The effect of parent-infant interaction on physiological outcomes during feeding in preterm infants

THESIS

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High quality parent-infant interactions contribute to successful newborn feeding outcomes through the parent’s structuring and co-regulation of the feeding. Quality of parental interaction during feeding is particularly important for supporting feeding in premature infants. Little is known about the effect of the quality of parent-infant interaction on the premature infant’s physiology during feeding. The purpose of this study is to investigate whether the quality of parent-infant interaction affects feeding skills, heart rate, respiratory rate, and oxygen saturation of premature infants during feeding over the first year of life. Secondary data from 61 premature infants were used for statistical analyses. A multiple imputation strategy was used during the analysis to accommodate intermittent missing values. Repeated-measures general linear models with multiple dependent variables were used to account for correlations within infants and between dependent variables. Quality of parent-infant interaction was not shown to be significantly related to the multivariate construct of infant physiology during feeding over the first year of life. Knowledge of important parent-infant interaction factors can assist nurses in providing the best assessment and intervention services to improve feeding and developmental outcomes for these vulnerable premature infants and their families.
Dedication

This document is dedicated to my family, friends, teachers, and mentors who have supported me during this entire journey of learning.
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Publications


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Chapter 1: Introduction

Parent-child interaction is central to the growth and development of the newborn (Barnard & Kelly, 2000). One of the primary ways in which parent-child interaction affects growth and development is through the structuring, regulation, and completion of the infant’s feeding (Sumner & Spietz, 1994). Premature infants are at high risk for both poor parent-child interaction and suboptimal feeding outcomes given their physiologic and developmental immaturity. Little is known about the effect of the quality of parent-child interaction on the premature infant’s physiology during feeding. Understanding the mechanisms by which parent-child interaction affects successful feeding outcomes can assist nurses in developing and evaluating interventions aimed at improving parent-child interaction and regulation during feeding. The purpose of this study was to investigate whether the quality of parent-child interaction affects the feeding skills, heart rate, respiratory rate, and oxygen saturation of the premature infant during the first year of life.
Chapter 2: Literature Review

Many factors contribute to parent-child interaction outcomes in premature infants. Because infants in the NICU are acutely ill, parents often miss early opportunities for normal interactions with their newborns, such as feeding, holding, or changing a diaper. In addition, premature infants have less expendable energy during interaction, leading to decreased alertness, responsiveness, eye contact, and clarity of cues (Barnard et al., 1984). Vague cues can make it difficult for parents to adequately respond to their infant’s needs. Moreover, the stressful environment of a NICU can be severely detrimental to parent mental health (Shaw et al., 2009). Parents of infants in the NICU are known to have much higher rates of anxiety and depression than parents of healthy babies (Bellini, 2009). Distress, anxiety, and depression all interact within the parent to produce significantly different parenting behaviors than those seen in parents with healthy term babies (Candelaria, Teti, & Black, 2011; Treyvaud et al., 2011; Wan & Green, 2009). Research has shown mothers of premature infants to be more controlling and less sensitive than parents of term babies (Muller-Nix et al., 2004). These infant and parental factors can lead to negative parent-child interactions in the NICU and beyond discharge (Korja et al., 2008). Given that mental illness is known to adversely affect interaction outcomes and that parents already report problems with bonding in the NICU, parents of premature infants are at high risk for strained relationships with their vulnerable infants (Forcada-Guex, Borghini, Pierrehumbert, Ansermet, & Muller-Nix,
Parent-child interaction is critical to the success of feeding, as the primary caregiver is responsible for the structuring, regulation, and completion of the infant’s feeding (Sumner & Spietz, 1994). Feeding is of special importance in the NICU as adequate weight gain and successful nipple feeding are criteria for release from the NICU (Shaker & Werner Woida, 2007). In addition, premature infants need sufficient intake to sustain growth and obtain optimal development after discharge (Lapillonne, Razafimahefa, Rigourd, Granier, & intervenants au seminaire Nutrition du premature du GEN-IdF, 2011; Nash et al., 2011; Wiedmeier, Joss-Moore, Lane, & Neu, 2011).

Feeding a stressful challenge for premature infants, who often struggle to maintain physiologic stability of their heart rate, respiratory rate, and oxygenation status during feeding (Lau, 2007; Thoyre & Carlson, 2003a). Premature infants experience numerous barriers to achieving physiologic stability during feeding and successful feeding outcomes because of their neurologic immaturity. These barriers include delayed opportunities to feed (Pickler & Reyna, 2003), inadequate engagement during feeding (Thoyre & Brown, 2004), weak oral-motor skills (Pridham, Steward, Thoyre, Brown, & Brown, 2007), and poor coordination of the suck, swallow, and breathing mechanism (Bauer, Prade, Keske-Soares, Haeffner, & Weinmann, 2008; Thoyre & Brown, 2004). In addition, suboptimal parent-child interaction factors can lead to negative feeding interactions and outcomes (Silberstein et al., 2009). Since premature infants are already at risk for poor feeding due to their inadequate neurological development (Silberstein et
al., 2009; Thoyre, Shaker, & Pridham, 2005), poor parent-child interaction compounds their risk of poor feeding outcomes and adds to the numerous obstacles these infants will face to achieve optimal neurodevelopment.

While previous literature has supported the importance of parent-child interaction to successful feeding outcomes (Pridham et al., 2005), little is known about the effect of the quality of parent-child interaction on the premature infant’s physiology during feeding. Theoretical and empirical evidence supports the supposition that caregivers are able to regulate the physiologic state of the neonate (Feldman, 2006; Feldman & Eidelman, 2007; Harrison, 2009; Poehlmann et al., 2011). However, recent studies in infants have examined the impact of parent-child interaction factors on other physiologic measures such as heart rate variability during feeding, but with mixed results (Brown, 2007; Harrison, 2009; Poehlmann et al., 2011). While Poehlmann (2011) found that positive parent-child interaction factors were related to infant heart-rate variability during feeding, Brown (2007) did not find a significant relationship, and Harrison (2009) only found a significant relationship with healthy term infants, but not infants with congenital heart defects. No studies have investigated the impact of parent-child interaction factors on heart rate, respiratory rate, and oxygenation.

We used Schore’s Theory of Right Brain Development and Affect Regulation as a guiding framework for this study (Schore, 2001). Schore’s model contends that through maternal-infant interaction, the mother’s behaviors augment right brain development, which leads to enhanced emotional and physiological regulation within the neonate. The right brain is connected to the limbic, sympathetic, and parasympathetic nervous systems,
which control autonomic function, emotions, and responses to stress (Figure 1).
Applying this framework, positive-parent child interaction activates and strengthens these pathways, leading to homeostasis and coordinated responses between the parasympathetic and sympathetic nervous systems during a stressful challenge such as feeding. Negative parent-child interaction can lead to dysregulation of the autonomic nervous system and unsuccessful physiologic responses to the stressful feeding challenge, resulting in poor control of oxygenation, heart rate, and respiratory rate. In this manner, the mother’s ability to structure and regulate the feeding through her interactions with her preterm infant are likely to affect her infant’s physiologic regulation during feeding.

An understanding of the mechanisms by which quality of parent-child interaction affects feeding outcomes would be essential in providing the most efficient and effective assessment and intervention services for premature infants and their families. A typical feeding episode can be greatly improved by teaching parents how to recognize infant readiness, hunger, satiation, and disengagement cues (Sumner & Spitz, 1994). Moreover, nurses can use education and intervention to guide parents in how to increase alertness for the feeding by talking and gently stroking their premature infants, how to position their infant during the feeding interaction for safe and efficient intake, and how to respond to cues for effective feeding (Shaker & Werner Woida, 2007). Physiologic dysregulation during feeding could be used as a potential source of evidence for suboptimal parent-child interaction during feeding and the need for intervention. Since premature infants’ behavioral cues are often vague and inconsistent with the ability of the baby to regulate during times of stress (Peng et al., 2010; Thoyre & Carlson, 2003b)
physiologic indicators could alert parents to interaction behaviors which support or disrupt their infant’s feeding. Physiologic dysregulation could also be used by clinicians as a more precise marker for the effectiveness of interventions aimed at improving parent-child interaction during feeding. We propose that the quality of parent-child interaction affects the physiology and skills of the premature infant during feeding; in essence, a higher quality of parent-child interaction will better assist the infant in physiologic regulation during the feeding challenge.
Chapter 3: Methods

This secondary data analysis utilized a descriptive, longitudinal design involving several possible covariates and dependent variables. The purpose of this study was to analyze how the quality of parent-child interaction affects feeding skill, heart rate, respiratory rate, and oxygen saturation of the premature infant during feeding over time. It was hypothesized that infants experiencing higher quality of parent-child interaction would display significantly greater skills during feeding and significantly more stable outcomes in the physiologic variables of heart rate, respiratory rate, and oxygen saturation over time.

Sample

The sample used for this secondary data analysis was part of the Correlates of Preterm and Term Infant Feeding Outcomes project, a longitudinal study whose purpose was to develop models of mediating and moderating factors including dietary intake, somatic growth, and development in order to predict and enhance feeding outcomes in term and preterm infants (Pridham et al., 2005; Pridham, Schroeder, Brown, & Clark, 2001; Pridham, Brown, Sondel, Clark, & Green, 2001). The original sample included a total of 114 term and premature infants. This secondary data analysis only utilizes data from the 61 premature infants.

Inclusion and exclusion criteria for the original study included mothers who were 18 years of age or older and had the ability to read and speak English. For the purposes
of this secondary data analysis, only premature infants less than or equal to 32 weeks gestational age at birth were included. All of the premature infants in the original study were required to have a diagnosis of respiratory distress syndrome (RDS), and many of these infants developed bronchopulmonary dysplasia during the hospital stay in the neonatal intensive care unit (NICU). In addition, preterm infants determined to have thyroid, gastrointestinal, congenital, or other pathologic conditions which would potentially interfere with dietary intake or digestive processes were excluded from the original study. All premature infants were required to be fed entirely by nipple or breast at time of hospital discharge. Moreover, infant birth weight had to be appropriate for gestational age, defined as above the 10th percentile for age (Babson & Benda, 1976). When a mother experienced multiple births, only one infant was included in the study; the infant who was hospitalized the longest was the infant included.

Recruitment and Data Collection

The original data were collected in the 1990s as part of the Correlates of Preterm and Term Infant Feeding Outcomes project. Mothers of the preterm infants were recruited before the infant was discharged from the NICU by nurses who were not members of the project staff. After consent to be contacted was obtained by hospital staff, a project staff member contacted the mother to explain the study and assess interest level. All mothers who agreed to participate in the study completed the consent form and were scheduled to complete four in-home visits during their infant’s first year of life. Data were collected during home visits when the infant was 1, 4, 8, and 12 months corrected age. These time periods were chosen based on the biobehavioral stages of
development during the first year of life (Emde, Gaensbauer, & Harmon, 1976). The goal was to have data collected within two weeks of each time point.

**Ethics**

The primary study was approved by the institutional review boards of the academic institution and participating clinical sites. During primary data collection, all mothers who chose to participate completed a signed consent form. An exemption from the Institutional Review Board at Nationwide Children’s Hospital was obtained as this secondary data analysis utilizes de-identified data. Additional approval was granted by the author of the primary study, Dr. Karen Pridham, in order to gain access to the de-identified database.

**Measures**

*Quality of Maternal Affect and Behavior.* Quality of maternal affect and behavior was measured using the Parent-Child Early Relational Assessment (PCERA; Clark, 2010). In this measure, parent-child interaction includes not only the emotional characteristics and behavioral traits that mother and child bring to the interaction, but also encompasses the respective experiences that each has as a result of the interaction (Clark, 2010). The PCERA is a 65 item assessment tool that incorporates parent, child, and dyadic subscales. For the purposes of this study, only the Parental Negative Affect and Behavior (PNAB) Subscale was used, as it is thought to be more theoretically important to the child’s health and development (Schore, 1996). Each item consists of an ordinal, 5-point Likert-type scale in which 5 is the most positive score (see Table 1 for sample items). Items with a score of 1 or 2 indicate areas of concern, whereas items with a score
of 4 or 5 indicate areas of strength. A score of 3 is considered a cut-off, with significant concern defined as a score of 2.5. In order to use the tool, the dyad engages in a semi-structured interaction that is observed and video-taped during four 5 minute segments (Clark, 2010). The video-tape is assessed for performance on the items. We used the feeding task as the context for our semi-structured interactions. This tool has adequate reliability and validity (Clark, 1999). Cronbach’s alpha for the PNAB Subscale is 0.86 (Clark, 2010). Interrater reliability is assessed by viewing 20% of tapes using two raters and has been shown to be 85% (Clark, 1999).

Neurodevelopmental risk. The Neurobiological Risk Score (NBRS) was used to measure neurodevelopmental risk. The purpose of the NBRS is to predict neurologic and developmental outcomes in high-risk infants. The NBRS assumes that if a physiologic event is sufficient to affect the infant’s development, the event must be able to cause cell injury (Brazy, Eckerman, Oehler, Goldstein, & O’Rand, 1991) Seven items (infection, blood pH, seizures, intraventricular hemorrhage, assisted ventilation, periventricular leukomalacia, and hypoglycemia) receive a score of 0, 1, 2, or 4. The scores on each of the seven variables are summed to obtain the total NBRS score. Total scores are calculated during the first two weeks of the infant’s hospital stay, and at discharge. Higher scores indicate more risk for adverse developmental outcomes. Infants with a cut-off score of 5 or more at two weeks post birth are considered to be at high risk for poor neurological development (Brazy et al., 1991). This measure has demonstrated adequate validity (Brazy, Goldstein, Oehler, Gustafson, & Thompson, 1993; Nunes et al., 1998). In one study, a revised 2-week score of greater than or equal to 5 or a discharge score of
greater than or equal to 6 demonstrated a 100% specificity and 100% positive predictive value for an abnormal outcome at 24 months of age (Brazy et al., 1991). NBRS has also been found to significantly correlate with the Bayley Scales of Infant Development, Mental Development Index (MDI) ($r = -0.61 \text{ to } -0.40$) and Psychomotor Development Index (PDI) ($r = -0.59 \text{ to } -0.46$), and with abnormal neurologic examination findings ($r = 0.59 \text{ to } 0.73$) (Brazy et al., 1991).

*Maturity at Birth.* Maturity at birth was measured by gestational age, which in the original study was determined by ultrasound before 20 weeks gestation if possible. Otherwise, gestational age was determined by examination shortly after birth. The staff neonatologist’s estimate of gestational age was used in the event of discrepancies between neonatal examination and the mother’s estimated data of delivery. Maturity at birth was also measured by birth weight. The infant’s birth was obtained using the infant’s hospital record. All infants were weighed on electronic scales.

*Physiologic variables.* All physiologic variables were measured during feeding. Oxygen saturation was measured by taking the mean of the infant’s oxygen saturation of arterial blood with a pulse oximeter during the first few minutes of feeding. Oxygen saturation levels were taken when the reading was stable during recording. Heart rate was measured using the pulse data from the pulse oximeter and was recorded during the first few minutes of feeding. Respiratory rate was measured by counting breaths for a full minute. Respiratory rate was measured by a licensed registered nurse during the first few minutes of feeding.
Feeding skills. Feeding skills were measured using an observational assessment tool specifically developed for the original study. The instrument, “Infant Feeding Skills; Expected Age and Visit When Accomplished,” is based on 4 subsets of skills based on four assessment periods at 1, 4, 8, and 12 months (Pridham et al., 2007). The skill subsets include 1) oral-motor skills, 2) hand/hand-eye skills, 3) head and trunk skills, 4) communicative-social skills. Skills were counted as observed if they were performed during any time when the research nurse was completing a data-collection visit. Thus, the instrument is a summation of 126 items which utilizes dichotomous scoring techniques (skill absent or present). The total feeding score was calculated by counting each skill that was performed.

Data Analysis

A multiple imputation strategy was used during the analysis to accommodate intermittent missing values. A semi-parametric approach was taken for multiple imputation, such that the first 20 infants who were most similar based on gestational age and Neurobiological Risk Score were selected as candidates for imputation of infant data with missingness. One infant was randomly selected from those candidates and added a stochastic element to avoid excessive repetition of values in the data. Finally, a total of 10 data sets were created using multiple imputation and combined in order to calculate one p-value for the covariates of interest (Li, Raghunathan, & Rubin, 1991). Repeated-measures general linear models (GLM) with multiple dependent variables were used to account for correlations within infants and between dependent variables. The quality of maternal-infant interaction, the main predictor of interest, was used as a time-varying
covariate so that the PCERA score at 1, 4, 8, and 12 months would be accounted for in the model. Finally, all variables were centered to ease interpretation of main effects in the presence of interaction terms. SAS Statistical software package and the R language and environment were used for all statistical analyses.

*Power Calculations.* Given the complexity of the statistical methods, standard statistical software available to calculate *a priori* power was not adequate to determine sample size for this secondary data analysis. However, power calculations were performed using the observed beta coefficients and correlation matrix during Monte Carlo simulations. One hundred simulations were run to determine the probability of observing a meaningful effect. The observed data from this pilot study were used to complete power calculations in order to determine appropriate sample size for future study. Based on the Monte Carlo simulations, a sample size of approximately 75 babies with no missing data would be needed to observe an effect of the quality of parent-infant interaction given a power of 0.80 an alpha level of 0.05 (See Figure 2).

*Assumptions.* To determine the appropriateness of repeated measures general linear models using multivariate regression, the assumptions of linearity, homogeneity, and normality were all assessed and met satisfaction. An overall alpha level of 0.05 was chosen for multivariate analysis. Furthermore, an alpha level of 0.0125 was chosen using the Bonferroni correction in order to control the Type I error rate at the univariate level for the four dependent variables and an alpha level of 0.0083 was chosen to control the Type I error rate for the six contrasts completed during univariate analyses.
Three covariates were assessed for inclusion of the final model because of their theoretical importance to the dependent variables. Gestational age, birth weight, and Neurobiological Risk Score have all been previously identified as influencing feeding skills, heart rate, respiratory rate, and oxygen saturation during feeding (Pridham et al., 2007; Thoyre & Carlson, 2003a; Thoyre et al., 2005). In general, smaller, younger, and more acutely ill premature infants struggle to maintain physiologic stability, such as heart rate, respiratory rate, and oxygen saturation, during feeding. Because the researcher is interested in assessing the effect of parent-child interaction quality on regulation of physiologic variables during feeding, these possible covariates were determined to be necessary for inclusion given the confounding nature of their effect on the dependent variables.
Chapter 4: Results

Sample Demographics

Demographic and descriptive statistics for the dependent variables can be found in Table 2 and 3. The average (SD) birth weight of the sample was 1122.6 (310.108) grams. The mean (SD) gestational age at birth for the sample was 28.3 (2.011) weeks. Forty-six percent of the premature infants were male. The mean (SD) age for mothers of the premature infants was 29.9 years (SD = 5.836). The average (SD) number of education years for mothers was approximately 14 years (SD = 2.648). Approximately half of the mothers made $35,000 or less. Finally, 88.5% of the mothers were of Caucasian race, 8.2% African American, and the remaining percent were of Asian and Hispanic descent.

Repeated-measures General Linear Models

The results for the repeated-measures GLM with multivariate regression demonstrate that the main predictor of interest, quality of parent-child interaction, was nonsignificant at the 0.05 alpha level ($F = 1.722; \text{df} = 4,5706; \text{p} = 0.142$). Therefore, the findings fail to conclude that the quality of parent-child interaction has a significant effect on the multivariate construct of infant physiology during feeding over the first year of life for an infant with an average birth weight, gestational age, and NBRS (See Table 4). Moreover, the covariates of gestational age at birth ($F = 0.707; \text{df} = 4,4514; \text{p} = 0.588$), NBRS ($F = 1.368; \text{df} = 4,677; \text{p} = 0.244$), and birth weight ($F = 0.377; \text{df} = 4,4980; \text{p} =$
0.825) were also nonsignificant at the 0.05 alpha level. Thus, the findings fail to conclude that gestational age at birth, NBRS, and birth weight have a significant effect on infant physiology during feeding over the first year of life for an infant with an average PNAB Subscale score. However, multivariate results do show that for the covariate effect of time at least one combination of the dependent variables is significant at the 0.05 alpha level (F = 73.53; df = 4,3851; p < 0.001). Thus, the multivariate results indicate that infants are significantly different on at least one combination of the four time points. All multivariate interaction terms were nonsignificant at the 0.05 alpha level, such as gestational age*quality of parent-child interaction (F = 0.889; df = 4,360; p = 0.471), NBRS*quality of parent-child interaction (F = 0.956; df = 4,3035; p = 0.431), birth weight*quality of parent-child interaction (F = 0.372; df = 4,242; p = 0.828), and time*quality of parent-child interaction (F = 0.797; df = 4,4346; p = 0.654).

When evaluating univariate results and controlling the alpha level for each of the four dependent variables, the level of significance applied would be α = 0.0125 using the Bonferroni correction. Univariate results for the effect of parent-child interaction group, gestational age at birth, NBRS, birth weight, and interaction terms were not assessed as results were nonsignificant at the multivariate level (Table 4). However, the significant multivariate main effect of time was assessed at the univariate level. The effect of time on feeding skills (F = 188.69; df = 3,1273; p < 0.001), heart rate (F = 29.29; df = 3,1231; p < 0.001), respiratory rate (F = 23.06; df = 3,517; p < 0.001) were all significant at the alpha level of 0.0125 (Table 5). Oxygen saturation was nonsignificant at the univariate alpha level of 0.0125 (F= 0.997; df = 3,1468; p = 0.393). Thus, time points are
significantly different with an alpha level of 0.0125 on the dependent variables of feeding skills, heart rate, and respiratory rate. Pairwise contrasts comparing time points for the dependent variables reveal significant differences between all time points for the dependent variable feeding skills. Additionally, all contrasts between time points for heart rate were significant, except for the contrast between time 3 and 4 (p = 0.0855) using a 0.00833 alpha level. Finally, all contrasts between time points for respiratory rate were significant, except for the contrast between time 2 and 3 (p = 0.1288). Contrasts for oxygen saturation were not assessed as this dependent variable was not significant at the univariate level.
Chapter 5: Discussion

The results demonstrate no significant effects for each of the covariates or for the main predictor, quality of parent-child interaction. This is inconsistent with previous literature, which indicates that mothers are responsible for structuring a feeding and regulating a baby’s responses to this stressful challenge (Brown, Thoyre, Pridham, & Schubert, 2009; Poehlmann et al., 2011; Pridham et al., 2005; Schore, 2001; Silberstein et al., 2009). There could be many possible explanations for insignificant findings in this sample of premature infants. First, although the Parental regulation of Negative Affect and Behavior Scale was used, other aspects of the quality of parent-infant interaction (as measured by different subscales) could have an impact on infant physiology during feeding. Second, the physiologic variables of heart rate, respiratory rate, and oxygen saturation may not have been sensitive enough to the effect of parent-infant interaction. The sensitivity of these physiologic variables as indicators of stress or dysregulation has been criticized earlier in premature infant literature (Stevens et al., 2009; Stevens & Franck, 1995). Third, it is possible that parents may affect their infant’s physiology during feeding in nonlinear ways, such as infants who experience higher quality of parent-infant interaction may have tighter control of their physiology during feeding (See Figure 3). This would be evidenced by differences in the variance of infant physiologic variables and not the means, which were used in our statistical analyses. Finally, other environmental and experiential factors could impact the infant’s physiology during
feeding, such that parental mechanisms unrelated to the quality of parent-infant interaction have a greater impact on infant physiology during feeding.

The results demonstrate a significant main effect of time, which makes intuitive and theoretical sense. Premature infants undergo vast developmental and physiologic changes over the first year of life. Feeding skill, heart rate, and respiratory rate drastically evolve over the first year of life due to maturation of the infant. Moreover, it is understandable that oxygen saturation was not significant over time, as this physiologic variable does not mature with age.

Limitations of the study are evident in the largely nonsignificant results of the research. This could have been due to low statistical power. In addition, it can also be noted that the correlations among the dependent variables were relatively weak and nonsignificant ($r < 0.10$), as well as the correlations between the possible covariates and dependent variables ($r < 0.10$). These insignificant correlations could have contributed to low power in the multivariate analysis. Conducting separate univariate analysis should be considered in future research given the weak relationships among the dependent variables. Future research should also investigate other possible covariates which are more highly correlated with the dependent variables. Moreover, the restricted criteria of including only premature infants under the age of 32 weeks gestation could have limited the variability of the sample. Although term infants were excluded from the study to further control for the effect of neurobiologic risk on the physiologic dependent variables, expanding the sample to include neonates of all gestational ages could increase sample variability. A larger and more diverse sample encompassing low-socioeconomic and
other minority groups would also enhance the comprehensiveness and generalizability of
the data. Although the research design does exhibit some limitations, there are strengths
to the design. A longitudinal analysis of repeated measures provides a unique
opportunity to look at the impact of parent-child interaction on physiologic feeding
variables over the first year of life.
Chapter 6: Conclusion

Parent-child interaction is central to the growth and development of infants during the first year of life. Parent-child interaction is also critical for optimal feeding outcomes, as the primary caregiver is responsible for structuring the feeding and regulating the infant’s responses during the feeding. Premature infants are a vulnerable population who are at high-risk for suboptimal parent-child interaction and feeding outcomes. Future research should investigate parent-child interaction factors which affect both behavioral and physiologic feeding outcomes of premature infants. Knowledge of important parent-child interaction factors can assist nurses in providing the best assessment and intervention services in order to improve developmental outcomes for these vulnerable premature infants and their families.
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Appendix A: Figures and Tables
Figure 1. Impact of Maternal Stimuli during Interaction on Infant Physiology. Diagram of pathways associated with infant neurobiological changes in response to positive maternal interaction. NAC = nucleus accumbens, CRH = corticotropin releasing hormone, ACTH = adrenocortiotropic hormone, SA = sinoatrial. Blue bordered boxes indicate hypothalamic-pituitary-adrenal (HPA) axis. Green bordered boxes indicate sympathomedullary axis. Orange bordered boxes indicate regulation of parasympathetic nervous system. Dashed lines indicate feedback loops.
Figure 2. Power Calculations from Monte Carlo Simulations of Observed Data. Figure of power calculations determined by Monte Carlo simulations using the observed beta coefficients and correlation matrix in this data. Graphs determine the sample size needed (shown on the x axis) to have a power of 0.8 (shown on the y axis). The point at which the horizontal power line intersects the vertical line is the sample size needed. PNAB = Parental Regulation of Negative Affect and Behavior Subscale, or the quality parent-infant interaction. GA = gestational age. NBRS2WK = Neurobiological Risk Score, taken at 2 weeks after birth. BirthWt = infant weight at birth. * = interaction term of the variables listed.
Table 1. Sample items from the PCERA.

(25) **Flexibility/Rigidity**

This scale assesses the parent’s demonstrated capacity for flexibility in relating to his/her child ranging from inflexible, controlled, stiff responses to infant/child’s behavior to relaxed, spontaneous, flexible responses evidencing a capacity to follow child’s lead, to adapt to changing circumstances or to generally be able to “shift gears.”

1 = Very rigid, inflexible.
2 = Rigid; brief instances of flexibility.
3 = Moderate flexibility; some rigidity present.
4 = Mostly flexible or easy going.
5 = Characteristically flexible; easy going, spontaneous.
6 = N.R.

(26) **Resourcefulness, Creativity**

This scale assesses the amount the parent initiates novel interactions with the child and may include extending and elaborating child’s initiations or facilitating child’s interest and pleasure in activities. Rater may infer parent’s ingenuity and resourcefulness.

1 = Not creative, limited in approach to child.
2 = Minimal creativity, resourcefulness.
3 = Some indication of creativity; ingenuity; resourcefulness.
4 = Usually creative.
5 = Very creative; original; resourceful, characteristic.
6 = N.R.

(27) **Intrusiveness**

This scale evaluates the parent’s intrusiveness and overinvolvement. This includes overstructuring, overcontrolling, interfering, overbearing, etc., so that the child’s initiative is often thwarted. This overinvolvement may be of a symbiotic nature and focus on the parent’s interference and domination of the child. Child’s age and task need to be taken into consideration.

1 = Very intrusive; domineering.
2 = Frequently intrusive; one or two instances of respect for child’s initiative.
3 = Moderately intrusive.
4 = Slight intrusive behavior; one or two brief instances.
5 = Not at all intrusive; includes respecting child’s autonomy.
### Table 2. Sample Demographics

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<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (g)</td>
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<td>61</td>
<td>1965</td>
<td>1122.57</td>
<td>310.108</td>
</tr>
<tr>
<td>Gestational Age (wks)</td>
<td>57</td>
<td>24.3</td>
<td>32.6</td>
<td>28.277</td>
<td>2.0111</td>
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<tr>
<td>Maternal age (yrs)</td>
<td>61</td>
<td>18</td>
<td>43</td>
<td>29.90</td>
<td>5.863</td>
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<tr>
<td>Maternal education (yrs)</td>
<td>61</td>
<td>10</td>
<td>21</td>
<td>13.95</td>
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<tr>
<td>Neurobiological risk (score at 2 wks)</td>
<td>61</td>
<td>0</td>
<td>12</td>
<td>2.87</td>
<td>1.979</td>
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<tr>
<td>Maternal Race (% Caucasian)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88.5%</td>
</tr>
<tr>
<td>Maternal Income (&lt;$35,000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52.5%</td>
</tr>
<tr>
<td>Infant Gender (% male)</td>
<td></td>
<td></td>
<td></td>
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<td>45.9%</td>
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Table 3. Descriptive Statistics for Dependent Variables

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<tr>
<th></th>
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<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
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<tr>
<td>FDG1</td>
<td>56</td>
<td>3</td>
<td>7</td>
<td>5.75</td>
<td>1.014</td>
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<td>FDG2</td>
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<td>FDG3</td>
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<td>16</td>
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<td>130</td>
<td>181</td>
<td>155.25</td>
<td>11.092</td>
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<td>145.64</td>
<td>15.480</td>
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<td>15.598</td>
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<td>Valid N</td>
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(listwise)
Table 4. Results of Repeated-Measures General Linear Models (GLM)

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<tr>
<th></th>
<th>F</th>
<th>df (num)</th>
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<th>p-value</th>
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<tr>
<td>Gestational age</td>
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<td>4514</td>
<td>0.588</td>
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<td>Birth weight</td>
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<td>4980</td>
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<td>Neurobiological risk score</td>
<td>1.368</td>
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<td>0.244</td>
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<td>Parent-Infant Interaction</td>
<td>1.722</td>
<td>4</td>
<td>5706</td>
<td>0.142</td>
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<td>Time</td>
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<tr>
<td></td>
<td>F</td>
<td>df (num)</td>
<td>df (den)</td>
<td>p-value</td>
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<tr>
<td>--------------------------------</td>
<td>--------</td>
<td>----------</td>
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<tr>
<td>Feeding skill</td>
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<tr>
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<td>&lt;0.0001</td>
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<td>Respiratory rate</td>
<td>23.06</td>
<td>3</td>
<td>517</td>
<td>&lt;0.0001</td>
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<td>Oxygen Saturation</td>
<td>0.997</td>
<td>3</td>
<td>1468</td>
<td>0.393</td>
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Figure 3. Scatter Plots of Maternal-Infant Interaction and Dependent Variables. Scatter plots of the relationships between quality of maternal-infant interaction and the four dependent variables at each of the four time points. T1, T2, T3, T4 = 1, 4, 8, and 12 months corrected age. PNAB = Parental Regulation of Negative Affect and Behavior, the subscale used to measure quality of maternal-infant interaction. FDG = number of feeding skills observed during feeding. HR = heart rate during beginning of feeding. RR = respiratory rate during beginning of feeding. O2FD = oxygen saturation during beginning of feeding.