Early Maternal Reflective Functioning and Infant Emotional Regulation in a Preterm Infant Sample at 6 Months Corrected Age

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Abstract

Objective This study investigated the influence of maternal reflective functioning (RF) on 6-month-old infants’ emotional self-regulating abilities in preterm infant–mother dyads. Methods 25 preterm (gestational age 28–34.5 weeks) infants’ affect, gaze toward mother, and self-soothing behaviors (thumb-sucking and playing with clothing) were measured during the still-face procedure at 6 months corrected age. Maternal RF was measured at 7–15 days post-delivery using the Parent Development Interview. Results Infants with high RF mothers showed the most negative affect during the still-face episode (M = 21.33s, SE = 5.44), whereas infants with low RF mothers showed the most negative affect in the reunion episode (M = 18.14s, SE = 3.69). Infants with high RF mothers showed significantly more self-soothing behaviors when distressed (Ms > 14.5s) than infants with low RF mothers (Ms < 1s), p’s < .01. Conclusion Maternal RF was associated with infants’ self-regulating behavior, providing preliminary evidence for the regulatory role of maternal RF in preterm infants’ emotion regulation capacity.

Key words: preterm infants; reflective functioning; relationship quality; still-face paradigm.

Infants who are born preterm are at an increased risk of a range of developmental impairments and psychological disorders that, in part, are linked to early self-regulatory and attachment difficulties and neurological abnormalities (Anderson & Doyle, 2003; Bhutta, Cleves, Casey, Cradock, & Anand, 2002; Crockenberg, Leerkes, & Jö, 2008; Delobel-Ayoub et al., 2009; Johnson et al., 2012; Treyvaud et al., 2012). The current evidence for biological and social experience in early-risk mechanisms of poor development is complex and remains incomplete. While the study of maternal responsiveness in infant caregiving practices is one important area in this field of research, uncertainties remain as to its mediating effect on self-regulatory and attachment behaviors and child development in the preterm population (Beckwith & Rodning, 1996; Magill-Evans & Harrison, 1999, 2001; Milgrom et al., 2010).

A meta-analysis of sensitivity and attachment interventions involving 7,636 families found that enhancing maternal sensitivity did affect childhood
attachment security for term and preterm children. Interventions conducted with referred samples of children with clinical problems were even more effective (Bakermans-Kranenburg, van Ijzendoorn, & Juffer, 2003). Although maternal sensitivity would appear to have a causal role in shaping attachment relationships, its effect on child development remains unclear. Much of the work of early intervention research in preterm populations has a component of dyadic interactions – enhancing maternal sensitivity and responsiveness to infant cues.

Another meta-analysis investigating mother-preterm infant interactions indicated that differences in interaction behaviors for preterm versus full-term infants are most pronounced during the first 6 months of life. Eleven (of 17) studies indicated that mothers of preterm infants tended to rate higher on intrusiveness and lower on sensitivity, including less frequent smiling and touching (Korja, Latva, & Lehtonen, 2012). This can be seen as an adaptive response to the preterm infants’ less organized responses and emotion regulation difficulties. Factors that may predispose preterm infants to emotional regulation difficulties include higher irritability, more difficulty regulating arousal, poorer attentional control, and lower levels of social initiations (Brown, Doyle, Bear, & Inder, 2006; Eckerman, Oehler, Medvin, & Hannan, 1994; Goldberg & Di Vitto, 2002; Hughes, Shults, McGrath, & Medoff-Cooper, 2002). However, the altered parenting behaviors exhibited with preterm infants can also be due to the increased prevalence of depression, anxiety, and stress symptoms in this population (Doering, Moser, & Dracup, 2000; Miles, Holditch-Davis, Schwartz, & Scher, 2007; Obeidat, Bond, & Callister, 2009; Schmucker et al., 2005). Specific parental risk factors associated with poor emotion regulation in term children include lower socioeconomic levels and education, maternal depression, and low maternal sensitivity (Murray & Cooper, 1997; O’Connor, Heron, & Glover, 2002; Silk, Shaw, Skuban, Oland, & Kovacs, 2006), and these risk factors are more common in mothers of preterm infants (Miles et al., 2007).

One factor recently shown to be necessary for sensitive parenting is maternal reflective functioning (RF). Maternal RF refers to the capacity to understand the child’s internal experience (thoughts, feelings, and intentions) (Slade, 2005). Highly reflective mothers have a capacity to regulate and reflect on their own thoughts and emotional experiences and link it with their child’s internal experiences and behavior (Slade, Grienenberger, Bernbach, Levy, & Locker, 2005). This capacity helps the caregiver to differentiate between their own and their child’s emotional needs, enabling parental responses that indicate a range of stresses and emotions can be accommodated, and thus assisting the infant in developing emotional regulation skills, including the ability to mentalize (Slade, 2005). Research demonstrates that high levels of RF capacity are associated with both secure maternal and infant attachment and less externalising behaviors in a range of high-risk groups, including foster care, economically disadvantaged, and adopted children (Bick, Dozier, & Moore, 2012; Priel, Melamed-Hass, Besser, & Kantor, 2000; Sadler et al., 2013; Slade, Grienenberger, et al., 2005). RF is similar to, but distinct from, other constructs such as parental efficacy (the parents’ beliefs about their capability to perform parenting tasks successfully; O’Neil, Wilson, Shaw, & Dishion, 2009), attachment (the enduring bond between the child and caregiver; Bowlby, 1969), and responsiveness (the parent’s ability to respond promptly, contingently, and appropriately to the child’s needs; Bornstein & Tamis-LeMonda, 1989).

Parental RF capacity is related to tolerance of infant distress (Rutherford, Goldberg, Luyten, Bridgett, & Mayes, 2013). Parents with increased interest in mental states persisted longer in soothing an inconsolable baby simulator (parenting-related task), but not in a non-parenting distress tolerance task. This suggests that parental RF is specifically related to tolerance of infant distress.

The RF measure in this study examines mothers’ ability to think about mental states and behavior and their representation of the child’s internal/emotional experience. Maternal RF is the key variable of interest because high RF capacity may enable better adaption and response to the less adaptive responses of some preterm infants. The influence of maternal RF on infant affect and regulatory behavior has not been investigated in a preterm infant sample. In this study, we investigated the relationship between maternal RF capacity measured at 7–15 days post-partum and infant affect and self-regulating behaviors at 6 months of age (corrected for prematurity) as measured in the still-face procedure (SFP).

Our hypothesis was exploratory. We aimed to investigate whether there were any significant differences in preterm infant responses (positive or negative affect, gaze toward mother, or self-soothing behaviors) across the different episodes of the SFP for infants who had experienced high versus low RF capacity. Maternal RF at 7–15 days was used to predict infant SFP responses at 6 months corrected age, to investigate whether early maternal RF can predict infant affect and emotion regulation capacity at 6 months corrected age.

**Method**

**Design**

Infants were recruited from the Neonatal Intensive Care Nursery at the Royal Brisbane and Women’s Hospital (RBWH), Australia, from May to October...
2011. Infants were eligible for enrollment at one week of age if born between 28 and 34.6 weeks’ gestation and free of congenital abnormality. Infants were excluded if maternal substance use, insufficient English fluency, or inability to complete follow-up assessments was identified. The RBWH and The University of Queensland Human Research Ethics Committees approved the study. Parental informed written consent was obtained for each mother–infant dyad.

Participants and Procedure
Thirty-six infants (including three sets of dizygotic twins) and 33 mothers enrolled in the study. Mothers completed the interview at 7–15 days (infant mean age = 11.63 days, SD = 2.69 days) and infant behavior was assessed at 6 months corrected age (±3 weeks) in the home. A researcher trained in RF interviewing and the SFP conducted assessments. Maternal and infant medical and demographic variables were collected from case notes. Of the 33 consenting mothers and their 36 infants, three mother–infant dyads (9%) withdrew before the first RF assessment and a further five dyads (15%) withdrew before the second assessment at 6 months (corrected age). All withdrawals were singleton births and their baseline perinatal and risk characteristics were statistically similar to the 25 infants who were retained in the sample. The five mothers who completed the first but not the second assessment had a similar proportion of high versus low maternal RF as the retained sample.

Measures
Infant Measure
The Still-Face Procedure (SFP) is an interactive social stressor task that assesses the infant’s emotion regulation capacity in the context of maternal variations in responsiveness and has been well-validated and is robust in regard to various sample variations (Adamson & Frick, 2003; Mesman, van Ijzendoorn, & Bakermans-Kranenburg, 2009; Tarabulsy et al., 2003; Tronick, Als, Adamson, Wise, & Brazelton, 1978), including the preterm population (De Schuymer, De Groote, Striano, Stahl, & Roeyers, 2011). The SFP consists of three two-minute episodes that are recorded: (1) free-play episode, a baseline normal face-to-face interaction; (2) still-face episode where the mother is unresponsive with neutral facial expression; and (3) a reunion episode of normal interaction. A meta-analysis has confirmed the classic still-face effect is characterized across the three episodes by reduced positive affect and gaze toward mother, and increased negative affect from baseline to still-face episode and partial recovery in the reunion episode (Mesman et al., 2009). The SFP measures the following infant behaviors during each of the three SFP episodes: positive affect (smiling and positive vocalizations), negative affect (fussing and crying), gaze (looking at mother’s face), sucking (thumb/finger-sucking), and playing (playing with seat/clothes) (Adamson & Frick, 2003; Mesman et al., 2009; Tronick et al., 1978). The responses were coded using the adapted Tarabulsy et al.’s (2009) scheme where the five infant behaviors were timed within each of the three episodes using a computer program. Total seconds for each behavior, during each episode, were calculated as absolute seconds/120-s episode.

Maternal Measures
The Parent Development Interview Revised (PDI-R) was used to assess maternal RF capacity (Slade, Aber, Bresgi, Berger, & Kaplan, 2004). This semi-structured clinical interview focuses on the mother’s view of the child, the emerging parent–child relationship, and the experience of being a parent and her own childhood experiences. The mother is invited to describe her child’s and her own behaviors and mental states, and how these may influence one another (Slade, 2005). Questions focus on a variety of situations, for example, when the mother felt anger and guilt in relation to her child. Responses on the PDI are scored according to the level of sophistication of the mental state references during the interview. The PDI-R is scored on an 11-point scale from -1 to 9, with higher scores indicating greater RF capacity. A score of 5 indicates typical RF in normative samples (Slade, Grienenberger, et al., 2005). Maternal RF was dichotomized, with scores ≥4 indicating higher RF capacity and scores <4 indicating low RF capacity. This was based on the RF scoring system whereby a score of 3 indicates questionable or low RF, meaning the mother uses mental state words (e.g., happy, sad) but typically provides responses that do not contain explicit RF (Slade, Bernbach, Grienenberger, Levy, & Locker, 2005). A score of 4 indicates a rudimentary mentalization capacity, such that links between mental states and/or mental states and behavior are demonstrated (Slade, Bernbach, et al., 2005). Mothers were reflecting on their parenting of infants who were in a Special Care Nursery, meaning mothers had limited access to their infants. Given this constraint, a score of 4 or more was deemed as high RF capacity in this sample. Interviews were audio-recorded and then transcribed and coded by a certified PDI-R coder. Previous research has reported that this measure is valid and reliable (Slade et al., 2004; Slade, Grienenberger, et al., 2005; Taubner et al., 2012) and the presence of two related, but distinct dimensions have been identified: self-mentalization and child-mentalization (Suchman, DeCoste, Leigh, & Borelli, 2010). Mothers of twins completed the PDI-R for each child.

Maternal and Infant Characteristics
Data for risk factors such as maternal age, education level, history of maternal abuse as a child, and
previous infant admission to neonatal nurseries were obtained from mothers, and perinatal information (gender, plurality, and gestation) was obtained from medical records.

Reliability
To establish reliability, 36% of the data on infants’ responses in the SFP were coded by a second observer, naive to the hypotheses under investigation. Examination of the video recordings indicated that all mothers maintained a neutral expression during the still-face episode, thus no data were discarded. Inter-coder reliability was high, \( r = .96 \). All RF transcripts were coded independently by two researchers. Reliability was high, \( r = .96 \).

Statistical Analyses
Frequencies, \( \chi^2 \) and \( t \)-tests statistics compared baseline characteristics and infant behavior responses in each of the SFP episodes between the high and low RF groups. To address our exploratory hypotheses, we used multi-level modeling (via Linear Mixed Models in SPSS for Windows, version 22, SPSS Inc., Chicago, IL, USA). The hypothesis regarding the effect of maternal RF capacity on preterm infant behaviors in the SFP was explored through the RF group (high vs. low) by SFP episode interaction. The number of seconds infants engaged in the specific behavior was the dependent outcome. SFP episodes (Level 1) were nested within each infant (Level 2). Maximum likelihood criteria were used. All models were tested using unstructured, first-order autoregressive, compound symmetry, and diagonal covariance structures to assess which was most appropriate. The unstructured covariance structure was retained in all models. Two models were specified for each of the five behavioral outcomes. Model 1 consisted of the main variables of interest regardless of statistical significance to answer our hypothesis: SFP episodes, RF, and the SFP episode by RF interaction. Additionally, any significant baseline characteristics that had a significant univariate association with the outcome at \( p < .1 \) (i.e., sex of infant, mother’s age, maternal history of child abuse) were also included. If the addition of these baseline variables yielded nonsignificant results (at \( p < .05 \)), they were removed from the multivariate model.

Results
Of the 25 infants, 10 infants (40%) experienced low maternal RF. There were no significant differences in the baseline infant (gender, plurality, gestation) and maternal (age, education level, previous neonatal intensive care unit [NICU] admission, history of child abuse) characteristics between the low and high RF groups (Table I).

Maternal RF and Infant Responses in the SFP
Infants of high and low RF mothers were compared on all five outcome responses: positive affect, negative affect, gaze toward mother, thumb-sucking, and playing with seat/clothing (Figure 1a–e). Only one outcome variable demonstrated significant differences between the low and high RF mothers. Infants who experienced high versus low maternal RF showed differences across the three SFP episodes on negative affect behavior only, \( F(2,25) = 3.92, p = .033 \). Follow-up pairwise comparisons revealed that infants with low RF mothers showed significantly more negative affect in the reunion episode (\( M = 18.14s, SE = 3.69 \)) than the initial play episode (\( M = 2.99s, SE = 1.18, p = .002 \)). Conversely, infants with high RF mothers showed the most negative affect during the still-face episode (\( M = 21.33s, SE = 5.44 \)), and this was significantly more than the initial play (\( M = 2.00s, SE = 0.96, p = .003 \)) or reunion (\( M = 9.58s, SE = 3.02, p = .043 \)) episode (Figure 1a). No significant effects were detected for the other infant outcome responses.

The highest level of negative affect was demonstrated in the still-face episode for infants of high RF mothers versus in the reunion episode for infants of low RF mothers. Analyses were conducted to determine the level of self-soothing that infants of high versus low RF mothers exhibited during the episode where they were producing the most negative affect (i.e., feeling most distressed). Two independent-groups \( t \)-tests were conducted on the mixed model estimates. This analysis revealed that during the episode eliciting the most negative affect, infants with high RF mothers showed significantly more thumb-sucking behavior (\( M = 14.53s, SD = 11.88 \)) than infants with low RF mothers (\( M = 0.98s, SD = 8.97 \), \( t(22) = 2.88, p = .008 \)). Similarly, during the episode eliciting most negative affect, infants with high RF mothers showed significantly more playing with seat/clothing behavior (\( M = 17.52, SD = 18.10 \)) than infants with low RF mothers (\( M = 0.69, SD = 4.02 \), \( t(15) = 3.48, p = .003 \)).

Discussion
We investigated whether there were differences in preterm infants’ affect, gaze toward mother, or self-soothing behaviors across the episodes of the SFP, depending on maternal RF capacity. Preterm infants who had experienced high versus low RF at 7–15 days post-partum differed in the level of negative affect exhibited during different episodes of the SFP at 6 months corrected age. Infants of mothers with high RF replicated the classic still-face effect: increased negative affect during the still-face episode compared with the initial free-play and reunion episodes (Mesman et al., 2009; Tronick et al., 1978). Infants
increase their negative affect to signal and protest the deviation from the sensitive responding they are accustomed to in everyday interactions with their mother. Infants of high RF mothers reduced their levels of negative affect in the reunion episode, indicating recovery following the stressful situation. In contrast, infants of low RF mothers showed a blunted negative response during the still-face episode but an increase in their negative affect in the reunion episode and a decrease in self-regulation behaviors.

It is possible that infants of low RF mothers did not find the still-face episode stressful, because they are somewhat accustomed to less responsive parenting. This interpretation is unlikely, as negative affect increased during this episode, relative to the initial free-play episode. However, even if preterm infants of low RF mothers do not experience increased distress in response to the still-face episode, this would indicate that preterm infants of low RF mothers react atypically to a non-responsive mother. It may indicate that these infants do not expect sensitive, contingent responses from their mothers in everyday interactions, as infant behaviors in the SFP are considered indicative of relationship quality (Mesman et al., 2009). This is in line with previous research indicating that there is a link between aspects of parental RF and tolerance for infant distress (Rutherford et al., 2013).

### Table I. Maternal and Infant Characteristics by High and Low Maternal RF Outcome

<table>
<thead>
<tr>
<th>Baseline risk</th>
<th>Low RF (n = 10)</th>
<th>High RF (n = 15)</th>
<th>OR (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>n %</td>
<td></td>
<td>n %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestational age ≤32 weeks</td>
<td>5 50</td>
<td>5 33</td>
<td>2.00 (0.39–10.31)</td>
<td>.407</td>
</tr>
<tr>
<td>Infant sex (male)</td>
<td>5 50</td>
<td>10 67</td>
<td>2.00 (3.9–10.00)</td>
<td>.407</td>
</tr>
<tr>
<td>Maternal age ≥35 years</td>
<td>2 20</td>
<td>8 53</td>
<td>4.55 (0.72–33.33)</td>
<td>.108</td>
</tr>
<tr>
<td>Plurality</td>
<td>3 30</td>
<td>2 13</td>
<td>2.79 (0.37–20.82)</td>
<td>.318</td>
</tr>
<tr>
<td>Maternal education level &lt;HSC</td>
<td>2 20</td>
<td>1 7</td>
<td>3.50 (0.27–44.95)</td>
<td>.336</td>
</tr>
<tr>
<td>Previous NICU admission</td>
<td>2 20</td>
<td>4 27</td>
<td>1.45 (0.21–10.00)</td>
<td>.703</td>
</tr>
<tr>
<td>Maternal history of child abuse</td>
<td>4 40</td>
<td>4 27</td>
<td>1.83 (0.33–10.10)</td>
<td>.486</td>
</tr>
</tbody>
</table>

### Figure 1.

(a) Mean (SE) infant behavior response of negative affect by RF group within each SFP episode. (b) Mean (SE) infant behavior response of positive affect by RF group within each SFP episode. (c) Mean (SE) infant behavior response of finger/thumb-sucking by RF group within each SFP episode (boxed points denote a significant difference). (d). Mean (SE) infant behavior response of playing with seat/clothing by RF group within each SFP episode (boxed points denote a significant difference). (e) Mean (SE) infant behavior response of gaze toward mother by RF group within each SFP episode.
Thumb-sucking and playing with the seat/clothing are considered self-soothing behaviors that assist the infant to regulate his/her own negative emotions (Tronick et al., 1978). When infants of high RF mothers are distressed, they show markedly higher levels of self-soothing than infants of low RF mothers. The most stressful episode (i.e., where most negative affect was exhibited) differed according to maternal RF capacity. During the most stressful episode, infants of high RF mothers showed substantially higher levels of self-soothing (14–18 s) than infants of low RF mothers (<1 s). This may suggest that preterm infants of low RF mothers are not as proficient at self-soothing during times of distress, suggesting poorer emotion regulation capacity. This is consistent with previous research showing that full-term infants who engage in more self-soothing behaviors show less negative affect during a stressful event and are better at decreasing their negative affect when distressed (Braungart-Rieker & Stifter, 1996). The ability to regulate one’s stress levels is important, as infants who have difficulty regulating distress are at increased risk of developing or having developmental behavior problems (Crockenberg et al., 2008).

Infants’ behavior during the SFP is associated with clinically meaningful behavioral and emotional outcomes in childhood. Term infants’ responses (positive and negative affect and self-regulatory behavior) during the SFP at 3–6 months are predictive of attachment relationships (Braungart-Rieker, Garwood, Powers, & Wang, 2001; Cohn, Campbell, & Ross, 1991; Ekas, Haltigan, & Messinger, 2013; Tronick, Ricks, & Cohn, 1982) and internalizing and externalizing behavior problems in childhood (Ekas et al., 2013; Moore, Cohn, & Campbell, 2001; Wagner, 2014; Willoughby, Waschbusch, Moore, & Propper, 2011). Thus, differences in affect and regulatory behaviors contingent upon maternal RF may have long-term implications.

Previous research with term infants indicates that greater maternal sensitivity is related to more adaptive behaviors, such as self-soothing, during the still-face and reunion episodes (Mesman et al., 2009). Research with term children also suggests that a mother’s capacity to regulate and reflect on her own, and her infant’s mental states, assists the infant in developing emotion regulation skills (Slade, 2005). The above findings may apply to preterm infants, such that high maternal RF capacity could enable better adjustment and response to the less adaptive behaviors of infants born preterm. It follows that the experience of more sensitive parenting (i.e., higher maternal RF) would relate to preterm infants’ ability to self-soothe during a stressful event.

Overall, results suggest that differences in emotion regulation are already present at 6 months corrected age, contingent on maternal RF capacity. This is particularly important for preterm infants, as these infants may experience more difficulties with early regulatory and interactive abilities (Mangelsdorf et al., 1996; Neu & Robinson, 2010). Early interventions aimed at improving maternal RF could be beneficial for long-term child outcomes, as RF is an ability that can be trained and improved (Slade, 2005).

Several intervention programs have been developed to enhance maternal RF (Slade, 2007). Sessions help mothers link their infants’ behavior and mental states and to understand how their own and their infant’s mental states may influence one another. This has shown great efficacy in at-risk groups (Sadler et al., 2013; Sleed, Baradon, & Fonagy, 2013). Results demonstrate that RF capacity post-intervention increased for the intervention group, relative to the controls, who typically declined in RF capacity over time (Sleed et al., 2013). RF training can also have important implications for other aspects of the parent–infant relationship. Mothers who had received RF training were more likely to have securely attached infants at 12 months (Sadler et al., 2013). Such interventions could be offered to mothers of preterm infants who demonstrate low RF capacity in the weeks after giving birth, to help prevent infant emotion regulation problems and mother–infant interaction difficulties from emerging. This may be particularly important for mothers of preterm infants, as these infants may be less responsive and adaptive initially and parents often have ongoing stress associated with the health of their infant ( Muller-Níx et al., 2004).

The small sample size of the present study is a significant limitation, and results need to be interpreted with caution owing to the sample size. As such, this study should be viewed as a preliminary investigation that yields suggestive results that require replication with a larger sample. Additionally, despite being recruited from one of the largest public hospitals in the state, the sample may have been lower-risk than the general preterm infant population (i.e., infants were at least 28 weeks’ gestation). However, the current study revealed a difference in infant responding based on maternal RF capacity, suggesting that there are important differences that warrant further investigation. Future research should examine the influence of RF on infant SFP responses in a large sample of preterm and full-term infant–mother dyads, to replicate the current results and investigate whether they are applicable to term infants. The inclusion of maternal stress and depression in analyses would also be beneficial. Finally, future research should investigate the specific risk factors for reduced RF capacity in mothers of preterm infants. Overall, given the small sample size, this study should be viewed as a preliminary pilot study that could inform future research. Future research is
needed to confirm the current findings in a larger sample.

In conclusion, this study suggests that as early as 6 months corrected age, preterm infants respond to and recover from stressful events differently, depending on the level of maternal RF capacity. The results support other research that links maternal RF capacity to mother–infant relationship quality and later attachment (Grienenberger, Kelly, & Slade, 2005; Slade, Grienenberger, et al., 2005). Understanding factors that influence the developing mother–infant relationship has the potential to guide interventions and improve later childhood outcomes for preterm infants, who are an at-risk group that can benefit from additional support.

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Conflicts of interest: None declared.

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