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# Measuring Maternal Behaviors in the Neonatal Intensive Care Unit

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One of the most important considerations in designing clinical infant research studies is the selection of reliable and valid measurement procedures. Few measures of caregiver–child interactions have been studied with newborns, particularly premature infants. The main objective of this study was to examine psychometric properties of the National Institute of Child Health and Human Development (NICHD) Mother-Child Interaction Qualitative Ratings in a sample of premature infants and their mothers to evaluate its use in the neonatal intensive care unit. Mother–baby dyads ( $N = 24$ ) were videotaped in a 10-min interaction in the NICU. Nine raters independently assessed dyadic interactions using the NICHD Mother–Child Interaction Qualitative Ratings in a fully crossed research design. Rater reliability was strong for mother and infant ratings (.76–.94). Scores yielded normal distributions for maternal sensitivity, positive regard, and flatness of affect and skewed distributions for maternal intrusiveness, detachment, negative regard, and all child ratings. Positive maternal behaviors correlated positively with one another and negatively with negative maternal behaviors. Thus, preliminary analyses suggest that scores obtained using the NICHD Mother–Child Interaction Qualitative Ratings with premature babies and their mothers in the neonatal intensive care unit demonstrate adequate interrater reliability, and distributional properties provide preliminary evidence of face validity.

**Key words:** *caregiver–infant interactions, maternal sensitivity, NICU, parenting*

One of the most complex challenges in designing clinical infant research studies involves selecting reliable and valid measurement procedures. The constructs of interest to researchers studying infant and child development are often not directly measurable and, therefore, must be inferred through observational methods or caregiver reports (Lakes & Hoyt, 2009). Researchers studying parenting, or specifically caregiver–child interactions and relationships, face this challenge as well. The quality of the early caregiver–child relationship is increasingly identified as a critical factor in child development, health, and well-being (Anderson, Gooze, Lemeshow, & Whitaker, 2012; Cusson, 2003; Escobar et al., 2014; Vinnall, Miller, Synnes, & Grunau, 2013), and research in this area is

likely to increase; therefore, there is a need to develop and study the reliability and validity of scores derived from selected measurement procedures. Poor reliability and validity can attenuate research results and increase the probability of Type I errors (Lakes & Hoyt, 2009).

In the present study, we analyze scores derived from an existing caregiver–child interaction measure designed for use in early childhood (ages birth through 6 years), which we applied in a sample of preterm infants who are enrolled in an early intervention study entitled Project BEGIN (Body composition, Exercise and Growth In Newborn preemies). The occurrence of preterm or low birth weight in infants is associated with increased risk for adverse developmental outcomes including cognitive and neurologic impairments, behavioral and emotional problems, attention problems, low executive function, and poor academic achievement (Aarnoudse-Moens, WeisglasKuperus, van Goudoever, & Oosterlaan, 2009; Marlow, Wolke, Bracewell, & Samara, 2005; Potharst et al., 2011; Saigal, Pinelli, Hoult, Kim, & Boyle, 2003). The quality of the caregiver–infant relationship is an essential factor contributing to developmental outcomes in these at-risk infants (Wijnroks, 1998). For example, two studies documented that parents of premature infants often felt stress and, thus, parent–infant interactions were disrupted (Erdeve et al., 2009; Melnyk, Oswalt, & Sidora-Arcoleo, 2014). ForcadaGueux, Pierrehumbert, Borghini, Moessinger, and Muller-Nix (2006) found that dyads of mothers and preterm infants showed more controlling interactions and fewer cooperative patterns than dyads with term infants at 6 months during a mother–infant play interaction. At 18 months, preterm infants of controlling dyads displayed more eating and social problems than term infants. Interestingly, preterm infants displaying cooperative patterns did not present any significant difference in developmental outcomes compared with term infants. In spite of the importance of parental influence on the development of infants, there is very little literature examining parenting of premature infants in neonatal intensive care unit (NICU) using an observational instrument (Cleveland, 2008).

The purpose of the present study was to evaluate a commonly used measure, the *Mother–Child Interaction—Semistructured Procedure* and the *Mother–Child Interaction Qualitative Ratings* (Vandell, 1979) with a sample of preterm infants and their mothers. Prior research has reported the psychometric properties of scores obtained using this measure with older infants, toddlers, and young children. To our knowledge, this is the first reported examination of scores obtained from a newborn population in a NICU. The first aim of this study was to determine whether or not rater agreement in this sample would be sufficient to

support its use in NICU research (i.e., would yield intraclass correlation coefficients [ICCs]  $>.70$ ). The second aim of this study was to determine whether or not these ratings could detect individual differences in maternal behavior.

Our hypotheses were as follows: (1) rater reliability would be sufficient to warrant use of the measure; (2) scores in behaviors that would be expected to yield a normal distribution in a sample of mothers (e.g., maternal sensitivity) would produce a normal distribution, and maternal behaviors that are less commonly displayed among mothers of newborns, such as negative regard, would yield positively skewed distribution, (3) desirable maternal behaviors, such as sensitivity to distress, would correlate positively with one another and negatively with undesirable maternal behaviors, such as negative regard, and

(4) rating infant behavior would be difficult in this population given their developmental stage; therefore, we expected that for most of the infant ratings, raters would note that there was “no opportunity to observe” particular behaviors. For this reason, we asked raters to code infant states, such as quiet sleep, and we examined interrater reliability as well as observed states.

## **METHODS**

### **Participants**

Twenty-four mother–infant dyads (infants were 54% male and 46% female) were recruited as part of a longitudinal intervention study designed to investigate the effects of assisted exercise on outcomes for premature infants in the first year of life. Tables 1 and 2 describe participant characteristics.

**Table 1.** Mother Characteristics (*N* = 24)

| Characteristics                      | Frequency | %    |
|--------------------------------------|-----------|------|
| <b>Race/Ethnicity</b>                |           |      |
| Hispanic/Latina                      | 12        | 50.0 |
| Black                                | 2         | 8.3  |
| Non-Hispanic                         | 1         | 4.2  |
| Asian                                | 1         | 4.2  |
| American Indian/<br>Alaska Native    | 0         | 0    |
| Pacific Islander                     | 1         | 4.2  |
| Other                                | 3         | 12.5 |
| No response <sup>a</sup>             | 7         | 29.2 |
| <b>Marital status</b>                |           |      |
| Married                              | 12        | 50.0 |
| Living with partner/<br>not married  | 3         | 12.5 |
| Separated                            | 1         | 4.2  |
| Single, never married                | 3         | 12.5 |
| No response                          | 5         | 20.8 |
| <b>Education</b>                     |           |      |
| Did not complete high<br>school      | 3         | 12.5 |
| High school                          | 6         | 25.0 |
| Some college or<br>vocational school | 4         | 16.7 |
| Bachelor's degree                    | 5         | 20.8 |
| Advanced degree                      | 1         | 4.2  |
| No response                          | 5         | 20.8 |
| <b>Monthly household<br/>income</b>  |           |      |
| Less than \$1,000                    | 2         | 8.3  |
| \$1,000–\$2,999                      | 9         | 37.5 |
| \$3,000–\$4,999                      | 3         | 12.5 |
| \$5,000–\$6,999                      | 1         | 4.2  |
| \$7,000–\$8,999                      | 1         | 4.2  |
| > \$9,000                            | 2         | 8.3  |
| No response                          | 6         | 25.0 |

<sup>a</sup>In total, 37.5% of those who selected "no response" to race had identified as Hispanic/Latina.

**Table 2.** Infant Characteristics (*N* = 24)

| Characteristic                   | Mean (SD)       |
|----------------------------------|-----------------|
| Gestational age (week)           | 26.29 (1.81)    |
| Birth weight (g)                 | 887.92 (245.94) |
| Birth height (cm)                | 33.94 (2.94)    |
| Birth head<br>circumference (cm) | 23.65 (2.14)    |

## Procedure

This study was approved by the institutional review board of the University of California, Irvine (protocol number: 20118156). All mother–infant dyads who met inclusion criteria were invited into the study. Inclusion criteria were as follows: (1) caregivers were 18 years of age or older and the legal guardian of a preterm infant, (2) infants were from a singleton pregnancy, with birth age of 23–29 weeks' gestation, (3) expected NICU discharge was at 34–40 weeks' gestation, and (4) expected discharge weight was between 1,800 and 3,500 g. Caregivers were excluded if they had a history of substance abuse, or if their infant had any conditions or cognitive anomalies likely to severely impact the ability of the premature baby and the caregiver to participate in a demanding study. Infants were excluded if they had significant lung disease of prematurity requiring supplemental oxygen or corticosteroids at discharge, significant

intraventricular hemorrhage grades III–IV, necrotizing enterocolitis, tracheostomy, bone diseases, osteogenesis imperfecta, hip or knee joint anomalies, arthrogryposis, fractures, skin disorders (e.g., epidermolysis bullosa), symptomatic congestive heart disease, or any other conditions or congenital anomalies likely to severely impact the ability of the premature infant to participate.

Consented participants were randomly assigned to intervention or control groups. A randomization schedule predetermined by study statisticians was used to stratify participants to ensure a 1:1 ratio between control and intervention groups within the following stratification criteria: hospital (4 study hospitals), gender, birth age (23–26 weeks, 27–29 weeks), and birth weight (<900 g, >900 g). Both intervention and control groups received instruction in current best practices of structured social interaction, based on Promoting First Relationships (Kelly, Zuckerman, & Rosenblatt, 2008). Mother–infant dyads randomized to the intervention group also participated in a developmentally dynamic physical activity program that engaged the caregiver as a partner. The program was designed and pilot tested for the purposes of augmenting lean body mass and improving bone mineralization and the ratio of lean to fat tissue. Parents were taught to perform infant exercises by specially trained NICU nurses and/or occupational and physical therapists and advised to conduct the exercises for at least 15–20 min every day for 1 year. All study participants were followed through the age of 12 months.

Mother–child interactions were evaluated at baseline in intervention and control groups in the NICU. Mothers were instructed to hold their infants and sit in a rocking chair in a private room. They were asked to interact with their infant, and a camera recorded their interaction for later analysis. Two professors with expertise in evaluating maternal–infant relationships trained a group of raters using the National Institute of Child Health and Human Development (NICHD) Qualitative Ratings manual instructions. Raters practiced coding during group training sessions using videotapes of caregivers with infants (these dyads were not the same dyads used for the present study). Subsequently, nine raters independently rated all 24 dyads by viewing 10-min recorded interactions and then entering ratings in a form provided through REDCap (Harris et al., 2009), a secure online data capture system hosted at the University of California, Irvine. All nine raters independently rated all 24 dyads in a fully crossed research design.

## **Measures**

### ***Mother–child interaction procedure***

The Mother–Child Interaction—Semistructured Procedure and the Mother–Child Interaction Qualitative Ratings were designed for the NICHD Study of Early Child Care and Youth Development (<http://secc.rti.org/home.cfm>) to investigate qualities of the mother, the child, and the dyad during play. Global representations of maternal behavior were rated on a 4-point Likert scale, ranging from “not at all characteristic” to “highly characteristic.” Raters rated interactions between mothers and their 6-, 15-, and 24-month-old children on the following dimensions: sensitivity to distress/responsiveness to distress, sensitivity/ responsiveness to nondistress, intrusiveness, detachment/disengagement, stimulation of cognitive development, positive regard for the child, negative regard for the child, and flatness of affect. Descriptions of factors varied across age groups to reflect developmental differences. For 36 and 54-month-old children, raters used a 7-point Likert scale, ranging from “very low” to “very high,” to assess five areas of maternal behavior: maternal supportive presence, respect for child’s autonomy, stimulation of cognitive development, hostility, and confidence. A maternal sensitivity composite was calculated on the basis of sums of factor ratings at each age group.

Psychometric properties of scores obtained using the Mother–Child Interaction Procedures in prior research have been reported for children aged 6, 15, 24, and 36 month and their mothers (NICHD Early Child Care Research Network, 1999). For maternal sensitivity, Cronbach’s  $\alpha$  ranged from .70 to .78, interrater reliability coefficients ranged from .83 to .87, and stability coefficients ranged from .39 to .48. It is likely that the low stability coefficients resulted from sampling on a single occasion (situation variance).

### ***Nursing Child Assessment Satellite Training (NCAST) infant states***

Infant states reflect how an infant responds to external and internal stimuli. Each state is influenced by an infant’s biorhythm, surrounding environment, and sensitive caregivers. According to Barnard (1999), there are six infant states that are characterized by body activity, eye movements, facial movements, breathing pattern, and level of response to internal and external stimuli, including two sleep states, one transitional state, and two awake states. Each state has its own behavioral cues. *Quiet sleep* refers to nearly still body movement, no eye and facial movements, smooth and regular breathing pattern, and high

threshold to stimuli. *Active sleep* is indicated by the presence of some body movements, rapid eye movements, irregular breathing pattern, subtle and brief facial expression, or more responsiveness to internal and external stimuli. *Drowsy* refers to variable activity level, with eyes being opened and closed occasionally, irregular breathing patterns, few facial movements, and delayed responses to internal and external stimuli. *Quiet alert* is indicated by minimal body activity, brightening and widening eyes, a regular breathing pattern, bright/smiling/sparkling facial expressions, and attentiveness to present stimuli. *Active alert* refers to substantial body activity, eyes open but less brightening, irregular breathing patterns, increased facial movements, and high sensitivity to stimuli. *Crying* is indicated by increased body activity, eyes tightly closed, a more irregular breathing pattern, grimaces, and extreme responsiveness to unpleasant stimuli (Summer & Spietz, 1994). While these states are operationally defined, there is no published reliability testing of rater determinations of the six states. To our knowledge, this study would be the first study to provide such data.

It is important to assess infants' states because they impact how a mother and an infant interact with each other. For example, if an infant is in either the *quiet* or *active alert* sleep state, "stimulation of development" may not be observed in the mother, and also "sociability" and "sustained attention" would not be easily observed in this infant. Holditch-Davis, Brandon, and Schwartz (2003) concluded that preterm infant behaviors need to be considered within the state in which they occur. From birth to 3 months, infants usually sleep approximately 14 hr (Barnard, 1999) per day. Asaka and Takada (2010) found that there was no difference in total sleep duration between preterm infants and term infants. In the present study, "state most observed" was developed to capture the state in which an infant spent most of time during the recorded interaction with a mother.

## Analyses

Data were extracted from REDCap and subsequently cleaned and analyzed in SPSS 22. To analyze rater reliability, items were analyzed by treating raters as items in a multi-item scale. Interrater reliability was estimated as the relative ICC for the composite score based on nine raters (Shrout & Fleiss, 1979). Before examining the distribution of scores in the sample and correlations between items, individual rater scores for a particular dyad were aggregated, yielding an average score for each item for each dyad. For each item, ratings were assigned a code in the database: "Not at all characteristic" 1, "Minimally characteristic" 2, "Moderately characteristic" 3, "Highly characteristic" 4, and "No opportunity to observe" 0. Items for which



a “0” was assigned were not included in distributional analyses. To analyze the distribution of scores, SPSS 22 was used to compute medians, means, standard deviations, skewness, and kurtosis. The Shapiro–Wilk test of normality was used. As a preliminary evaluation of validity, the Pearson correlations between ratings of maternal behaviors were examined using aggregate scores.

## **RESULTS**

### **Hypothesis 1: Rater reliability**

Results for rater reliability are presented in Table 3. Rater reliability ranged from moderate (ICC  $.76$  for Flatness of Affect) to strong (ICC  $.90$  for Sensitivity to Distress and  $.94$  for Child Negative Mood), with most values indicating strong rater agreement.

### **Hypothesis 2: Score distribution**

Scores yielded normal distributions for maternal sensitivity, positive regard, and flatness of affect (see Table 3). As expected, maternal intrusiveness, detachment, negative regard, and all child ratings yielded significantly positively skewed distributions.

### **Hypothesis 3: Correlations between maternal ratings**

Scores for maternal sensitivity to distress yielded significant, positive correlations with sensitivity to nondistress and positive regard and significant, negative correlations with negative regard (see Table 4). Maternal sensitivity to nondistress was also significantly, negatively correlated with detachment/disengagement as well as flatness of affect and significantly, positively correlated with stimulation of development and positive regard.

### **Hypothesis 4: Infant states**

Interrater reliability ranged from ICC  $.73$  to  $.94$ . “All States Observed” was a category developed to describe how an infant may change during the 10-min observation period. Seven (29.2%) infants were observed to experience one state, five infants (20.8%) experienced two states, eight (33.3%) experienced three states, and four (16.7%) experienced four states. The state “Most Observed” was reported to be *quiet sleep* (see Table 5).

**Table 3.** The Mother-Child Interaction Semistructured Procedure and the Mother-Child Interaction Qualitative Ratings: Interrater Reliability and Distribution of Scores ( $n = 214$  Ratings)

| Item                       | ICC | Median | Mean (SD)   | % Nonobservable | Skewness | Kurtosis | $W(p)$        |
|----------------------------|-----|--------|-------------|-----------------|----------|----------|---------------|
| <b>Mother ratings</b>      |     |        |             |                 |          |          |               |
| Sensitivity to distress    | .90 | 3.06   | 3.07 (0.40) | 50.5            | 0.33     | 0.08     | .95 (.44)     |
| Sensitivity to nondistress | .84 | 3.00   | 3.03 (0.41) | 1.4             | 0.26     | 0.24     | .98 (.86)     |
| Intrusiveness              | .83 | 1.06   | 1.20 (0.31) | 2.8             | 1.98     | 3.99     | .77 (<.001)** |
| Detachment/disengagement   | .83 | 1.29   | 1.34 (0.35) | 0               | 1.91     | 5.10     | .82 (<.001)** |
| Stimulation of development | .89 | 1.63   | 1.93 (0.82) | 41.1            | 0.96     | -0.21    | .86 (.01)**   |
| Positive regard            | .84 | 3.17   | 3.12 (0.41) | 0               | 0.46     | -0.18    | .96 (.50)     |
| Negative regard            | -   | 1.00   | 1.01 (0.03) | 0               | 3.22     | 9.12     | .35 (<.001)** |
| Flatness of affect         | .76 | 1.50   | 1.45 (0.37) | 2.8             | 0.57     | -0.37    | .91 (.07)     |
| Sensitivity composite      | -   | 3.03   | 3.05 (0.36) |                 | 0.44     | 0.58     | .96 (.45)     |
| <b>Child ratings</b>       |     |        |             |                 |          |          |               |
| Positive mood              | .89 | 0.83   | 0.88 (0.78) | 55.2            | 0.43     | -1.13    | .90 (.02)*    |
| Negative mood              | .94 | 0.94   | 1.03 (0.91) | 47.2            | 1.12     | 0.93     | .88 (.01)*    |
| Activity level             | .89 | 0.72   | 0.94 (0.82) | 54.2            | 0.58     | -0.85    | .91 (.04)*    |
| Sociability                | .83 | 0.17   | 0.42 (0.52) | 79.3            | 1.00     | 0.00     | .81 (<.001)** |
| Sustained attention        | .78 | 0.22   | 0.40 (0.53) | 80.8            | 1.39     | 0.98     | .78 (<.001)** |

*Note.* For each item, ratings were assigned a code in the database: "Not at all characteristic" = 1, "Minimally characteristic" = 2, "Moderately characteristic" = 3, "Highly characteristic" = 4, and "No Opportunity to Observe" = 0. Items for which a "0" was assigned were not included in distributional analyses. ICC = intraclass correlation coefficient; SD = standard deviation.

\* $p < .05$ .

\*\* $p < .01$ .

**Table 4.** Correlations Between Qualitative Ratings on The Mother–Child Interaction—Semistructured Procedure and the Mother–Child Interaction

| Ratings of Mothers            | 1     | 2      | 3    | 4      | 5      | 6      | 7   |
|-------------------------------|-------|--------|------|--------|--------|--------|-----|
| 1. Sensitivity to distress    |       |        |      |        |        |        |     |
| 2. Sensitivity to nondistress | .64** |        |      |        |        |        |     |
| 3. Intrusiveness              | -.36  | -.03   |      |        |        |        |     |
| 4. Detachment/disengagement   | -.22  | -.68** | -.18 |        |        |        |     |
| 5. Stimulation of development | .33   | .66**  | .07  | -.48*  |        |        |     |
| 6. Positive regard            | .58** | .80**  | .07  | -.54** | .81**  |        |     |
| 7. Negative regard            | -.45* | -.27   | .13  | -.09   | -.24   | -.34   |     |
| 8. Flatness of affect         | -.37  | -.60** | -.29 | .45*   | -.54** | -.65** | .18 |

Note. \* $p < .05$ ; \*\* $p < .01$ .

## DISCUSSION

The first aim of this study was to determine whether or not rater agreement in this sample would be sufficient (i.e., would yield ICCs  $>.70$ ) to support use of the Mother–Child

Interaction—Semistructured Procedure and the Mother–Child Interaction Qualitative Ratings in NICU research. Results indicated that rater agreement was sufficient. The second aim of this study was to determine whether or not these ratings could detect individual differences in maternal behavior, as evidenced by a normal distribution of scores in behaviors that would be expected to yield a normal distribution in a sample of mothers (maternal sensitivity). Maternal sensitivity and positive regard yielded normally distributed scores in this sample. As expected, maternal behaviors that are less commonly observed (at least in laboratory settings) among mothers of newborns (e.g., negative regard) yielded skewed distributions. Moreover, as expected, rating infant behavior was difficult in this sample. For most of the infant ratings, raters noted that there was “no opportunity to observe” particular behaviors. As Gerner (1999) noted, it may be more important at this developmental stage to measure maternal variables than infant variables.

Significant correlations between items were more often observed on ratings that yielded a normal distribution. In other words, as would be expected, when raters indicated that there was no opportunity to observe a particular characteristic or when few individual differences on that characteristic were noted, the data did not yield significant correlations.

As infant behaviors were predicted to be difficult to observe in this sample, infant states were recorded. Interrater agreement was sufficient for infant states, and as expected, infant states were not consistent across the 10-min observation period.

**Table 5.** Infant States: Interrater Reliability and Distribution of Scores ( $n = 214$  Ratings)

| Infant States: Item | ICC | All States Observed (%) | State Most Observed (%) |
|---------------------|-----|-------------------------|-------------------------|
| <i>Quiet sleep</i>  | .94 | 74.3                    | 53.5                    |
| <i>Active sleep</i> | .73 | 34.6                    | 6.6                     |
| <i>Drowsy</i>       | .78 | 41.1                    | 9.9                     |
| <i>Quiet alert</i>  | .91 | 31.3                    | 17.8                    |
| <i>Active alert</i> | .81 | 26.6                    | 6.1                     |
| <i>Crying</i>       | .91 | 33.6                    | 6.1                     |

Note. ICC = intraclass correlation coefficient.

### Limitations and future directions

Further research is needed to study additional psychometric characteristics of scores derived using the Mother–Child Interaction—Semistructured Procedure and the Mother–Child Interaction Qualitative Ratings. In future studies, we will conduct generalizability analyses to evaluate the generalizability of scores using *Person Rater Item Occasions* analyses (see Lakes & Hoyt, 2008, 2009). This research would also yield valuable information regarding the number of raters and occasions needed to maximize generalizability. In addition, more research is needed to evaluate the predictive and concurrent validity of the scores. For example, it will be important to examine the stability of early maternal sensitivity over time and in different situations.

### CONCLUSIONS AND CLINICAL IMPLICATIONS

This study of rating methods to measure caregiver–infant interactions has potential to inform and advance nursing care in NICU settings because maternal sensitivity is a particularly important construct to study in infant development (Behrens, Hart, & Parker, 2012). Results of our study provide researchers with information about an observational approach to evaluating parenting in the NICU. It is imperative that sufficient attention be paid to the reliability and validity of the scores derived from various measurement approaches used to assess caregiver–infant interactions, particularly in research with NICU samples where few instruments have been studied. A score’s reliability and validity has a profound impact on the quality of research produced, which in turn affects clinical understanding and intervention. As described in the discussion of attenuation by Lakes and Hoyt (2009), measurement error can adversely affect our confidence in scores and distort research findings. Such measurement

error attenuates effect sizes such that observed relationships between scores systematically underestimate the true relationship between the constructs of interest and increase the probability of Type I errors. Attenuation poses a serious threat to advancement of early intervention research. With a growing awareness of the importance of targeting early interventions at critical periods of life, there is a vital need for developing and refining measurement tools to support developmental research and clinical practices, beginning as soon as possible, even while an infant is still in the NICU.

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