Mother–Child Interactions in the NICU: Relevance and Implications for Later Parenting

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Objective This study examined the feasibility of observing mother–child interactions in the neonatal intensive care unit (NICU), whether NICU interactions related to later interactions, and how interactions related to child and maternal characteristics. **Methods** The sample included 130 preterm infants and their mothers, observed in a feeding interaction in the NICU. Dyads were observed through 36 months postterm. **Results** Observed maternal positive affective involvement and verbalizations in the NICU were associated with the same parenting behaviors at 24 months, social support, socioeconomic status, and being born in the late preterm period. Maternal negative affect and behavior were unrelated to later maternal negativity or child and maternal characteristics. **Conclusions** Positive parenting assessed in the NICU appears related to later parenting interaction quality, suggesting early assessment is possible. Maternal negative affect and behavior toward children may not consistently emerge until later in development.

Key words assessment; parenting; prematurity; social support.

Each year, 11.7% of children are born preterm (<37 weeks' gestation) in the United States (Hamilton, Martin, & Ventura, 2012). Because a growing number of infants survive their neonatal intensive care unit (NICU) stays (Matthews & MacDorman, 2012), more families must interact with medically vulnerable infants in the NICU setting. Having a premature infant in the NICU can be stressful and even traumatic (Feldman-Reichman, Miller, Gordon, & Hendricks-Munoz, 2000), and maternal distress and depression are often elevated (Brummelte, Grunau, Synnes, Whitfield, & Petrie-Thomas, 2011; Singer et al., 1999). In response to the stresses of the NICU environment, models of family-centered care (Gooding et al., 2011; Griffin, 2006) have become more prevalent and include building on family strengths, involving and collaborating with family members in decision-making, and providing support for families during the NICU visit and through the transition to home. Family-centered care models promote use of skin-to-skin contact and parental education designed to support development and positive interaction qualities at home (Feldman, Eidelman, Sirota, & Weller, 2002; Gooding et al., 2011). Yet, these interventions have often focused on universal strategies, rather than targeted preventions aimed at improving interaction quality for families most at risk or those likely to engage in poor interaction quality (Cooper et al., 2007).

The quality of parent–child interactions is considered paramount in supporting children's development, serving as the foundation for secure attachment, development of joint attention and emotion regulation, and later cognitive and social emotional development (Ainsworth, Blehar, Waters, & Wall, 1978; Bornstein & Tamis-LeMonda, 1989; Thompson, 2008). A child who develops a secure attachment derives comfort from contact with the attachment figure if distressing or threatening situations arise and uses the attachment figure as a base from which to explore the environment with increasing confidence over time (Ainsworth et al., 1978). Yet, the quality of parent–child

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interactions that supports the development of secure attachment can be compromised when infants are born preterm. During play interactions, preterm infants exhibit less emotional positivity, cooperation, and responsiveness than term infants, and their mothers engage in more intrusive and less sensitive behaviors (Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983; Forcada-Guex, Pierrehumbert, Borghini, Moessinger, & Muller-Nix, 2006). Other studies have found higher levels of intrusiveness, lower levels of sensitivity, and more difficulties scaffolding (e.g., gradually supporting and guiding as needed to achieve higher levels of problem-solving) for mothers of preterm compared with term infants (Clark, Woodward, Horwood, & Moor, 2008).

This vulnerability in parent–child interactions in infants born preterm is critical for two reasons. First, children born preterm appear to have lower vagal activity, more difficulties with state regulation, and poorer visual attention than full-term children (Feldman & Eidelman, 2003; Field & Diego, 2008; Sigman & Parmalee, 1974). Thus, parent–child interactions must be especially responsive and sensitive to the needs of the preterm child to foster the emergence of self-regulation and other skills. Second, studies have shown that because of these regulatory difficulties, parenting may be differentially important to children's future development (Landry, Smith, & Swank, 2003; Poehlmann et al., 2012). Landry and colleagues (2001) found that maternal responsiveness was a particularly important contributor to the cognitive development of children born preterm, whereas others have found that sensitive and responsive mother–child interactions are associated with better self-regulation, improved joint attention, and fewer behavior problems in children born preterm (Clark et al., 2008).

Aside from the risk to parent–child interaction quality posed by the neonatal status of the child (e.g., gestational age), interaction quality may also be affected by other contextual factors that occur during the infant's NICU stay. Poor social support, maternal depression, and lower socioeconomic status (SES) have all been associated with more difficulty in coping with the infant's NICU stay and having a successful transition to home (Beck, 2003, Boykova & Kenner, 2012; Pinelli, 2000). Further, these factors have been shown to contribute to the quality of parent–child interactions throughout early development for preterm children (Korja et al., 2008; Lutz et al., 2012). Thus, it is important to screen for challenging parent–child interactions in the NICU setting, especially within the population of preterm infants, as a means to identifying those most at risk for future negative interactions and potentially compromised development.

Despite these findings, observational research focusing on mother–child interactions in preterm infants has generally occurred following the child's departure from the NICU, and it has typically occurred in home or laboratory settings (Crnic et al., 1983; Forcada-Guex et al., 2006; Poehlmann et al., 2011), with several exceptions. Observed parent–child interactions have been used as part of outcome assessments for family-based NICU interventions, suggesting that parents can learn to recognize their infants' cues and provide more stimulating interactions and positive affect (Browne & Talmi, 2005; Feldman, Eidelman, Sirota, & Weller, 2002). Feldman and Eidelman (2003) have also used measurements of mother–child interaction in the NICU to assess feeding-related outcomes. However, these NICU studies have rarely provided long-term follow-up or examined the stability of measurements over time. Moreover, longitudinal studies examining parent–child interactions in infants born preterm rarely start before 4 months corrected age (Barnard, Bee, & Hammond, 1984; Landry et al., 2001; Muller-Nix et al., 2004; Poehlmann et al., 2012). It is still unclear how NICU measurements of observed parent–child interactions relate to later parenting in other environments where children are more active participants in interactions and when parents have more experience caring for their infants.

One measure often used to examine observed parent–child relations during early development is the Parent–Child Early Relational Assessment (PCERA; Clark, 1985, 2010). In addition to attachment theory, the PCERA draws from multiple developmental and psychological theories including joint attention, emotional availability, as well as incorporating psychodynamic, self-psychology, and cognitive linguistics theories. The PCERA describes patterns of relatedness between parents and children, and it can be used to capture the quality of affective and behavioral parent–child interactions during free play, feeding, or a structured task from infancy to early childhood. The PCERA was developed to provide a profile of areas of strength and concern for which to focus therapeutic work and to document change in dyads at risk for early relational disturbances, particularly focusing on parental positive affect, sensitivity/responsiveness, connectedness/emotional availability, and dyadic reciprocity to assist the infant/child in regulating affect, attention, and behavior. Longitudinal studies using the PCERA with preterm infants have shown that more positive and less negative parenting interactions are associated with better sleep patterns, weight gain, and greater cognitive skills, as well as fewer behavior and attentional problems (Poehlmann et al., 2010, 2012;

Pridham, Lin, & Brown, 2001; Schwichtenberg & Poehlmann, 2009). A few studies have used the PCERA to examine parent–child interactions of preterm infants in the NICU (Weber, Harrison, & Steward, 2012) but have not provided long-term follow-up, whereas longitudinal studies using the PCERA in preterm infants have not begun until 1 month or 4 months. However, utilization of the PCERA in the NICU may allow professionals to identify vulnerable parent–child dyads at risk for interaction difficulties, and thus allow for the development of more targeted interventions for these families.

Research Questions

1. Can videotaped observations of mother–infant interactions in the NICU be coded using the PCERA with newborns who are primarily less than 40 weeks' gestational age, including having adequate reliability, variability, and internal consistency?
2. How do the parenting scales of the PCERA, collected in the NICU with preterm infants, relate to characteristics of the mother (SES, social support, depression) and infant (neonatal risk, gestational age, days in NICU, feeding type)?
3. Are the parenting scales of the PCERA, coded in the NICU, associated with PCERA measurements of the same dyads at later timepoints and in different contexts?

Method

Participants

A total of 181 infant–mother dyads were recruited from three NICUs in Southcentral and Southeastern Wisconsin between 2002 and 2005. A research nurse from each hospital invited families to participate if they met the following criteria: (a) infants were born at $\leq$37 weeks' gestation or weighed $<$2,500 g at birth; (b) infants had no known congenital malformations, prenatal drug exposures, or significant neurological findings during the NICU stay (e.g., Down syndrome, periventricular leukomalacia, grade IV intraventricular hemorrhage); (c) mothers were at least 17 years of age; (d) mothers could read English; and (e) mothers self-identified as the infant's primary caregiver. If a child was part of a multiple birth, one child was randomly selected to participate in the study. As the hospital would not allow us to be the ''first contact'' for families and they gave us only information about families who signed consent forms, 181 (97%) participated in data collection. However, videotaped feeding observations in the hospital were only completed on 130 mother–child dyads (the first 51 subjects enrolled in the study did not complete the observation because of a change in protocol). Given the research questions of interest, we restricted the analyses to these 130 dyads.

The current study included data from the NICU ($n = 130$), 4-month ($n = 115$), 9-month ($n = 112$), 16-month ($n = 112$), 24-month ($n = 112$), and 36-month ($n = 103$) assessments. Families lost to attrition did not differ from families who remained on birthweight, gestational age, neonatal health, child gender, paternal age, family income, number of children in the family, maternal marital status, or maternal or child race. However, families were more likely to be lost to attrition when the mother was younger and had completed fewer years of education. Participant and family characteristics paralleled the population of Wisconsin during the data collection period. Infants varied by gestational age: very preterm infants $<$30 weeks ($n = 32$, 24.6%), moderate preterm infants between 30 and 33 6/7 weeks ($n = 54$, 41.5%), and late preterm infants between 34 and 36 weeks or of low birthweight ($n = 44$, 33.8%). At the time of the videotaped observation and hospital discharge, infants ranged in age from 33 weeks' gestational age to 4 weeks postterm (mean [M] = 36.7, standard deviation [SD] = 1.67). See Table I for the sample demographics and participant characteristics.

Procedure

Families were enrolled through three hospitals following institutional review board (IRB) approval. An IRB-approved brochure was distributed to families, a research nurse described the study to eligible families, and interested mothers signed consent forms. A researcher met with mothers in the NICU just before infant's discharge, and mothers completed questionnaires. Mothers were then videotaped feeding their infants. They fed the infants in the manner in which they usually fed (breast or bottle-fed) in a room where feedings routinely occurred; the first 5 min of the feeding was later coded using the PCERA. Nurses completed a history of hospitalization via review of infant's medical records following discharge. When the child was 4 and 9 months (corrected for prematurity), research assistants completed a home visit and recorded a 15-min mother–child free-play interaction. The research assistants also videotaped a routine feeding between mother and child during the 9-month session. At 16, 24, and 36 months, mothers and children visited the laboratory playroom and were videotaped in free play using standard toys.

Table I. *Sample Demographic and Neonatal Characteristics at NICU Discharge (N = 130)*

Variable	Range or frequency (and %)	Mean	*SD*
Maternal age	17–42	29.66	6.20
Maternal education (years)	8–21	14.27	2.63
Family income per Year ($)	0–210,000	58,133	44,936.31
Number of children mother has given birth to	1–11	2	2.63
Gender of child			
Male	68 (52.3%)		
Female	62 (47.7%)		
Infant race			
African American	19 (14.6%)		
Asian	1 (0.8%)		
Caucasian	87 (66.9%)		
Latino	2 (1.5%)		
Middle Eastern	2 (0.8%)		
Multiracial	20 (15.4%)		
Marital status			
Married or cohabitating	105 (80.8%)		
Not married or cohabitating	25 (19.2%)		
Infant gestational age at birth (in weeks)	23.71–37.14	31.88	3.02
Infant birth weight	564–3328	1,776.63	580.72
Extremely low (<1,000 g)	19 (14.6%)		
Very low (<1,500 g)	25 (19.2%)		
Low (<2,500 g)	74 (56.9%)		
Normal (≥2,500 g)	12 (9.2%)		
Days hospitalized	2–136	30.31	27.16
Multiple birth	27 (20.8%)		
Medical concerns			
Apnea	91 (70.0%)		
Respiratory distress syndrome	76 (58.5%)		
Chronic lung disease	11 (8.5%)		
Gastroesophageal reflux	12 (9.2%)		
Sepsis and other infections	18 (13.8%)		

Note. NICU = neonatal intensive care unit.

Measures

Infant Prematurity and Neonatal Risk

The hospitalization form completed by nurses was used to create a neonatal health risk index, drawing on previous indices for preterm infants (Littman & Parmelee, 1978; Scott, Bauer, Kraemer, & Tyson, 1997). Infant birthweight and gestational age were standardized using *z*-scores and then reverse-coded so that higher scores reflected more prematurity and lower birthweight. Next, 10 dichotomized neonatal medical complications (1 = present, 0 = absent) were summed and standardized: apnea, respiratory distress, chronic lung disease, gastroesophageal reflux, multiple birth, supplementary oxygen at NICU discharge, apnea monitor at NICU discharge, 5-min Apgar score <6, ventilation during NICU stay, and NICU stay of >30 days. This risk index was averaged with the reversed-coded gestational age and birthweight. The resulting index ($M = 0.001$, $SD = 2.67$) had a Cronbach's $\alpha = .89$, with higher scores reflecting more neonatal risk.

Parenting

At every timepoint, infant–mother interactions were videotaped and later coded using the PCERA by raters trained to reliability and blind to gestational age and research questions. The PCERA is a system designed to assess the frequency, duration, and intensity of affect and behavioral characteristics of parents and infants that occur during 5 min of face-to-face interactions. Feeding observations varied in length, so for consistency, the first 5 minutes of the feeding interaction were always coded (at both NICU and 9 months). In the 15-min free-play interaction, the middle interaction period from 5 to 10 min was always coded. The PCERA protocol indicates that the first 5 min of a free play should be a warm-up. Each variable is coded on a 1 (less positive and/or more negative affect or behavior) to 5 (more positive and/or less negative affect or behavior) scale. The variables in each scale are averaged together to form a total score between 1 and 5. Previous studies have reported acceptable internal consistency and factorial validity ($\alpha = .86–.91$; Clark, 1999).

The PCERA has three established scales for parenting based on factor analysis (Clark, 1999) with 22 variables. The *Parental Positive Affective Involvement and Verbalization (PAIV) Scale* consists of 11 items, including tone of voice, positive affect, enjoyment, amount and quality of verbalizations, visual contact, structuring of the environment, mirroring, creativity, and social initiative. From 4 to 36 months, internal consistency in this sample's PAIV scale was high ($\alpha = .92, .86, .94, .90, .89, .88$ for 4-month play, 9-month feeding, 9 month play, 16, 24, and 36 months, respectively). The *Parental Negative Affect and Behavior (NAB) Scale* consists of five items, including angry, hostile tone and mood, expressed negative affect, displeasure, and contingent responsivity to perceived negative behavior. Lower scores indicate more displeasure, frustration, and negativity in affect or tone of voice, whereas higher scores indicate less negativity. From 4 to 36 months, internal consistency was high ($\alpha = .86, .89, .91, .90, .89, .94$ for 4-month play, 9-month feeding, 9 month play, 16, 24, and 36 months, respectively). The *Parental Insensitivity, Intrusiveness, and Inconsistency (III) Scale* consists of eight

items, including parental rigidity, insensitivity, inconsistency, intrusiveness, anxiety, physical contact, structuring and mediating of the environment, and reading and responding to cues and verbalizations. Lower scores indicate more insensitive and intrusive behavior, whereas higher scores indicate more sensitive and consistent behavior. Both the PAIV and III scales use ''amount of verbalizations'' and ''structuring and mediating of the environment'' in the scoring. From 4 to 36 months, internal consistency for III was adequate ($\alpha = .83$, .74, .84, .70, .78, .71 for 4-month play, 9-month feeding, 9 month play, 16, 24, and 36 months, respectively). Ten percent of the sample at each timepoint was independently coded by four research assistants. Coders receive 40 hrs of training and reach reliability of at least 80% inter-rater agreement, and inter-rater percent agreement ranged from .83 to .97 across codes and timepoints, with a mean of .88. Coders never rated the same dyad at more than one timepoint. Percent agreement is the standard used in with the PCERA (Clark, Hyde, Essex, & Klein, 1997; Poehlmann et al., 2010; Pridham et al., 2001). Kappas for individual codes were also tested to control for chance agreement (kappas ranged from .58 to 1.0, mean kappa = .83).

Maternal Social Support

Maternal social support was assessed using the Maternal Support Scale (Lutz et al., 2012). It consists of 21 questions asking about support from the baby's father, the mother's parents, and the baby's father's parents. Mothers answered ''yes'' or ''no'' across seven choices of support: emotional, information, household, child care, financial, rest, and other. An *Emotional Support* scale was created by summing the emotional support items endorsed by family members (3 items, $\alpha = .60$), an *Information Support* scale was created by summing the information support items (3 items, $\alpha = .65$), and an *Instrumental Support* scale was created by combining the household, child care, financial, and rest items (12 items, $\alpha = .75$).

Depression

Maternal depressive symptoms were measured at discharge using the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977), a 20-item self-report questionnaire of depressive symptoms rated on a 4-point scale (0 = rarely/none of the time to 3 = all the time). Higher scores indicate more symptoms; scores of ≥ 16 indicate clinically relevant symptoms ($M = 13.2$, $SD = 9.36$, range = 0–42, $\alpha = .88$). In the NICU, 31.5% of women reported CES-D scores in the clinical range ($n = 41$). Mothers whose CES-D score exceeded the clinical cutoff were contacted by a licensed psychologist and provided referral information.

Maternal SES

Mothers completed a demographic questionnaire while infants were in the NICU, including data regarding maternal age, years of education, and family income. Family income was initially skewed owing to one family reporting an income of $500,000, so it was top-coded to the next highest family with a reported family income of $210,000. An SES index was created by standardizing and averaging maternal education and family income ($\alpha = .76$).

Results

Collection of the PCERA With Preterm Infants in the NICU

Of the 22 items of the PCERA used to create the three parenting scales, only one item did not reach adequate inter-rater reliability at NICU and thus was not used. This item (#18) tracks the number of times a parent initiates social interactions that do not include task directives; coders reported that it was difficult to determine whether the child became engaged as a result of the social initiative. It was therefore dropped from the PAIV scale, and that NICU scale is the average of 10 items, rather than the 11 items at later timepoints. Ten percent of the sample was independently coded by four trained research assistants, and percent agreement ranged from .88 to .94, with an average of .92. Intraclass correlation coefficients computed at the conclusion of the coding were PAIV scale (ICC = .90), NAB scale (ICC = .73), and III scale (ICC = .84).

Although none of the NICU PCERA items used in the scales showed problematic skewness or kurtosis (skew ≥ 2, kurtosis ≥ 6), a few items showed limited variability. The following six items had < 10% of mothers with a score between 1 and 3 (e.g., more negative): Item #1 on NAB scale: Angry, Hostile Tone of Voice (4.6%); Item #5 on NAB scale: Expressed Negative Affect (7.7%); Item #6 on NAB scale: Angry, Hostile Mood (5.4%); Item #11 on NAB scale: Displeasure and Disapproval (9.2%); Item #14 on III scale: Amount and Quality of Negative Physical Contact (2.3%); and Item #27 on III scale: Intrusiveness (2.3%). Also of note, 82% of mothers were given a 3 on Item #26: Creativity, which falls within the PAIV scale.

The three parenting scales are based on a confirmatory factor analysis (Clark, 1999) and were chosen to test how well the established scales work in the NICU. However, a confirmatory factor analysis was still conducted in Mplus

Version 6.12.12 (Muthén & Muthén, 2010), and results indicated adequate fit, RMSEA = .06, CFI = .94, and SRMR = .08. Internal consistency was good to adequate for all three PCERA scales. The PAIV scale was identical to the internal consistency reported in the initial validity study ($\alpha = .91$; Clark, 1985, 1999). The NAB scale also had good internal consistency ($\alpha = .87$). The internal consistency of the III scale was adequate ($\alpha = .72$), although lower than initial reports ($\alpha = .86$). All three scales were normally distributed.

How Does Observed Parenting in the NICU Relate to Other Familial Attributes?

First, exploratory analyses using bivariate correlations and independent-samples *t*-tests were run to assess how well the three PCERA scales related to other parental and child attributes also collected at hospital discharge (Table II). Maternal age, SES, whether the mother lived with the infant's father, child gender, and number of children were examined. Age and SES were moderately associated with the PAIV and III scales (respectively, age: $r = .36$, $p < .001$, $r = .33$, $p < .001$; SES: $r = .42$, $p < .001$, $r = .36$, $p < .001$), indicating higher quality parenting was associated with being older, more educated, and having a higher income. Living with the baby's father was also associated with higher PAIV scores, $t\ (127) = -2.87$, $p = .005$, and lower levels of insensitive or intrusive behavior, $t\ (128) = -2.93$, $p = .004$. The NAB scale was unrelated to any sociodemographic factors. Gender and the number of children were unrelated to the scales.

Table II. *Correlations of PCERA Scales With Other Attributes at Hospital Discharge (n = 130)*

Variable	Scale 1: PAIV	Scale 2: NAB	Scale 3: III
Maternal age	.36**	−.07	.33**
SES	.42**	.12	.36**
Number of children	−.04	−.02	.03
Gestational age	.10	.05	.08
Gestational weight	.09	.12	.08
Days in the neonatal intensive care unit	−.06	−.06	−.08
Neonatal risk	−.10	−.10	−.10
Child age at observation	.04	−.04	−.03
Emotional support	.21*	.08	.25*
Information support	.14	.12	.19*
Instrumental support	.11	.07	.19*
Depressive symptoms	.04	−.12	−.03

Note. PAIV = Parental Positive Affective Involvement and Verbalizations; NAB = Parental Negative Affect and Behavior; III = Parental Insensitivity, Intrusiveness, and Inconsistency; SES = socioeconomic status; PCERA = Parent–Child Early Relational Assessment. Higher scores on the PCERA indicate more positive and less negative and insensitive parenting, whereas lower scores indicate more negative, insensitive, and intrusive parenting.
*$p < .05$, **$p < .001$.

Second, child risk factors (gestational age, gestational weight, neonatal risk, number of days in the NICU, and age of child at time of observation) were not correlated with any of the scales (e.g., $r = .10$, $p = .267$; $r = .09$, $p = .338$; $r = -.10$, $p = .284$; $r = -.06$, $p = .538$; $r = .04$, $p = .682$ for PAIV, respectively). Follow-up analyses also examined children by preterm classification. Children born in the late preterm period had mothers with higher positive affective involvement and verbalizations (PAIV) than other preterm children, $t\ (127) = -1.99$, $p = .049$. Of note, gestational age was not significantly correlated with SES in this study ($r = .15$, $p = .083$). There were no significant differences in the NAB or III scales, nor any differences when comparing very preterm children to both groups of children born later. There were no significant differences in any scales between children who were breastfed and bottle- or tube-fed during the NICU observation. However, mothers who reported that they "sometimes breastfed" or "always breastfed" exhibited less insensitivity and intrusiveness than mothers who reported that they "never breastfed," $t\ (103) = 2.23$, $p = .028$.

Third, bivariate correlations examined relations among the parenting scales, emotional, informational, and instrumental support, and depressive symptoms. More emotional support had a small correlation with higher PAIV ($r = .21$, $p = .018$), and less intrusiveness, insensitivity, and inconsistency ($r = .25$, $p = .004$). Greater informational and instrumental supports were also associated with less intrusive, insensitive, or inconsistency ($r = .19$, $p = .034$, $r = .19$, $p = .029$, respectively), although the correlation strength was modest. Depressive symptoms were also unrelated to the PAIV, NAB, or III scales. Follow-up analyses comparing mothers below and above the clinical cutoff of the CES-D found no differences.

How Does Parenting Observed in the NICU Relate to Later Observed Parenting in Other Contexts?

Table III shows the exploratory correlations of the NICU PCERA scales to the PCERA at later timepoints. Previous papers have reported about the stability of the PCERA at later timepoints (Poehlmann et al., 2011). The correlation between the NICU PAIV scale and III scale was strong ($r = .73$, $p < .001$), and thus, models did not include both scales owing to multicollinearity. Regressions examining the relation of each scale at NICU to the same scale at later timepoints were conducted using path analysis in Mplus, with all models estimated using full information

Table III. *Correlations of PCERA at Hospital Discharge With PCERA at Other Timepoints*

Variable	NICU Scale 1: PAIV	NICU Scale 2: NAB	NICU Scale 3: III
PAIV NICU feeding	–	.20*	.73*
NAB NICU feeding	.20*	–	.37*
III NICU feeding	.73**	.37*	–
PAIV 4-month play	.31*	.08	.29*
NAB 4-month play	.19*	.09	.08
III 4-month play	.25*	−.02	.19*
PAIV 9-month feeding	.47**	.14	.39**
NAB 9-month feeding	.10	.01	−.09
III 9-month feeding	.26*	.03	.11
PAIV 9-month play	.45**	.14	.41**
NAB 9-month play	.19*	.14	.21*
III 9-month play	.36**	.03	.35**
PAIV 16-month play	.32**	.05	.16
NAB 16-month play	.18†	.18†	.10
III 16-month play	.13	−.01	−.04
PAIV 24-month play	.32*	.18†	.36*
NAB 24-month play	.22*	.04	.28*
III 24-month play	.22*	.01	.24*
PAIV 36-month play	.24*	.11	.22*
NAB 36-month play	.01	.03	−.02
III 36-month play	.01	−.10	.02

Note. PAIV = Parental Positive Affective Involvement and Verbalizations; NAB = Parental Negative Affect and Behavior; III = Parental Insensitivity, Intrusiveness, and Inconsistency; NICU = neonatal intensive care unit; PCERA = Parent–Child Early Relational Assessment. Higher scores on the PCERA indicate more positive and less negative and insensitive parenting, whereas lower scores indicate more negative, insensitive, and intrusive parenting.
†$p < .08$, *$p < .05$, **$p < .001$.

maximum likelihood to account for missing data. Models were created based on the initial exploratory correlations, so higher SES, living with the baby's father, and emotional support were used as covariates in all models. Maternal age was initially examined as a covariate, but it did not provide predictive value and was strongly correlated with SES ($r = .60$, $p < .001$), so it was dropped from the final model for power and parsimony. Neonatal risk was included as a covariate, despite the lack of correlation, given the nature of the population. The dichotomous variable of having a late versus earlier preterm infant was examined as an alternative to neonatal risk, but there were no significant differences in the findings, and thus, the continuous neonatal risk variable was used in the final models. Given the lack of correlations between the NICU NAB scale and negativity at other timepoints, regressions from NAB at NICU to later negativity were not completed. As a number of regressions were completed, the false discovery rate method was used to control for potential type I error (Benjamini & Hockberg, 1995).

Predictors of Positive Affective Involvement and Verbalization

The NICU PAIV scale was correlated with the PAIV scale at all other timepoints (Table III). In regressions, the NICU PAIV predicted PAIV at all timepoints and contexts except for the 36-month lab play observation (Table IV). The relation was strongest for the 9-month feeding and play tasks ($\beta = .52$, $p < .001$, $\beta = .34$, $p < .001$, respectively). Greater SES was also modestly associated with higher PAIV at all but two timepoints. After adjusting with false discovery rate, neonatal risk, emotional support, and living with a father were not significantly associated with later PAIV. Overall, the models predicted 18.7% of the variance at 4 months, 25.9% of the variance in the 9-month play task, 31.4% of the variance in the 9-month feeding task, 22.5% of the variance in PAIV scores at 16 months, 27.6% of the variance at 24 months, and 10% of the variance at 36 months.

Predictors of Insensitivity, Intrusiveness, and Inconsistency

The NICU III scale was moderately associated with later III play scores at 4-, 9-, and 24-month play (Table III). In regressions, after accounting for covariates, NICU III modestly predicted III 9-month play scores ($\beta = .34$, $p = .006$). Higher SES was moderately associated with less insensitivity, intrusiveness, and inconsistency at 9-, 16-, 24-, and 36-month play, and greater neonatal risk was associated with more insensitivity at 24 months (Table IV). Overall, the models predicted 27.4% of the variance in III scores at the 9-month play task, and 27.8% of the variance in the 24-month play task.

The NICU PAIV scale was correlated with the III scale in 4-, 9-, and 24-month play and 9-month feeding. Given that the reliability, internal consistencies, and variability of the NICU PAIV scale were superior to the NICU III scale, regressions similar to those presented in Table IV were also run for these outcomes using NICU PAIV as a predictor. Greater PAIV at NICU was associated with lower insensitivity and intrusiveness at the 9-month play ($\beta = .24$, $p = .018$) and feeding ($\beta = .27$, $p = .018$) tasks, but not at the 4-month ($\beta = .18$, $p = .079$) or 24-month ($\beta = .06$, $p = .496$) play.

Predictors of Negative Affect and Behavior

The NICU NAB scale was not correlated with negativity at any other timepoint, although there was a trend toward significance at 16 and 24 months. Greater PAIV scores at NICU were associated with less maternal negativity at 9- and 24-month play. However, exploratory regressions were completed with NICU PAIV scores as a predictor of

Table IV. *Regressions to Later Measurements of the PCERA*

Predictor	4-month play β	9-month play β	9-month feed β	16-month play β	24-month play β	36-month play β
Set 1: Predictors of later PAIV						
Neonatal risk	.13	.03	.12	.00	−.09	.07
SES	.13	.28*	−.05	.17*	.24*	.24†
Live with father at birth	.24†	−.02	−.01	.12	.23†	−.11
Emotional support	−.04	.15	.03	.10	.00	.00
PAIV at NICU	.22*	.34**	.52**	.18*	.18*	.18
Set 2: Predictors of later III						
Neonatal risk	.02	.10	.05	−.01	−.22*	.01
SES	.12	.33**	.05	.35**	.38**	.30*
Live with father at birth	.23	.06	−.00	.13	.06	.07
Emotional support	−.07	.08	.16	−.05	−.06	.00
III at NICU	.10	.23*	.08	−.16	.10	−.07

Note. Numbers represent standardized regression coefficients. PAIV = Parental Positive Affective Involvement and Verbalizations; NAB = Parental Negative Affect and Behavior; III = Parental Insensitivity, Intrusiveness, and Inconsistency; NICU = neonatal intensive care unit; SES = socioeconomic status; PCERA = Parent–Child Early Relational Assessment. Higher scores on the PCERA indicate more positive and less negative and insensitive parenting, whereas lower scores indicate more negative, insensitive, and intrusive parenting. Living with father was dichotomously coded, such that 1 = living with father and 0 = not living with father.

†$p < .08$, *$p < .05$, **$p < .001$ with p-values corrected for multiple comparisons.

the NAB at these two timepoints, and they were not significant.

Discussion

This study investigated the feasibility of measuring mother–infant interaction quality during the infant's NICU stay, relations among mother–infant interactions and other infant and family attributes, and how mother–infant NICU interactions corresponded with interactions at later timepoints. This is one of the first studies to examine mother–child interactions in the NICU in relation to interactions 3 years later in multiple contexts in preterm infants.

Of note is that maternal PAIV in the NICU related to later measurements of maternal positive affect and behavior up to 24 months in a variety of contexts, even after controlling for SES, emotional support, presence of a coparent, and neonatal risk. These findings suggest that positive parenting behaviors can successfully be coded in the NICU, and that there is variability in the quality of maternal–child interactions in preterm infants, even before they are discharged in the NICU.

Further, these findings indicate that positive parenting seen in the NICU seems to represent a stable style or trait of parenting that can be seen throughout early childhood. The majority of infants in the study were not even term age at the time of the initial observation, and parents had not yet brought them home. Because mothers had limited experience parenting their infants during the NICU observation, mothers may be driving the parenting experience at that time. Consistent with these observations, the transition to parenting literature suggests that parent personality is an important influence on parenting behavior (Heinicke, 2002), and the attachment literature suggests that parental internal working models of relationships predict parenting behaviors (Madigan et al., 2006).

In contrast, maternal negative affect and behavior in the NICU was unrelated to later measurements of the same behaviors as well as other child and family factors. Although the PCERA was coded with sufficient reliability and internal consistency on all three parenting scales, the NAB scale, in particular, had items with low frequency and variability, which may have led to the lack of associations. Perhaps parents exhibit little negativity toward medically vulnerable newborns or when infants are less active in the interaction. Negative, insensitive, or inconsistent parent–child interactions can be influenced by the child's behavior, and thus be more salient when the child is older and a more active player in the dyadic interaction. In addition, the PCERA does not only include the tone and verbalizations that the parent directs toward the child, but also negativity and anger that is not directed toward, but overheard by the child. The PCERA is coded in this manner because an infant does not recognize to whom the mother is speaking. However, the NICU setting may have fewer distractions and people toward whom to direct emotions, in comparison with the home.

Maternal insensitive, intrusive, and inconsistent behavior in the NICU was only associated with similar

behaviors during 9-month play, after accounting for other measures. Again, this may be due to difficulties with internal consistency and variability with the III scale. The III scale was associated with emotional, instrumental, and informational social support at the NICU. It is possible that mothers who did not feel the emotional availability of other significant adults in their life may have experienced more anxiety and thus had more difficulty with being sensitive toward their infants during feeding, a task that requires both emotional attunement and nurturing. However, given that emotional support was not a significant predictor in the regression analyses, much about its influence on parent–child interactions is still unknown.

Measures of neonatal risk were largely unassociated with parenting quality. However, when the sample was categorically divided into infants born in the late preterm period, and children born earlier, the mothers of late preterm children exhibited greater positive affect and behavior. Perhaps there is more of a natural cutoff or breaking point for gestational age in relation to parental perceptions and behaviors, where children are seen as particularly ''fragile,'' and only then does it seem to influence parental behavior. The degree of fragility may be conveyed to mothers through conversations with doctors and nurses. Studies comparing parenting of children born preterm and term have found more positive parent–child interactions in term children (Landry et al., 2001; Muller-Nix et al., 2004), but research has largely focused on between-group differences, ignoring the within-class variability in children born prematurely. Yet, within preterm children, the interplay of parent–child interactions and emerging regulatory abilities may be critical. A recent study of parent–child interactions in preterm infants found that maternal positive affect and involvement declined in quality over time, but this decline was not as steep for children who exhibited better vagal regulation (Poehlmann et al., 2011). Given the regulatory difficulties of infants born preterm, parent–child interactions and regulatory skills may interact in key ways to foster development, in a process that begins in the NICU.

Interestingly, maternal depressive symptoms and social support were unrelated to parenting. Although greater maternal emotional support was initially associated with more positive parenting, emotional support dropped out from the final regression models. The lack of correlation with maternal depression was surprising, given previous findings (Clark et al. 1997; Lovejoy, Graczyk, O'Hare, & Neuman, 2000). However, depressive symptoms in mothers of infants in the NICU are typically elevated compared with mothers of term infants (Singer et al., 1999) and are associated with stress and trauma of having an infant in the NICU (Davis, Mohay, & Edwards, 2003). Perhaps some mothers report on a situational depression based on the circumstances and setting, rather than a longer-lasting negative mood state.

Further, higher levels of maternal positive affective involvement and lower levels of maternal insensitivity, intrusiveness, and inconsistency were associated with greater SES. Although consistent with research on socioeconomic differences in maternal responsivity and warmth (Hoff, Laursen, Tardif, & Bornstein, 2002; Poehlmann et al., 2011), the effects of socioeconomics can show themselves even in the mother's earliest interactions with her infant.

There are some limitations that should be noted. Although this is a substantial sample for observational data in a high-risk population, the number of mother–child dyads limits the power to detect more subtle relations. Further, although the 51 dyads that did not complete NICU observations were not different from the included dyads on demographic or study variables, it is possible that there were cohort effects that were not detected. Additionally, the social initiative item, which is part of the maternal PAIV scale, was not codable in the NICU setting owing to lack of infant responsiveness or participation in social interaction. Finally, although adjustments were made to correct for potential type I error, it is important to note that these are correlational analyses, and effect sizes tended to be small to medium in size. Parent–child interactions in the NICU are clearly not the only determinant of later interactions, and only tell part of the story.

A mother's positive affective and behavioral involvement in the NICU was related to parenting 2 years later, which has clinical implications for supportive interventions in the NICU in a family-centered care model. Although the PCERA is an extensive assessment of the quality of parenting affect and behavior, infant/child affect and behavior, and dyadic interactions that for research purposes takes a significant amount of time to code, the positive parenting scale only has 10 items and can be evaluated with a 5-min observation of a routine caregiving task. Thus, adaptation of a subscale focusing solely on the more positive aspects of parental affect and behavior may be a useful clinical tool that could be implemented by NICU social work staff and family advocates. Parents can be videotaped interacting with their infants during feeding, and this videotape can then be reviewed in a respectful and collaborative manner with the parents and social worker. Other interventions focusing on parent–child interactions in depressed mothers (Clark, Tluczek, & Wenzel, 2003) and children with behavior problems (Eyberg, Boggs, & Algina, 1995) have found joint viewing and discussion of videotaped observations to be successful in improving parent–child interactions. Parents can discuss their experiences of

interacting with their infants (who may have difficulties with responsivity and regulation), their sense of competence, and their own emotional needs as they discover additional ways of reading and sensitively responding to their vulnerable babies. Enhancing positive parent–child interactions during infancy can hopefully lead to increased maternal positivity and sensitivity during early childhood, thereby setting the stage for the development of secure attachment, improved cognitive and self-regulatory skills, and better social emotional development.

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