moderately strong

Very strong

5. Over the past two weeks I have been trying to picture in my mind what the developing baby actually looks like in my womb:

Almost all the time

Very frequently

Frequently

Occasionally

Not at all

6. Over the past two weeks I think of the developing baby mostly as:

A real little person with special characteristics

A baby like any other baby
7. **Over the past** two weeks I have felt that the baby inside me is dependent on me for its well-being:

- [ ] Totally
- [ ] A great deal
- [ ] Moderately
- [ ] Slightly
- [ ] Not at all

8. **Over the past** two weeks I have found myself talking to the baby when I am alone:

- [ ] Not at all
- [ ] Occasionally
- [ ] Frequently
- [ ] Very frequently
- [ ] Almost all the time I am alone

9. **Over the past** two weeks when I think about (or talk to) my baby inside me, my thoughts:

- [ ] Are always tender and loving
- [ ] Are mostly tender and loving
Are a mixture of both tenderness and irritation

Contain a fair bit of irritation

Contain a lot of irritation

10. The picture in my mind of what the baby at this stage actually looks like inside the womb is:

Very clear

Fairly clear

Fairly vague

Very vague

I have no idea at all

11. Over the past two weeks I think about the baby inside me I get feelings which are:

Very sad

Moderately sad

A mixture of happiness and sadness

Moderately happy

Very happy
12. Some pregnant women sometimes get so irritated by the baby inside them that they feel like they want to hurt it or punish it:

☐ I couldn’t imagine I would ever feel like this

☐ I could imagine I might sometimes feel like this, but I never actually have

☐ I have felt like this once or twice myself

☐ I have occasionally felt like this myself

☐ I have often felt like this myself

13. Over the past two weeks I have felt:

☐ Very emotionally distant from my baby

☐ Moderately emotionally distant from my baby

☐ Not particularly emotionally close to my baby

☐ Moderately close emotionally to my baby

☐ Very close emotionally to my baby

14. Over the past two weeks I have taken care with what I eat to make sure the baby gets a good diet:

☐ Not at all

☐ Once or twice when I ate
Occasionally when I ate
Quite often when I ate
Every time I ate

15. When I first see my baby after the birth I expect I will feel:

- Intense affection
- Mostly affection
- Dislike about one or two aspects of the baby
- Dislike about quite a few aspects of the baby
- Mostly dislike

16. When my baby is born I would like to hold the baby:

- Immediately
- After it has been wrapped in a blanket
- After it has been washed
- After a few hours for things to settle down
- The next day

17. Over the past two weeks I have had dreams about the pregnancy or baby:

- Not at all
- Occasionally
- Frequently
- Very frequently
18. Over the past two weeks I have found myself feeling, or rubbing with my hand, the outside of my stomach where the baby is:

- [ ] A lot of times each day
- [ ] At least once per day
- [ ] Occasionally
- [ ] Once only

19. If the pregnancy was lost at this time (due to miscarriage or other accidental event) without any pain or injury to myself, I expect I would feel:

- [ ] Very pleased
- [ ] Moderately pleased
- [ ] Neutral (i.e. neither sad nor pleased; or mixed feelings)
- [ ] Moderately sad
- [ ] Very sad
Appendix 3. Breastfeeding Attrition Prediction Tool

**BAPT**

Please circle the number that most closely describes how you feel about each statement.

1 = Strongly Disagree   6 = Strongly Agree

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Breastfeeding is more convenient than formula feeding.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>2. Breastfeeding is painful.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>3. Formula feeding allows the mother more freedom.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>4. Infant formula can cause allergies.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>5. Breastmilk is healthy for the baby.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>6. No one else can help feed the baby when you are breastfed.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>7. It is difficult to breast feed in public.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>8. Formula fed babies tend to get sick.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>9. Breastmilk is more nutritious than infant formula.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>10. Breastfeeding makes your breast sag.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>11. Formula feeding is easier than breastfeeding.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>12. Formula fed babies are more fussy than breastfed babies.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>13. Breastfeeding makes you closer to your baby.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>14. Breastfeeding makes returning to work difficult.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>15. Formula fed babies are easier to satisfy than breastfed babies.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>16. Formula fed babies tend to be overweight.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>17. Breastfeeding is more economical than formula feeding.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>18. When you breastfeed you never know if the baby is getting enough milk.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>19. Mothers who formula feed get more rest than breastfeeding mothers.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>20. Breastfeeding is natural.</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>21. Breastfeeding is more time consuming than formula feeding.</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>
22. Formula feeding lets the father become close to the baby.  1  2  3  4  5  6
23. Infant formula can cause constipation.  1  2  3  4  5  6
24. Breastfeeding is best for the baby.  1  2  3  4  5  6
25. Breastfeeding is personally satisfying.  1  2  3  4  5  6
26. Breastfeeding is messy.  1  2  3  4  5  6
27. Breastfeeding ties you down.  1  2  3  4  5  6
28. Breastfeeding helps you bond with your baby.  1  2  3  4  5  6
29. Mothers who formula feed get back into shape sooner.  1  2  3  4  5  6

FOR EACH OF THE FOLLOWING INDIVIDUALS INDICATE HOW MUCH THEY WANT YOU TO BREASTFEED.

<table>
<thead>
<tr>
<th>Definitely NOT</th>
<th>Definitely Breastfeed</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>30. The baby’s father thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>31. My mother thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>32. My mother-in-law thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>33. My sister thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>34. My closest female friend thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>35. My doctor thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>36. My midwife thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>37. La Leche League thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>38. The hospital nurses think I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>39. My baby’s doctor thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>40. My childbirth educator thinks I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>41. Other relatives think I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>42. People who are important to me think I should:</td>
<td>1  2  3  4  5  6</td>
<td>0</td>
</tr>
<tr>
<td>NOT Important To Me</td>
<td>Important To Me</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>43. Using a feeding method that is convenient is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>44. Using a feeding method that doesn’t cause me pain is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>45. Using a feeding method that lets me have some freedom is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>46. Using a feeding method that is healthy for my baby is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>47. Using a feeding method that is healthy for my baby is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>48. Using a feeding method that lets someone else feed my baby is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>49. Using a feeding method that is easy to do in public is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>50. Using a feeding method that protects my baby from getting sick is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>51. Using a feeding method that is nutritious is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>52. Using a feeding method that won’t make my breasts sag is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>53. Using a feeding method that is easy is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>54. Using a feeding method that keeps my baby from being fussy is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>55. Using a feeding method that lets me be close to my baby is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>56. Using a feeding method that makes it easy to return to work is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>57. Using a feeding method that satisfies my baby is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>58. Using a feeding method that keeps baby from being overweight:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>59. Using a feeding method that is economical is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>60. Using a feeding method where I know the baby is getting enough:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>61. Using a feeding method that lets me get lots of rest:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>62. Using a feeding method that is natural is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>63. Using a feeding method that saves time is:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>64. Using a feeding method that lets the father be close to the baby:</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
</tbody>
</table>
65. Using a feeding method that doesn’t cause constipation is: 1 2 3 4 5 6
66. Using a feeding method that is best for my baby is: 1 2 3 4 5 6
67. Using a feeding method that is personally satisfying is: 1 2 3 4 5 6
68. Using a feeding method that is not messy is: 1 2 3 4 5 6
69. Using a feeding method that doesn’t tie me down is: 1 2 3 4 5 6
70. Using a feeding method that helps me bond with my baby is: 1 2 3 4 5 6
71. Using a feeding method that lets me get back into shape is: 1 2 3 4 5 6

**HOW MUCH DO YOU CARE ABOUT THE FOLLOWING PEOPLE'S OPINION ON HOW YOU SHOULD FEED YOUR BABY?**

<table>
<thead>
<tr>
<th>Do Not Care At All(1)</th>
<th>Care Very Much(6)</th>
<th>N/A(0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>72. The baby’s father</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>73. Your mother</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>74. Your mother-in-law</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>75. Your sister</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>76. Your closest female friend</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>77. Your doctor</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>78. Your midwife</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>79. La Leche League</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>80. Your hospital nurse(s)</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>81. Your baby’s doctor</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>82. Your childbirth educator</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>83. Other relatives</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
<tr>
<td>84. People who are important to you</td>
<td>1 2 3 4 5 6</td>
<td>0</td>
</tr>
</tbody>
</table>
PLEASE INDICATE THE DEGREE TO WHICH YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS.

<table>
<thead>
<tr>
<th>(1) STRONGLY DISAGREE</th>
<th>(6) STRONGLY AGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>85. I have the necessary skills to breastfeed</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>86. I am physically able to breastfeed</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>87. I know how to breastfeed</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>88. I am emotionally ready to breastfeed</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>89. I am determined to breastfeed</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>90. I won’t need help to breastfeed</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>91. I have total control over my breastfeeding</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>92. Breastfeeding is easy</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>93. I am confident I can breastfeed</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>94. I know I will have enough milk for the baby</td>
<td>1 2 3 4 5 6</td>
</tr>
</tbody>
</table>
Appendix 4. Breastfeeding Self-Efficacy Scale

**BSES**

**PLEASE CIRCLE THE ANSWER THAT BEST DESCRIBES HOW CONFIDENT YOU ARE WITH BREASTFEEDING YOUR BABY. (There is no right or wrong answer)**

1=Not At All Confident  
2=Not Very Confident  
3=Sometimes Confident  
4=Confident  
5=Very Confident

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I can always determine that my baby gets enough milk.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>I can always cope with breastfeeding like I have other challenging tasks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>I can always breastfeed my baby without using formula as a supplement.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>I can always ensure that my baby is properly latched on for the whole feeding.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>I can always manage the breastfeeding situation to my satisfaction.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>I can always manage to breastfeed even if my baby is crying.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>I can always keep wanting to breastfeed.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>I can always comfortably breastfeed with my family members present.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>I can always be satisfied with my breastfeeding experience.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>I can always deal with the fact that breastfeeding can be time-consuming.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11.</td>
<td>I can always finish feeding my baby on one breast before switching to the other.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12.</td>
<td>I can always continue to breastfeed my baby for every feeding.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13.</td>
<td>I can always manage to keep up with my baby’s breastfeeding demands.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14.</td>
<td>I can always tell when my baby is finished breastfeeding.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix 5. Maternal Breastfeeding Evaluation Scale

**MBFES**

**INDICATE YOUR AGREEMENT OR DISAGREEMENT WITH EACH STATEMENT BY CIRCLING THE BEST ANSWER.**

SD=Strongly Disagree  
D=Disagree  
N=No Opinion or Unsure  
A=Agree  
SA=Strongly Agree

1. With breastfeeding I felt a sense of inner contentment. SD D N A SA  
2. Breastfeeding was a special time with my baby. SD D N A SA  
3. My baby wasn’t interested in breastfeeding. SD D N A SA  
4. My baby loved to nurse. SD D N A SA  
5. It was a burden being my baby’s main source of food. SD D N A SA  
6. I felt extremely close to my baby when I breastfed. SD D N A SA  
7. My baby was an eager breast feeder. SD D N A SA  
8. Breastfeeding was physically draining. SD D N A SA  
9. It was important to me to be able to nurse. SD D N A SA  
10. While breastfeeding, my baby’s growth was excellent. SD D N A SA  
11. My baby and I worked together to make breastfeeding go smoothly. SD D N A SA  
12. Breastfeeding was a very nurturing, maternal experience. SD D N A SA  
13. While breastfeeding, I felt self-conscious about my body. SD D N A SA  
14. With breastfeeding, I felt too tied down all the time. SD D N A SA  
15. While breastfeeding, I worried about my baby gaining enough weight. SD D N A SA  
16. Breastfeeding was soothing when my baby was upset or crying. SD D N A SA  
17. Breastfeeding was like a high of sorts. SD D N A SA  
18. That I could produce the food to feed my own baby was very satisfying. SD D N A SA  
19. In the beginning, my baby had trouble breastfeeding. SD D N A SA
20. Breastfeeding made me feel like a good mother.  
21. I really enjoyed nursing.  
22. While breastfeeding, I was anxious to have my body back.  
23. Breastfeeding made me feel more comfortable as a mother.  
24. My baby gained weight really well with breast milk.  
25. Breastfeeding made my baby feel more secure.  
26. I could easily fit my baby’s breastfeeding with my other activities.  
27. Breastfeeding made me feel like a cow.  
28. My baby did not relax while nursing.  
29. Breastfeeding was emotionally draining.  
30. Breastfeeding felt wonderful to me.
Appendix 6. Demographic Information Questionnaire

I.D.________________ Ethnic Group________________

Today’s Date__________ Mother’s Age ____________

Infant’s Expected Date of Birth ____________ Father’s Age ____________

HOUSEHOLD INFORMATION

1. Are you currently ________?
   A. Employed outside the home
   B. In school
   C. A full-time stay-at-home mom

2. Do you have other children? ________ How many? ____________

3. If employed outside the home, what do you do? ______________________

4. What was the last grade you completed in school? ____________________

5. In your home, who brings home the most money? ____________________

6. What does he/she do? ____________________________________________

7. What was the last grade he/she completed? _________________________

SUPPORT SYSTEM

1. Please circle the type of family structure for your home.
   A. Single parent
   B. Traditional Nuclear Family (Mom, Dad and children), or
   C. Extended Family (Other relatives live with you and your children)

2. How many times have you moved in the last year? ________

3. How many relatives live in your area? __________

4. How many relatives can you count on in times of real need? __________

5. How many good friends do you have? __________

6. How long have you been married or seeing your boyfriend? ________

7. Does your relationship with him give you support? ______

STRESS & COPING

1. Do you or anyone else in your household have any health problems? __________

2. If so, please explain __________________________________________________________________________

3. Do you or anyone in your household have a drinking or drug problem? __________

4. If so, does this cause problems for you? __________________________________________________________________________

5. How many bedrooms do you have in your home? __________________________________________________________________________

6. On average, how many people visit your home per day? __________________________________________________________________________

7. Have you or any of your family experienced some sort of stress or major life change which caused you to feel sad or stressed?
HEALTH INFORMATION

1. Have you or any of your family been diagnosed with a mood disorder? (If NO, skip to question 4) _________
2. Who was diagnosed with a mood disorder?_________
3. What mood disorder?_______________________
4. Are you taking any medications? (If NO, skip question 5)_______________
5. Is the medication for yourself or the baby?

FEEDING PLANS

1. What is the primary feeding method you plan to use? (If bottle, skip to question 4)____________________
2. How long do you intend to breastfeed?________________________
3. When did you decide to breastfeed?
   A. Before you were pregnant
   B. During the first three months of the pregnancy (1st trimester)
   C. During the middle three months of the pregnancy (2nd trimester)
   D. During the last three months of the pregnancy (3rd trimester)
4. Have you breastfed before?___________
5. Was the experience:
   A. Extremely successful
   B. Very successful
   C. Slightly successful
   D. Not at all successful
Appendix 7. Center for Epidemiological Studies-Depression Scale

**CES-D**

The following questions concern how you've been feeling lately. For each question, please indicate how often you've felt this way during the past week. The choices are:

1 = Rarely or none of the time (less than a day)  
2 = Some or little of the time (1 - 2 days)  
3 = Occasionally or a moderate amount of the time (3 - 4 days)  
4 = Most of the time (5 - 7 days)

<table>
<thead>
<tr>
<th></th>
<th>Less than 1 day</th>
<th>1-2 days</th>
<th>3-4 days</th>
<th>5-7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I was bothered by things that don’t usually bother me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. I did not feel like eating, my appetite was poor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. I felt I could not shake the blues even with the help from my families or friends.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. I felt that I was just as good as other people.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. I had trouble keeping on my mind what I was doing.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. I felt depressed.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7. I felt that everything I did was an effort.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. I felt hopeful about the future.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9. I thought my life has been a failure.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. I felt fearful.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11. My sleep was restless.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12. I was happy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13. I talked less than usual.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14. I felt lonely.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15. People were unfriendly.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16. I enjoyed life.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17. I had crying spells.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18. I felt sad.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19. I felt like people disliked me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20. I could not get “going”.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix 8. Edinburgh Postpartum Depression Scale

As you are pregnant or have recently had a baby, we would like to know how you are feeling. Please check the answer that comes closest to how you have felt in the past 7 days, not just how you feel today.

Here is an example, already completed.

I have felt happy:
- Yes, all the time
- Yes, most of the time (This would mean: "I have felt happy most of the time" during the past week)
- No, not very often
- No, not at all

In the past 7 days:

1. I have been able to laugh and see the funny side of things
   - As much as I always could
   - Not quite so much now
   - Definitely not so much now
   - Not at all

2. I have looked forward with enjoyment to things
   - As much as I ever did
   - Rather less than I used to
   - Definitely less than I used to
   - Hardly at all

*3. I have blamed myself unnecessarily when things went wrong
   - Yes, most of the time
   - Yes, some of the time
   - Not very often
   - No, never

4. I have been anxious or worried for no good reason
   - No, not at all
   - Hardly ever
   - Yes, sometimes
   - Yes, very often

*b. I have felt scared or panicky for no very good reason
   - Yes, quite a lot
   - Yes, sometimes
   - No, not much
   - No, not at all

6. Things have been getting on top of me
   - Yes, most of the time I haven't been able to cope at all
   - Yes, sometimes I haven't been coping as well as usual
   - No, most of the time I have coped quite well
   - No, I have been coping as well as ever

*7 I have been so unhappy that I have had difficulty sleeping
   - Yes, most of the time
   - Yes, sometimes
   - Not very often
   - No, not at all

*8 I have felt sad or miserable
   - Yes, most of the time
   - Yes, quite often
   - Not very often
   - No, not at all

*9 I have been so unhappy that I have been crying
   - Yes, most of the time
   - Yes, quite often
   - Only occasionally
   - No, never

*10 The thought of harming myself has occurred to me
   - Yes, quite often
   - Sometimes
   - Hardly ever
   - Never

Administered/Reviewed by

Date


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Appendix 9. Infant Behavior Questionnaire-Revised

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Infant Behavior Questionnaire - Revised

Subject No. __________________ Date of Baby’s Birth

Today’s Date _______________ Age of Child

Sex of Child _______________

INSTRUCTIONS:
Please read carefully before starting:

As you read each description of the baby’s behavior below, please indicate how often the baby did this during the LAST WEEK (the past seven days) by circling one of the numbers in the left column. These numbers indicate how often you observed the behavior described during the last week.

(3)
(2) Less (4) (5) (X)
Very Than About More (6) Does
(1) Rare Half the Half the Than Half Almost (7) Not
Never y Time Time the Time Always Always Always Apply

The “Does Not Apply” (X) column is used when you did not see the baby in the situation described during the last week. For example, if the situation mentions the baby having to wait for food or liquids and there was no time during the last week when the baby had to wait, circle the (X) column. “Does Not Apply” is different from “Never” (1). “Never” is used when you saw the baby in the situation but the baby never engaged in the behavior listed during the last week. For example, if the baby did have to wait for food or liquids at least once but
never cried loudly while waiting, circle the (1) column. Please be sure to circle a number for every item.

**Feeding**

During feeding, how often did the baby:

1 2 3 4 5 6 7 X . . . . (1) lie or sit quietly?
1 2 3 4 5 6 7 X . . . . (2) squirm or kick?
1 2 3 4 5 6 7 X . . . . (3) wave arms?
1 2 3 4 5 6 7 X . . . . (4) notice lumpy texture in food (e.g., oatmeal)?

In the last week, while being fed in your lap, how often did the baby:

1 2 3 4 5 6 7 X . . . . (5) seem to enjoy the closeness?
1 2 3 4 5 6 7 X . . . . (6) snuggle even after she was done?
1 2 3 4 5 6 7 X . . . . (7) seem eager to get away as soon as the feeding was over?

How often did your baby make talking sounds:

1 2 3 4 5 6 7 X . . . . (8) while waiting in a high chair for food?
1 2 3 4 5 6 7 X . . . . (9) when s/he was ready for more food?
1 2 3 4 5 6 7 X . . . . (10) when s/he has had enough to eat?

**Sleeping**

Before falling asleep at night during the last week, how often did the baby:

1 2 3 4 5 6 7 X . . . . (11) show no fussing or crying?

During sleep, how often did the baby:

1 2 3 4 5 6 7 X . . . . (12) toss about in the crib?
1 2 3 4 5 6 7 X . . . . (13) move from the middle to the end of the crib?
1 2 3 4 5 6 7 X . . . . (14) sleep in one position only?

After sleeping, how often did the baby:

1 2 3 4 5 6 7 X . . . . (15) fuss or cry immediately?
1 2 3 4 5 6 7 X . . . . (16) play quietly in the crib?
1 2 3 4 5 6 7 X . . . . (17) cry if someone doesn’t come within a few minutes?

How often did the baby:

1 2 3 4 5 6 7 X . . . . (18) seem angry (crying and fussing) when you left
When going to sleep at night, how often did your baby:
1 2 3 4 5 6 7 X . . . . (21) fall asleep within 10 minutes?
1 2 3 4 5 6 7 X . . . . (22) have a hard time settling down to sleep?
1 2 3 4 5 6 7 X . . . . (23) settle down to sleep easily?

When your baby awoke at night, how often did s/he:
1 2 3 4 5 6 7 X . . . . (24) have a hard time going back to sleep?
1 2 3 4 5 6 7 X . . . . (25) go back to sleep immediately?

When put down for a nap, how often did your baby:
1 2 3 4 5 6 7 X . . . . (26) stay awake for a long time?
1 2 3 4 5 6 7 X . . . . (27) go to sleep immediately?
1 2 3 4 5 6 7 X . . . . (28) settle down quickly?
1 2 3 4 5 6 7 X . . . . (29) have a hard time settling down?

When it was time for bed or a nap and your baby did not want to go, how often did s/he:
1 2 3 4 5 6 7 X . . . . (30) whimper or sob?
1 2 3 4 5 6 7 X . . . . (31) become tearful?

**Bathing and Dressing**

When being dressed or undressed during the last week, how often did the baby:
1 2 3 4 5 6 7 X . . . . (32) wave her/his arms and kick?
1 2 3 4 5 6 7 X . . . . (33) squirm and/or try to roll away?
1 2 3 4 5 6 7 X . . . . (34) smile or laugh?
1 2 3 4 5 6 7 X . . . . (35) coo or vocalize?

When put into the bath water, how often did the baby:
1 2 3 4 5 6 7 X . . . . (36) smile?
1 2 3 4 5 6 7 X . . . . (37) laugh?
1 2 3 4 5 6 7 X . . . . (38) splash or kick?
1 2 3 4 5 6 7 X . . . . (39) turn body and/or squirm?

When face was washed, how often did the baby:
1 2 3 4 5 6 7 X . . . . (40) smile or laugh?
1 2 3 4 5 6 7 X . . . . (41) fuss or cry?
1 2 3 4 5 6 7 X . . . . (42) coo?

When hair was washed, how often did the baby:
1 2 3 4 5 6 7 X . . . . (43) smile?
1 2 3 4 5 6 7 X . . . . (44) fuss or cry?
1 2 3 4 5 6 7 X . . . . (45) vocalize?
Play

How often during the last week did the baby:
1 2 3 4 5 6 7 X . . . . (46) look at pictures in books and/or magazines for 2-5 minutes at a time?
1 2 3 4 5 6 7 X . . . . (47) look at pictures in books and/or magazines for 5 minutes or longer at a time?
1 2 3 4 5 6 7 X . . . . (48) stare at a mobile, crib bumper or picture for 5 minutes or longer?
1 2 3 4 5 6 7 X . . . . (49) play with one toy or object for 5-10 minutes?
1 2 3 4 5 6 7 X . . . . (50) play with one toy or object for 10 minutes or longer?
1 2 3 4 5 6 7 X . . . . (51) spend time just looking at playthings?
1 2 3 4 5 6 7 X . . . . (52) repeat the same sounds over and over again?
1 2 3 4 5 6 7 X . . . . (53) laugh aloud in play?
1 2 3 4 5 6 7 X . . . . (54) repeat the same movement with an object for 2 minutes or longer (e.g., putting a block in a cup, kicking or hitting a mobile)?
1 2 3 4 5 6 7 X . . . . (55) pay attention to your reading during most of the story when looking at picture books?
1 2 3 4 5 6 7 X . . . . (56) smile or laugh after accomplishing something (e.g., stacking blocks, etc.)?
1 2 3 4 5 6 7 X . . . . (57) smile or laugh when given a toy?
1 2 3 4 5 6 7 X . . . . (58) smile or laugh when tickled?

How often during the last week did the baby enjoy:
1 2 3 4 5 6 7 X . . . . (59) being sung to?
1 2 3 4 5 6 7 X . . . . (60) being read to?
1 2 3 4 5 6 7 X . . . . (61) hearing the sound of words, as in nursery rhymes?
1 2 3 4 5 6 7 X . . . . (62) looking at picture books?
1 2 3 4 5 6 7 X . . . . (63) gentle rhythmic activities, such as rocking or swaying?
1 2 3 4 5 6 7 X . . . . (64) lying quietly and examining his/her fingers or toes?
1 2 3 4 5 6 7 X . . . . (65) being tickled by you or someone else in your family?
1 2 3 4 5 6 7 X . . . . (66) being involved in rambunctious play?
1 2 3 4 5 6 7 X . . . . (67) watching while you, or another adult, playfully made faces?
1 2 3 4 5 6 7 X . . . . (68) touching or lying next to stuffed animals?
1 2 3 4 5 6 7 X . . . . (69) the feel of soft blankets?
1 2 3 4 5 6 7 X . . . . (70) being rolled up in a warm blanket?
1 2 3 4 5 6 7 X . . . . (71) listening to a musical toy in a crib?
When playing quietly with one of her/his favorite toys, how often did your baby:
1 2 3 4 5 6 7 X . . . . (72) show pleasure?
1 2 3 4 5 6 7 X . . . . (73) enjoy lying in the crib for more than 5 minutes?
1 2 3 4 5 6 7 X . . . . (74) enjoy lying in the crib for more than 10 minutes?

When something the baby was playing with had to be removed, how often did s/he:
1 2 3 4 5 6 7 X . . . . (75) cry or show distress for a time?
1 2 3 4 5 6 7 X . . . . (76) seem not bothered?

When tossed around playfully how often did the baby:
1 2 3 4 5 6 7 X . . . . (77) smile?
1 2 3 4 5 6 7 X . . . . (78) laugh?

During a peekaboo game, how often did the baby:
1 2 3 4 5 6 7 X . . . . (79) smile?
1 2 3 4 5 6 7 X . . . . (80) laugh?

How often did your baby enjoy bouncing up and down:
1 2 3 4 5 6 7 X . . . . (81) while on your lap?
1 2 3 4 5 6 7 X . . . . (82) on an object, such as a bed, bouncer chair, or toy?

How often did the infant look up from playing:
1 2 3 4 5 6 7 X . . . . (83) when the telephone rang?
1 2 3 4 5 6 7 X . . . . (84) when s/he heard voices in the next room?

When your baby saw a toy s/he wanted, how often did s/he:
1 2 3 4 5 6 7 X . . . . (85) get very excited about getting it?
1 2 3 4 5 6 7 X . . . . (86) immediately go after it?
1 2 3 4 5 6 7 X . . . . (87) get very excited about getting it?
1 2 3 4 5 6 7 X . . . . (88) immediately go after it?
1 2 3 4 5 6 7 X . . . . (89) seem not to get very excited about it?

Daily Activities

How often during the last week did the baby:
1 2 3 4 5 6 7 X . . . . (90) cry or show distress at a change in parents’ appearance, (glasses off, shower cap on, etc.)?
1 2 3 4 5 6 7 X . . . . (91) when in a position to see the television set, look at it for 2 to 5 minutes at a time?
1 2 3 4 5 6 7 X . . . . (92) when in a position to see the television set, look at it for 5 minutes or longer?
1 2 3 4 5 6 7 X . . . (93) protest being placed in a confining place (infant seat, play pen, car seat, etc.?)
1 2 3 4 5 6 7 X . . . (94) startle at a sudden change in body position (for example, when moved suddenly)?
1 2 3 4 5 6 7 X . . . (95) appear to listen to even very quiet sounds?
1 2 3 4 5 6 7 X . . . (96) attend to sights or sounds when outdoors (for example, wind chimes or water sprinklers)?
1 2 3 4 5 6 7 X . . . (97) move quickly toward new objects?
1 2 3 4 5 6 7 X . . . (98) show a strong desire for something s/he wanted?
1 2 3 4 5 6 7 X . . . (99) startle to a loud or sudden noise?
1 2 3 4 5 6 7 X . . . (100) look at children playing in the park or on the playground for 5 minutes or longer?
1 2 3 4 5 6 7 X . . . (101) watch adults performing household activities (e.g., cooking, etc.) for more than 5 minutes?
1 2 3 4 5 6 7 X . . . (102) squeal or shout when excited?
1 2 3 4 5 6 7 X . . . (103) imitate the sounds you made?
1 2 3 4 5 6 7 X . . . (104) seem excited when you or other adults acted in an excited manner around him/her?

When being held, how often did the baby:
1 2 3 4 5 6 7 X . . . (105) pull away or kick?
1 2 3 4 5 6 7 X . . . (106) seem to enjoy him/herself?
1 2 3 4 5 6 7 X . . . (107) mold to your body?
1 2 3 4 5 6 7 X . . . (108) squirm?

When placed on his/her back, how often did the baby:
1 2 3 4 5 6 7 X . . . (109) fuss or protest?
1 2 3 4 5 6 7 X . . . (110) smile or laugh?
1 2 3 4 5 6 7 X . . . (111) wave arms and kick?
1 2 3 4 5 6 7 X . . . (112) squirm and/or turn body?

When the baby wanted something, how often did s/he:
1 2 3 4 5 6 7 X . . . (113) become upset when s/he could not get what s/he wanted?
1 2 3 4 5 6 7 X . . . (114) have tantrums (crying, screaming, face red, etc.) when s/he did not get what s/he wanted?

When placed in an infant seat or car seat, how often did the baby:
1 2 3 4 5 6 7 X . . . (115) wave arms and kick?
1 2 3 4 5 6 7 X . . . (116) squirm and turn body?
1 2 3 4 5 6 7 X . . . (117) lie or sit quietly?
1 2 3 4 5 6 7 X . . . (118) show distress at first; then quiet down?

122
When frustrated with something, how often did your baby:
1 2 3 4 5 6 7 X . . . (119) calm down within 5 minutes?

When your baby was upset about something, how often did s/he:
1 2 3 4 5 6 7 X . . . (120) stay upset for up to 10 minutes or longer?
1 2 3 4 5 6 7 X . . . (121) stay upset for up to 20 minutes or longer?
1 2 3 4 5 6 7 X . . . (122) soothe her/himself with other things (such as a stuffed animal, or blanket)?

When rocked or hugged, in the last week, how often did your baby:
1 2 3 4 5 6 7 X . . . (123) seem to enjoy her/himself?
1 2 3 4 5 6 7 X . . . (124) seemed eager to get away?
1 2 3 4 5 6 7 X . . . (125) make protesting noises?

When reuniting after having been away during the last week how often did the baby:
1 2 3 4 5 6 7 X . . . (126) seem to enjoy being held?
1 2 3 4 5 6 7 X . . . (127) show interest in being close, but resisted being held?
1 2 3 4 5 6 7 X . . . (128) show distress at being held?

When being carried, in the last week, how often did your baby:
1 2 3 4 5 6 7 X . . . (129) seem to enjoy him/herself?
1 2 3 4 5 6 7 X . . . (130) push against you until put down?

While sitting in your lap:
1 2 3 4 5 6 7 X . . . (131) how often did your baby seem to enjoy her/himself?
1 2 3 4 5 6 7 X . . . (132) how often would the baby not be content without moving around?

How often did your baby notice:
1 2 3 4 5 6 7 X . . . (133) low-pitched noises, air conditioner, heating system, or refrigerator running or starting up?
1 2 3 4 5 6 7 X . . . (134) sirens from fire trucks or ambulances at a distance?
1 2 3 4 5 6 7 X . . . (135) a change in room temperature?
1 2 3 4 5 6 7 X . . . (136) a change in light when a cloud passed over the sun?
1 2 3 4 5 6 7 X . . . (137) sound of an airplane passing overhead?
1 2 3 4 5 6 7 X . . . (138) a bird or a squirrel up in a tree?
1 2 3 4 5 6 7 X . . . (139) fabrics with scratchy texture (e.g., wool)?

When tired, how often was your baby:
1 2 3 4 5 6 7 X . . . (140) likely to cry?
1 2 3 4 5 6 7 X . . . (141) show distress?

123
At the end of an exciting day, how often did your baby:
1 2 3 4 5 6 7 X . . . (142) become tearful?
1 2 3 4 5 6 7 X . . . (143) show distress?

For no apparent reason, how often did your baby:
1 2 3 4 5 6 7 X . . . (144) appear sad?
1 2 3 4 5 6 7 X . . . (145) seem unresponsive?

How often did your baby make talking sounds when:
1 2 3 4 5 6 7 X . . . (146) riding in a car?
1 2 3 4 5 6 7 X . . . (147) riding in a shopping cart?
1 2 3 4 5 6 7 X . . . (148) you talked to her/him?

**Two Week Time Span**

When you returned from having been away and the baby was awake, how often did s/he:
1 2 3 4 5 6 7 X . . . (149) smile or laugh?

When introduced to an unfamiliar adult, how often did the baby:
1 2 3 4 5 6 7 X . . . (150) cling to a parent?
1 2 3 4 5 6 7 X . . . (151) refuse to go to the unfamiliar person?
1 2 3 4 5 6 7 X . . . (152) hang back from the adult?
1 2 3 4 5 6 7 X . . . (153) never “warm up” to the unfamiliar adult?

When in the presence of several unfamiliar adults, how often did the baby:
1 2 3 4 5 6 7 X . . . (154) cling to a parent?
1 2 3 4 5 6 7 X . . . (155) cry?
1 2 3 4 5 6 7 X . . . (156) continue to be upset for 10 minutes or longer?

When visiting a new place, how often did the baby:
1 2 3 4 5 6 7 X . . . (157) show distress for the first few minutes?
1 2 3 4 5 6 7 X . . . (158) continue to be upset for 10 minutes or more?
1 2 3 4 5 6 7 X . . . (159) get excited about exploring new surroundings?
1 2 3 4 5 6 7 X . . . (160) move about actively when s/he is exploring new surroundings?

When your baby was approached by an unfamiliar person when you and s/he were out (for example, shopping), how often did the baby:
1 2 3 4 5 6 7 X . . . (161) show distress?
1 2 3 4 5 6 7 X . . . (162) cry?

When an unfamiliar adult came to your home or apartment, how often did your baby:
1 2 3 4 5 6 7 X . . . (163) allow her/himself to be picked up without protest?
1 2 3 4 5 6 7 X . . . (164) cry when the visitor attempted to pick her/him
When in a crowd of people, how often did the baby:
1 2 3 4 5 6 7 X . . . (165) seem to enjoy him/herself?

Did the baby seem sad when:
1 2 3 4 5 6 7 X . . . (166) caregiver is gone for an unusually long period of time?
1 2 3 4 5 6 7 X . . . (167) left alone/unattended in a crib or a playpen for an extended period of time?

When you were busy with another activity, and your baby was not able to get your attention, how often did s/he:
1 2 3 4 5 6 7 X . . . (168) become sad?
1 2 3 4 5 6 7 X . . . (169) cry?

When your baby saw another baby crying, how often did s/he:
1 2 3 4 5 6 7 X . . . (170) become tearful?
1 2 3 4 5 6 7 X . . . (171) show distress?

When familiar relatives/friends came to visit, how often did your baby:
1 2 3 4 5 6 7 X . . . (172) get excited?
1 2 3 4 5 6 7 X . . . (173) seem indifferent?

Soothing Techniques

Have you tried any of the following soothing techniques in the last two weeks? If so, how quickly did your baby soothe using each of these techniques? Circle (X) if you did not try the technique during the LAST TWO WEEKS.

When rocking your baby, how often did s/he:
1 2 3 4 5 6 7 X . . . (174) soothe immediately?
1 2 3 4 5 6 7 X . . . (175) not soothe immediately, but in the first two minutes?
1 2 3 4 5 6 7 X . . . (176) take more than 10 minutes to soothe?

When singing or talking to your baby, how often did s/he:
1 2 3 4 5 6 7 X . . . (177) soothe immediately?
1 2 3 4 5 6 7 X . . . (178) not soothe immediately, but in the first two minutes?
1 2 3 4 5 6 7 X . . . (179) take more than 10 minutes to soothe?

When walking with the baby, how often did s/he:
1 2 3 4 5 6 7 X . . . (180) soothe immediately?
1 2 3 4 5 6 7 X . . . (181) not soothe immediately, but in the first two minutes?
1 2 3 4 5 6 7 X . . . (182) take more than 10 minutes to soothe?
When giving him/her a toy, how often did the baby:
1  2  3  4  5  6  7  X . . . . (183) soothe immediately?
1  2  3  4  5  6  7  X . . . . (184) not soothe immediately, but in the first two minutes?
1  2  3  4  5  6  7  X . . . . (185) take more than 10 minutes to soothe?

When showing the baby something to look at, how often did s/he:
1  2  3  4  5  6  7  X . . . . (186) soothe immediately?
1  2  3  4  5  6  7  X . . . . (187) not soothe immediately, but in the first two minutes?
1  2  3  4  5  6  7  X . . . . (188) take more than 10 minutes to soothe?

When patting or gently rubbing some part of the baby’s body, how often did s/he:
1  2  3  4  5  6  7  X . . . . (189) soothe immediately?
1  2  3  4  5  6  7  X . . . . (190) not soothe immediately, but in the first two minutes?
1  2  3  4  5  6  7  X . . . . (191) take more than 10 minutes to soothe?
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