

**EXPLORING THE FOUNDATIONS OF ATTACHMENT:  
RELATIONS BETWEEN MOTHER-INFANT INTERACTION  
AT 4-5 MONTHS AND ATTACHMENT SECURITY  
AT 12 MONTHS**

by

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## **ABSTRACT**

Similarities between the Still Face procedure in early infancy and the Strange Situation at one year have been noted by a number of researchers. To date, however, few studies have investigated whether mother and infant behaviour in the Still Face procedure is predictive of later attachment security. The present study tested three hypotheses with respect to relations between mother and infant behaviour in a Still Face procedure at 4-5 months and attachment security at 12 months. In an initial lab visit at 4-5 months mothers were asked to interact with their infants for 2 minutes (Interactive phase), remain still-faced for 1 minute (Still Face phase), and resume interaction for 2 minutes (Reengagement phase). Mother and infant behaviour was assessed for the frequency and contingency of mother and infant smiles during the Interactive and Reengagement phases and infant social bids to the mother during the Still Face phase. In a follow-up lab visit at 12 months, infants' security of attachment to their mothers was assessed in the Strange Situation.

Contrary to expectations, maternal contingent responsiveness to infant behaviour in either the initial Interactive phase or the Reengagement phase of the Still Face procedure was not correlated with attachment security at 12 months. Similarly, and in contrast to previously published findings, no correlation was found between infant social bids to their mothers during the Still Face phase and later attachment security. In an exploratory analysis of the Still Face procedure data, a number of correlations were found among mother and infant behaviour across phases of the Still Face procedure with respect to the timing and frequency of infant social behaviour in the Reengagement

phase. These findings are discussed in relation to theory and previously published research. Suggestions for future research are also discussed.

**Keywords:** mother-infant interaction, infant social and emotional development, Still Face procedure, attachment security

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## INTRODUCTION

The Still Face procedure (Tronick, Als, Adamson, Wise, & Brazelton, 1978) has been used by researchers to investigate a range of aspects of early mother-infant interaction. The procedure most strikingly demonstrates young infants' sensitivity to disruptions in social interaction and their active participation in initiating and maintaining social interactions (Tronick, Ricks, & Cohn, 1982). The Still Face procedure is a laboratory procedure in which mothers and infants are seated facing each other and the mother is instructed to (a) initially interact with her infant as she normally would, (b) suddenly become physically still and facially and vocally unresponsive, and (c) reengage her infant in normal interaction. Infants show a range of responses to this procedure, referred to as the Still Face effect, including bids to reengage their mother, reduced positive affect and gaze aversion during the still face phase, and less positive affect and gaze to mother during the reengagement phase, relative to the initial interactive phase (Mesman, Van IJzendoorn, & Bakermans-Kranenburg, 2009; Toda & Fogel, 1993). A number of studies using the Still Face procedure have identified individual differences in the quality of mother-infant face-to-face interaction and infant behaviour during the procedure (for reviews see Adamson & Frick, 2003; Mesman et al., 2009).

Individual differences in maternal sensitivity and related differences in infant behaviour during the Still Face procedure are of interest to researchers because maternal sensitivity is thought to facilitate infant development in a number of domains including emotion regulation and social competence, both of which are seen in infants' responses to the procedure. Furthermore, mothers' sensitivity in responding to their infants' social gestures is considered to be essential to the establishment of a secure

attachment relationship at 12 months of age (Ainsworth, Bell, & Stayton, 1971; Bowlby, 1969). Because maternal sensitivity, infants' expectations regarding their own and their caregivers' social competence, and attachment are closely related phenomena, it has been suggested (e.g., Cohn, Campbell, & Ross, 1991; Cohn, 2003) that the Still Face procedure may provide a laboratory "snapshot" of the qualities of mother-infant interaction that lead to secure attachment to caregivers. The initial interactive phase of the procedure likely reflects the manner in which mother-infant dyads typically engage with each other when the infant is in an alert, playful state, including how sensitive the mother is to her infant's social gestures. The still face phase reveals infants' responses to a violation of their expectations for reciprocal social interaction, including regulating their emotional discomfort by averting their gaze and attempting to re-establish interaction. Mother-infant interaction in the reengagement phase of the procedure has been relatively neglected by researchers (Cohn, 2003), but it is possible that it reflects an important aspect of the mother-infant relationship with respect to how repairs to disruptions in social interaction are handled. In sum, the Still Face procedure provides researchers a means to observe systematically individual differences in mother-infant interaction early in infancy that may be related to important developmental achievements, such as attachment to caregivers. To date, however, few studies investigating this possibility have been published (Mesman et al., 2009), despite the potential for clinical application (Papousek, 2007) and relevance to developmental psychopathology (Fonagy, Gergely, & Jurist, 2002).

The purpose of the present study is to investigate aspects of mother and infant behaviour in the Still Face procedure early in infancy that have not yet been studied in relation to attachment security at 12 months of age. Specifically, the mother and infant behaviour of interest in the present study is: (a) the timing and consistency of mothers'

responses to their infants' expressions of affect during the interactive phases (i.e., initial interaction and re-engagement phases) of the procedure, and (b) infant social behaviour during the re-engagement phase. Although there are theoretical reasons to expect that this behaviour may be reflective of the quality of the mother-infant relationship early in infancy and, therefore, predictive of attachment security later in infancy, this possibility has only rarely been systematically investigated.

### **Maternal Sensitivity**

Maternal sensitivity is a broad concept within developmental psychology originally proposed by Bowlby and Ainsworth to be the most important aspect of maternal behaviour early in infancy that leads to secure attachment at 12 months of age (Ainsworth et al., 1971; Bowlby, 1969). Ainsworth et al. (1971) described sensitive mothers as being capable of taking their infant's perspective and seeing their infant as a separate person; for example, the sensitive mother "respects [the infant's] activity-in-progress and thus avoids interrupting him" (p. 43). Maternal behaviour considered to demonstrate sensitivity is diverse and researchers have defined and measured maternal sensitivity in a number of different ways (De Wolff & van IJzendoorn, 1997). Mothers' sensitivity to their infants' gestures and communications is also considered to be expressed differently in different contexts (Ainsworth, Blehar, Waters, & Wall, 1978), such that behaviour that might be considered to be reflective of a mother's sensitivity to her infant in one situation may not be considered so in another. With respect to face-to-face interaction in early infancy (i.e., before 6 months of age), the timing and consistency of mothers' facial and vocal responses to their infants' expressions of emotion is considered to be indicative of maternal sensitivity (e.g., Bigelow, MacLean, Proctor, Myatt, Gillis, & Power, 2010).

Findings of studies assessing maternal sensitivity in relation to later developmental outcomes such as attachment security have varied and there has been disagreement among researchers about the appropriateness of some attempts to define the concept for purposes of measurement (for a review see De Wolff & van IJzendoorn, 1997). In particular, studies using rating scales to measure maternal sensitivity have yielded mixed results. Given that infants' interest in face-to-face interaction, particularly with respect to smiling and vocalizing, reaches a peak at around 4-5 months of age (Stern, 1985), measures derived from microanalytic coding of mothers' facial and vocal responses to their infants' displays of affect may be an appropriate assessment of maternal sensitivity at this stage of development (Bigelow et al., 2010).

### **Maternal contingent responsiveness**

Mothers' tendency to respond to their young infants' social behaviour in a temporally close and emotionally congruent manner is referred to as maternal contingent responsiveness (e.g., Bigelow, 1999).<sup>1</sup> The importance of early face-to-face interactions with caregivers for infant development has been attributed in part to the contingent nature of these interactions (Bigelow, 1999, 2001; Gergely & Watson, 1999; Stern, 1985, 1999). Caregivers tend to engage young infants in social interaction by imitating infant behaviour that they perceive to be of an emotional nature, for example by matching smiling and vocal tone to an infant vocalization that appears to express pleasure or

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<sup>1</sup> My use of the terms contingent and contingent responsiveness follows the work of authors (e.g., Bigelow, 2001; Gergely & Watson, 1996, 1999) who use contingent to specify one partner's (A) responses to an interactive partner (B) that occur in a temporally close and emotionally/behaviourally congruent manner to that partner's (B) behaviour. This body of research originated in Watson's (e.g., 1985) studies of infants' responses to the experience of having a ribbon attached to one of their legs at one end and at the other to a mobile. Infants show positive affect to the experience of kicking their leg and seeing the mobile move. Watson referred to this as perfect contingency. The contingency that I am concerned with is thus more accurately referred to as social contingency (i.e., temporally close and emotionally/behaviourally congruent but not perfect). Because I think the context makes it clear, I typically drop the word social.

happiness (Gergely & Watson, 1999; Stern, 1985). Responses from caregivers that reflect infants' own behaviour are thought to facilitate early social and emotional development because infants are able to learn that their own actions are associated with changes in their caregivers' responses to them (Bigelow, 1999). The consistency and timing of caregiver responses is considered important because, in interactions with caregivers that are highly contingent, infants are able to perceive the effect of their behaviour on others (Gergely & Watson, 1999). In this way, infants also learn to use their facial and vocal behaviour in an instrumental manner, as a means to elicit anticipated contingent responses from their caregivers (e.g., Stern, 1999).

By about 4 months of age infants begin to develop relatively stable social expectations (Brownell, 1986), which include expectations about their caregivers' ability to soothe them when they are distressed and engage with them when they are playful (Stern, 1985). Individual differences in mothers' contingent responsiveness to their infants have been shown to be related to differences in infant social expectations around this age. For example, Bigelow (1998) found that, in dyadic face-to-face interactions with both their mothers and strangers, 4- and 5-month-old infants were more responsive to strangers whose level of contingent responsiveness was similar to that of their mothers. In contrast, infants were less responsive to strangers who responded either more or less contingently to them than their mothers. This finding suggests that infants have expectations about social interactions that are aligned with the contingent responsiveness of their mothers, and that these expectations are formed through infants' interactions with their mothers.

In an earlier phase of the present study, Mcquaid, Bibok, and Carpendale (2009) found that 4- and 5-month-old infants of mothers who scored high on a measure of contingent responsiveness during the initial interaction phase of the Still Face procedure

made more social bids to their mothers during the still face phase of the procedure compared to infants of mothers who scored low on the measure. Similar to Bigelow (1998), this finding supports the idea that young infants' social expectations are formed within their interactions with their caregivers. Furthermore, individual differences in infants' social bids during the still face phase suggest that infants of mothers who interact with them in a highly contingent manner may have greater expectations about social interaction being reciprocal in nature and also that their mothers will respond to their social gestures compared to infants of mothers who respond in a less contingent manner. Because the Still Face procedure is considered to be mildly distressing for infants around four months of age (e.g., Toda & Fogel, 1993), infant social bids during the still face phase may also reflect developing dyadic regulatory abilities. Individual differences in maternal contingent responsiveness may also be related to differences in infants' expectations about how successful they will be in engaging their mothers when they are distressed (cf. Cohn & Elmore, 1988; Cohn & Tronick, 1987).

Like the broader concept of maternal sensitivity, maternal contingent responsiveness has been defined and measured in a number of different ways by different researchers. In the present study, including the earlier phase presented above, contingent responsiveness is specifically defined as maternal affective behaviour (i.e., smiles and vocalizations) that follows similar infant affective behaviour within one second and that occurs while the mother and infant are looking at each other. Evidence from studies on non-social contingency learning suggest that young infants are only able to detect the contingency between their own action (e.g., leg kicking) and an outcome (e.g., movement of a mobile) if the outcome occurs within three seconds of the infants' action (Watson, 1985). Furthermore, evidence from studies on mother-infant interaction have

shown that mothers' smiling and vocal responses tend to occur within one second of their infants' smiles and vocalizations (e.g., Bigelow, 1998; Symons & Moran, 1994).

In addition to inconsistent definitions of the concept of maternal contingent responsiveness among researchers, precise operational definitions are lacking in published studies that have investigated maternal contingent responsiveness in relation to infant behaviour in the Still Face procedure. For example, Braungart-Rieker, Garwood, Powers, and Notaro (1998) investigated the relationship between mothers and fathers' sensitivity, which they defined as contingent responding and appropriate levels of stimulation during the interactive phase, and their 4-month-old infants' affect, self-comforting behaviour, object orientation, and parent orientation during the still face phase. They found that infants of highly sensitive mothers showed less negative affect and more parent orientation during the still face phase than infants of less sensitive mothers. Similarly, Haley and Stansbury (2003) found that 5- and 6-month-old infants of parents who were more responsive during the initial interactive phase displayed less negative affect and spent more time looking at their parent during the still face phase than infants of less responsive parents. It is difficult, however, to interpret the results of these studies with respect to contingent responsiveness. In the Braungart-Rieker et al. study, contingent responsiveness was assessed independently of whether or not the infant was looking at the parent while the parent was engaged in a particular behaviour and they did not specify whether parents' facial affect was included in their assessment of contingent responsiveness. In the Haley and Stansbury study, parental responsiveness was defined as parent behaviour that was contingent to infant vocalizations and facial expressions, regardless of whether or not the infant was looking at the parent at the time of the response. Furthermore, the exact operational definition of contingent is not clearly specified in either study.

In contrast to Mcquaid et al., neither Braungart-Rieker et al. nor Haley and Stansbury found any correlations between their measures of contingent responsiveness during the initial interactive phase and infant positive affect or social bids during the still face phase. Because the Mcquaid et al. measure of contingent responsiveness is generated from maternal behaviour in relation to infant behaviour while the mother and infant are looking at each other it is essentially a dyadic variable. It is possible that this measure of contingent responsiveness captures an aspect of the way in which mothers interact with their infants that is salient for the infant and that is more indicative of young infants' developing social expectations than other measures. Further supporting this possibility, Carter, Mayes and Pajer (1990) found that maternal smiles alone (i.e., the frequency of mother smiles rather than the timing of mother smiles in relation to infant smiles) during the initial interactive phase were not related to infant social bids during the still face phase. Similarly, in the Mcquaid et al. study, the frequency of mother smiles alone was not predictive of infant social bids. Only mother smiles that were contingent to infant smiles during the initial interactive phase were related to infant social bids during the still face phase. This finding suggests that although maternal affective behaviour alone may represent some characteristic of the mother in interaction with her infant, such as warmth, maternal contingent responsiveness assessed with respect to the timing and consistency of infant behaviour may be more representative of the dyadic context in which infant social competence and expectations develop.

In sum, Mcquaid et al. (2009) and Bigelow (1998), described above, both defined maternal contingent responsiveness as maternal affective behaviour (i.e., smiles and vocalizations) that followed similar infant affective behaviour within one second, while the mother and infant were looking at each other. The findings of both studies suggest that maternal contingent responsiveness assessed in this way captures individual

differences in the way mothers respond to their infants' social gestures that are related to individual differences in infant social expectations at four to five months of age. The possibility that this measure also captures at least something of the concept of maternal sensitivity is supported by a recent study by Bigelow and colleagues (2010), in which mothers' contingent responsiveness in face-to-face interaction with their 4-month-old infants was found to be related to attachment security at 30 months. Consistent with the theory that mothers' sensitivity in responding to their infants' social gestures leads to secure attachment, mothers who responded to their young infants' vocalizations in a highly contingent manner had children who were securely attached to them in the early preschool years.

### **Attachment security**

The quality of attachment to caregivers is a marker of infant mental health around 12 months of age. Individual differences in infants' security of attachment to their caregivers are thought to impact development in a number of domains. Prospective longitudinal studies have shown that insecurely attached infants are at risk for a number of negative developmental outcomes including emotional and behavioural difficulties that increase the risk of experiencing psychological problems later in life (e.g., Sroufe, Egeland, Carlson, & Collins, 2005). Attachment security at 12 months is assessed in the Strange Situation (Ainsworth & Wittig, 1969), a standardized laboratory procedure in which infants' behaviour during two separations and reunions with their caregiver is assessed. According to attachment theory, an infant's internal working model (i.e., the infant's expectations for the caregiver's presence when sought and ability to comfort the infant when distressed) is formed through daily interactions with caregivers in the first year of life and beyond (Bowlby, 1969). Infant behaviour in the Strange Situation, in

particular, when the mother leaves the infant and then returns, is considered to reflect these expectations.

Four categories of infant attachment security have been identified: secure, insecure-avoidant, insecure-resistant, and insecure-disorganized (Ainsworth, Blehar, Waters, & Wall, 1978; Main & Solomon, 1986). The behaviour of secure infants is characterized by indications of missing their mother during the separations, greeting her when she returns, and then settling and returning to play. In contrast, insecure-avoidant infants show little or no distress during the separations from their mother and actively ignore or avoid her during the reunions. Insecure-resistant infants show high levels of distress during the separations and seek or signal for contact with their mother during the reunions but they are not settled by her and may show strong resistance to being picked up and comforted. In contrast to the first three attachment categories, insecure-disorganized infants lack a coherent, organized behavioural strategy to regulate their distress at being separated from their mother. They behave in contradictory ways during the reunions including incomplete or interrupted movements, becoming completely still, or engaging in repetitive body movements such as rocking or ear pulling.

Since the first published studies of mother and infant behaviour in the Still Face procedure researchers have noted similarities between it and the Strange Situation at 12 months (e.g., Tronick et al., 1982). The presence or absence of infant social bids to the mother during the still face phase has been thought of as representing infants' expectations about their mothers' tendency to respond to their social gestures and thus to be indicative of the infant's developing internal working model of their attachment to their mothers (Cohn et al., 1991; Tronick et al., 1982). Compared to the initial interactive and still face phases, the reengagement phase of the Still Face procedure has not been extensively studied by researchers. It has been suggested, however, that infant

behaviour in this phase may be even more indicative of the developing attachment relationship as this phase represents a return to interaction following a psychological separation similar to the reunions following physical separation in the Strange Situation (Cohn, 2003). Despite the similarities between the procedures, however, only a few longitudinal studies investigating relations between mother and infant behaviour in the Still Face procedure and attachment behaviour in the Strange Situation have been published.

A recent review and meta-analysis by Mesman et al. (2009) reported five published studies that investigated infant or mother behaviour in a face-to-face Still Face procedure during infants' first year (infants' ages ranged from three to nine months) and subsequent attachment security at 12 months. The first of these was a pilot study by Tronick et al. (1982) in which infants who made bids to reengage their mother (i.e., smiled or vocalized while looking at their mother) during the still face phase of the procedure at six months were more likely to be classified as securely attached at 12 months and infants who made no bids were classified as insecurely attached. The sample size of this study was small ( $n = 17$ ). Twelve of 13 infants who made social bids were classified as securely attached in the Strange Situation and none of the four infants who made no bids were. In separate small samples of three ( $n = 12$ ) and nine ( $n = 17$ ) month old infants in the Tronick et al. pilot study, no relations were found between infant social bids during the still face phase and 12 month attachment security. With a larger sample ( $N = 66$ ), in which one half of the mothers had experienced postpartum depression, Cohn et al. (1991) found that 6-month-old infants who made social bids during the still face phase were more likely to be securely attached at 12 months whereas infants who made no bids were more likely to be classified as avoidant. Similar to Tronick et al., this was the only age for which a significant result was found. No

relation was found between social bids when the infants were assessed in the Still Face procedure at two or four months of age and their later attachment security.

In a multi-phase longitudinal study that assessed 3-month-old infants in the Still Face procedure and their later attachment security at 12 months, Fuertes, Lopes-dos-Santos, Beeghly, and Tronick (2009) found that future secure infants displayed more positive affect across the three phases of the procedure compared to future insecure infants. Because infant behaviour was pooled across phases, however, it is not clear what this result means with respect to infant social expectations beyond that which could be obtained from face-to-face interaction with the mother that did not involve a still face phase. Furthermore, since infant behaviour in the still face phase was not analyzed separately from behaviour in the other phases, it is not possible to assess whether this finding suggests that infant social expectations at as early as three months of age may be indicative of the developing mother-infant attachment relationship. However, given that the infant behaviour was assessed in a dyadic context that is somewhat distressing for both the infant and the mother, it is possible that this result reflects something of the nature of the infant's developing internal working model of the mother.

The studies described above investigated whether infant behaviour in the still face phase of the procedure was related to later attachment security. One published study reported exploratory analyses of infant behaviour in the reengagement phase at four months and attachment security at 12 months. Kogan and Carter (1996) used a rating scale that incorporated aspects of reunion behaviour codes from the Strange Situation to measure infant behaviour in the reengagement phase of the Still Face procedure. They had a small sample and the variability of attachment classifications was low (only 6 of 22 infants were classified as insecure), but they found that infant resistance and attention seeking during the reengagement phase of the Still Face

procedure was related to the contact maintenance attachment behaviour code in the reunion episodes of the Strange Situation. Although it is not possible to make any conclusions about whether infant behaviour in the reengagement phase is indicative of social expectations related to attachment security based on this finding, it lends support to the idea that this phase of the Still Face procedure may capture infant behaviour that is similar to reunion behaviour in the Strange Situation.

Only one published study has assessed relations between maternal behaviour in the interactive phases of the procedure and infant attachment security at 12 months. In a follow-up to the study described above (Braungart-Rieker et al., 1998), Braungart-Rieker, Garwood, Powers, and Wang (2001) assessed parental sensitivity, which they defined as contingent responsiveness and appropriate levels of stimulation during the initial interactive phase (see above), in the Still Face procedure at four months and attachment security at 12 months. They found that mothers of infants classified as securely attached at 12 months were more sensitive than mothers of infants classified as insecure-resistant. Infants who were securely attached to their mothers at 12 months also displayed more positive affect during the still face phase of the procedure compared to infants who were insecurely attached.

### **The present study**

The purpose of the present study is to address some gaps in the research on mother and infant behaviour in the Still Face procedure in relation to infant attachment security at 12 months of age. It extends the Mcquaid et al. (2009) study by following up infants at 12 months who were initially assessed in the Still Face procedure at four or five months. To date, only one study (Braungart-Rieker et al., 2001) has investigated whether maternal behaviour in the initial interactive phase of the Still Face procedure is predictive of attachment security in the Strange Situation. No studies have investigated

whether maternal contingent responsiveness assessed with respect to the timing and consistency of maternal behaviour in relation to infant behaviour in the interactive phases is related to attachment security at 12 months, although some researchers have proposed that maternal contingent responsiveness early in infancy should be related to later attachment security (Koos & Gergely, 2001). Thus, one goal of this study is to apply a measure of contingent responsiveness that may reflect an important aspect of maternal sensitivity in early infancy to the question of whether mother and infant behaviour in the Still Face procedure predicts later attachment security.

Another goal of the present study is to assess mother and infant behaviour in the reengagement phase of the Still Face procedure. This phase of the procedure has typically been neglected in Still Face studies, despite providing researchers with an opportunity for studying how mothers and their young infants repair a break in interaction that is mildly distressing for both partners. Behaviour in this phase may be more indicative of the quality of the mother-infant relationship than behaviour during the initial interactive phase and therefore predictive of later attachment security.

### **Summary of hypotheses**

1- Maternal contingent responsiveness in the initial interactive phase of the Still Face procedure will be related to attachment security. Infants of mothers who score high on the measure of maternal contingent responsiveness will be securely attached at 12 months.

2- Maternal contingent responsiveness in the reengagement phase of the Still Face procedure will be related to attachment security. Infants of mothers who score high on the measure of maternal contingent responsiveness will be securely attached at 12 months.

3- Infant social bids in the still face phase will be related to attachment security. Infants who make more bids to their mothers during this phase will be securely attached at 12 months.

4- Because no previous studies have assessed infant behaviour in the reengagement phase of the Still Face procedure with respect to social expectations, no specific predictions are tested in the present study. Instead, exploratory correlations will be examined among mother and infant variables (i.e., smiles, bids, contingent responsiveness) across phases of the Still Face procedure with respect to timing and frequency of infant social behaviour in the reengagement phase.

## **METHOD**

### **Participants**

Participants were 72 mother-infant dyads who were first seen when the infants (37 girls and 35 boys) were 4-5 months ( $M = 144$  days,  $SD = 19$  days, range: 118 to 198 days) and followed up when the infants were 12 months of age ( $M = 54$  weeks,  $SD = 2.5$  weeks, range: 47 to 62 weeks). The participants were from a city in Western Canada. They were recruited with advertisements in local newspapers and were paid \$30 at each lab visit for their participation. The total number of dyads recruited was 104. Nine dyads were excluded from the study at Phase 1 due to: cultural/language concerns (5 Chinese dyads who were recent immigrants to Canada) or incomplete Still Face procedure (4 dyads). Nineteen dyads were either not able to be contacted for Phase 2 (i.e., phone number not longer in service, they had moved) or were contacted but unable to return to the lab. In the majority of these cases, it was not possible to contact the mothers 8 months later. Four additional dyads were excluded from the study at Phase 2 due to camera problems (1) and incomplete Strange Situation procedures (3).

Socioeconomic status of the infants' families was measured by a Canadian index (Blishen, Carroll, & Moore, 1987) based primarily on education, income, and to a lesser extent, occupational prestige. In the index, occupations are divided into 514 groups, ranging from SES scores of 17.81 to 101.75 ( $M = 42.74$ ,  $SD = 13.28$ ). The scores of the higher status parent in the participants' families yielded a SES mean of 56.21 ( $SD = 14.49$ ). The percentage of parents with a university degree or more was 48%, 44% had some university or college education, 6% had only a high school diploma, and 2% were

without high school diploma. The ethnic composition of the infants' families was 82% Euro-Caucasian, 10% Asian, 1% Black, and 7% mixed.

## **Phase 1 (Age 4-5 months)**

### **Procedure**

This phase of the study took place in a corner of a laboratory room that was sectioned off by a grey divider in order to minimize distractions. The infants were placed in a commercial infant seat and the mothers sat facing them at eye level. The experimenter remained in the room for the duration of the procedure but was seated on the other side of the divider. Mothers were instructed (a) to interact with their baby as they normally would for two minutes (Interactive phase); (b) when they heard a knock, to adopt a "straight face" for one minute (i.e., that they could look at their baby but were not to touch or respond to him or her in any way) (Still Face phase); and (c) following another knock, to resume interacting for another two minutes (Reengagement phase). Mothers were also told they should feel free to interrupt the procedure at any time if their infant became upset. Two video cameras were used. One was focused on the infant and the other on the mother to record their face and upper body. Video signals from the two cameras were fed through a mixer to generate a split-screen digital recording of the infant and the mother.

### **Scoring**

The digital recordings were scored for infant and mother facial expressions, vocalizations, and gaze in each of the three phases using the Interact observational data analysis program. Interact allows coders to start, stop, and rewind the recordings as needed. The recordings were scored in real-time. Facial expressions were scored as smiles (raised cheeks and upturned mouth), frowns (furrowed brow and downturned

mouth) or neutral. Vocalizations were scored as positive, negative, or nil. Infant digestive sounds such as burps and hiccups were excluded. Gaze was scored as looking to or away from partner. Each type of behaviour was given a unique keystroke. Pressing a key signalled the onset of its respective behaviour (e.g., a smile) and pressing another key within the same category of behaviour (e.g., facial expressions) signalled the onset of another behaviour (e.g., neutral expression) and the offset of the previous behaviour (e.g., smile). The temporal resolution of the program is 1 video frame (1 frame = 1/30 of a second) and the duration, onset and offset of each type of behaviour is converted into seconds by the program. Frequency and co-occurrences of behaviour were also generated by the program. Scoring was done in separate passes for each infant and mother category of behaviour, for a total of 6 passes per dyad.

Interrater reliability was assessed by two different raters for a subsample (20%,  $n = 15$ ) of the mother-infant dyads using Interact. The time interval used for the reliability calculations was very conservative (1 frame = 1/30 of a second). The mean kappa across phases was .72 (range = .52-.93) for infant facial expressions, .73 (range = .60-.85) for mother facial expressions, .51 (range 0-.86) for infant vocalizations, .72 (range = .44-.81) for mother vocalizations, and .92 (range = .87-.96) for infant gaze. Because mothers almost never looked away from their infants, kappa was not calculated for mother gaze. The kappas were low for infant vocalizations due to infrequent occurrence (see Uebersax, 1987).

A check of whether mothers were able to remain still-faced for the duration of the still face phase was also conducted. None of the mothers displayed an open-mouth smile. Six mothers displayed slight, closed-lipped smiles at some point during the SF phase (5 of them once, one of them twice). Only one of these mothers smiled (once)

when the infant was looking at her but this occurred in the last 2 seconds of the SF phase and the infant did not display any smiles after this point.

## **Measures**

Because mothers did not frown or make negative vocalizations during the interactive or reengagement phases and infant frowns and vocalizations of a positive or negative nature were infrequent across the phases, measures were generated from mother and infant smiles and gaze only. This pattern of infrequent infant frowns has been observed in other studies of mother-infant face-to-face interaction (Bigelow, MacLean, & MacDonald, 1996; Toda & Fogel, 1983; Stack & Muir, 1992). Infrequent infant vocalizations have also been observed in similar studies with 4- and 5- month-old infants (Bigelow & Birch, 1999).

## **Social Smiles**

In order to assess behaviour that is salient for the infants, analyses were conducted on the smiles that occurred while the mother and infant were looking at each other. These smiles are referred to as Social Smiles. Social Smiles scores were calculated for the infant in all three phases and for the mother in the Interactive phase and Reengagement phase. Definitionally, infant Social Smiles are the same across phases but may be considered conceptually different during the Still Face phase. A number of researchers have referred to infant smiling and gazing to mother during the Still Face phase as social elicits or social bids in reference to infants' attempts to elicit social responses from their mothers (Carter, Mayes, & Pajer, 1990; Cohn et al., 1991; Tronick et al., 1982). In keeping with this convention, and to distinguish infant behaviour among the phases, infant smiles while looking to mother during the Still Face phase are

referred to as Social Bids; infant smiles while looking to mother during the Interactive phase and the Reengagement phase are referred to as Social Smiles.

### **Maternal Contingent Responsiveness**

Maternal Contingent Responsiveness scores for the Interactive phase and the Reengagement phase were generated for each dyad, reflecting the contingency of the mother's behaviour to her infant's behaviour (i.e., social smiles). Mother smiles were defined as contingent if they followed, within one second, a smile by the infant. For example, a mother's smile is contingent if its onset occurs within a time frame that starts at the onset of the infant's social smile and ends at one second following the offset of the infant's smile. Only smiles which occurred when the infant and mother were looking at each other were included.

Maternal Contingent Responsiveness scores for smiles were generated by computing the geometric mean for two conditional probabilities of mother behaviour in relation to infant behaviour: 1- the probability that any given infant smile will be followed by a mother smile within one second, and 2- the probability that any given mother smile is a response, within one second, to an infant smile. Thus, both probabilities must be high in order for a contingent responsiveness score to be high. This method also controls for the rate of both infant and mother smiles. For example, a mother who smiles frequently but not contingently will have a lower conditional probability than a mother who smiles infrequently but contingently. Furthermore, the geometric mean is the preferred measure of central tendency when the data are proportions and it is more conservative than the arithmetic mean. Conceptually, contingent responsiveness scores are a measure of the probability that a mother will smile in response to an infant's smile within one second. As such, contingency scores as a measure of probability are mathematically distinct from the frequencies of both infant and mother smiles; that is, the

magnitude of a contingent responsiveness score is not a mathematical function of the frequency of infant and mother smiles from which it is created. Rather, it is a mathematical function of the temporal relation of mother smiles following infant smiles within one second. Thus, conceptually, infant smiles and mother smiles are definitionally independent. That is, the occurrence of an infant smile does not entail that a mother smile necessarily follow that infant smile. Hence, the frequency of either infant or mother social smiles may or may not be correlated with the contingent responsiveness score; however, any correlation observed between either of the frequencies of infant or mother smiles with the contingent responsiveness scores does not result from the mathematical definition of the contingent responsiveness scores.

### **Infant Contingent Responsiveness**

Although no specific predictions were made with respect to infant contingent responsiveness, scores were generated in the same way as maternal contingent responsiveness and are included for exploratory purposes. Infant contingent responsiveness is rarely included in studies of maternal contingent responsiveness (Bigelow, 1998, 1999; Bigelow & Rochat, 2006 are exceptions) but researchers have pointed to the importance of assessing infant development in the context of dyadic interaction (e.g., Carpendale & Lewis, 2004; Cohn & Tronick, 1987) and infant contingent responsiveness assessed in this way may be informative.

### **Infant time to reengage**

In order to explore the possibility that infant behaviour in the Reengagement Phase is indicative of the mother-infant relationship with respect to infant expectations about repairs to disruptions in interaction, infant time to reengage was assessed. Infant time to reengage was calculated as the time in seconds that it took infants to return to

smiling and looking at the mother following the Still Face phase (i.e., time to first instance of a social smile in the Reengagement phase).

## **Phase 2 (Age 12 months)**

### **Procedure**

The second phase of the study took place in a laboratory room that had a one-way mirror along one of its walls to permit video recording (from a camera room on the other side of the mirror) and constant observation of the infants during the procedure. The mothers and infants took part in the Strange Situation procedure (Ainsworth & Wittig, 1969), which is a structured series of separations and reunions designed to elicit attachment and exploratory behaviour in 12-month-old infants. The procedure was explained to the mothers and they were instructed to follow the experimenter's signals for leaving and returning to the room. The procedure consists of seven 3-minute episodes. Initially, the mother and infant are together in a laboratory room with toys on the floor for the infant to play with (Episode 1). A "stranger" (i.e., a female research assistant unknown to the mother or infant) then enters the room, talks to the mother, and plays with the infant (Episode 2). The mother then leaves the room and the infant and stranger are together in the room (Episode 3). The mother returns and the stranger leaves the room (Episode 4). The mother exits the room again leaving the infant alone in the room (Episode 5). The stranger then returns to the room (Episode 6). The mother returns again and the stranger leaves (Episode 7). Mothers were able to observe their infant from the camera room during the separations. Episodes 3, 5, and 6 were shortened if the infants became too upset and mothers were told they should feel free to interrupt the procedure at any time if their infant became upset. Two infants became too upset to complete the procedure and one mother chose to end the procedure in Episode

5 when her infant followed her out the door. These are the three dyads that were excluded from the study due to incomplete procedures.

Because it is known that separations from caregivers impacts the attachment relationship, mothers were asked on their second visit to the lab whether their infants had spent any amount of time away from them due to hospitalization (of either the mother or the infant) or other reason. No mothers reported separations of this nature.

### **Assessment of attachment security**

Video recordings of the Strange Situations were coded by researchers (one coder, Elizabeth Carlson, coded all of the tapes, and a second coder coded a portion of the tapes for reliability) at the Institute of Child Development at the University of Minnesota who are trained in the Strange Situation coding procedure (Ainsworth et al., 1978). Interrater reliability was assessed for a subsample ( $n = 22$ ) of the Strange Situations. Interrater agreement was 86%. The reliability disagreements corresponded to cases that were difficult to code (i.e., Strange Situations in which the stranger partially obscured the infant during the reunion episodes or infant behaviour was unusual). These cases were reviewed by the Strange Situation coding group at the Institute of Child Development and recoded by the lead coder, Dr. Elizabeth Carlson.

Fifty-three infants were classified as securely attached and 19 as insecurely attached (4 insecure-avoidant, 6 insecure-resistant, and 9 insecure-disorganized). The number of secure compared to insecure classified infants is similar to that reported by other researchers working with comparable (i.e., community rather than clinical) samples of mothers and infants (e.g., Braungart-Rieker et al., 2001; Meins, Fernyhough, Fradley, & Tuckey, 2001). The number of infants classified as insecure-disorganized is higher

and the number of insecure-avoidant infants is lower than in distributions of community samples typically reported (van IJzendoorn & Kroonenberg, 1988).

### **Analytic plan**

Point biserial correlations and a series of logistic regression analyses were the statistical analyses planned to address the goals of this study. Although there are theoretical reasons for testing differences among the four attachment classification categories, studies that use community samples, including the present study, rarely have enough variability to allow for this and so treat attachment security as a dichotomous variable (i.e., secure vs. insecure). Point biserial correlations were planned among each of the 12 infant and mother variables considered to be potential predictor variables and infant attachment security. The potential predictor variables were: infant sex; infant age in the Still Face phase; infant social smiles, mother social smiles, infant contingent responsiveness, and mother contingent responsiveness in the initial interactive phase; infant social smiles, mother social smiles, infant contingent responsiveness, and mother contingent responsiveness in the reengagement phase; and infant social bids in the still face phase. The per comparison  $\alpha$  was Bonferroni corrected for 13 pairwise correlation tests with familywise error rate fixed at .1. A separate logistic regression analysis was planned for each of the first three hypotheses. Only infant and mother variables found to be significantly related to attachment security in the point biserial correlation analyses were to be included as predictors in the regressions. Repeated measures ANOVAs on infant smiles and gaze to mother across the three phases of the Still Face procedure were also planned as a manipulation check to assess whether the infants displayed a still face effect. For each of the contrasts,  $\alpha$  was set at .01.

A power analysis was conducted to determine the sample size needed for testing each of the three main hypotheses using logistic regression. The sample size needed to

detect a small effect at  $\alpha = .05$  is  $n = 197$ . No previously conducted studies were available to guide selection of effect size for this analysis but a small effect size was chosen because a meta-analysis (De Wolff & van IJzendoorn, 1997) showed a combined effect size of  $r = .24$  for studies assessing parental sensitivity and attachment security in non-clinical samples. It was not possible to obtain data for 197 dyads for the present study. One hundred participants were originally recruited but due to attrition and problems during data collection the sample size was reduced to 72. This sample size is similar to or greater than all but one of the Still Face procedure and Strange Situation studies described above. Possible implications of reduced power due to small sample size are addressed in the Discussion.

# RESULTS

## Descriptive Analyses

Table 1 shows the means, *SDs*, and ranges for duration of infant and mother behaviour across phases of the Still Face procedure. Table 2 shows the means, *SDs*, and ranges for frequency of infant and mother behaviour across phases of the Still Face procedure. Mothers did not frown or make negative vocalizations during the Interactive or Reengagement phases. Consistent with other studies of mother-infant face-to-face interaction with similar aged infants (e.g., Bigelow et al., 1996; Toda & Fogel, 1983; Stack & Muir, 1992), few infants (range  $n = 3-14$ ) displayed negative facial or vocal affect across the phases. More infants ( $n = 47$ ) made positive vocalizations; however, these were infrequent (cf. Bigelow & Birch, 1999). Thus, analyses were conducted on the infant and mother smiles and gaze data only.

As a manipulation check for a Still Face effect, repeated measures ANOVAs were conducted on the duration data. Contrasts between the Interactive phase and Still Face phase showed that infants smiled less ( $F = 129.36, p < .001$ ) and looked to mother less ( $F = 101.32, p < .001$ ) during the Still Face phase than during the Interactive phase. Contrasts between the Still Face phase and the Reengagement phase showed that infants smiled more ( $F = 49.52, p < .001$ ) and looked to mother more ( $F = 54.58, p < .001$ ) in the Reengagement phase than in the Still Face phase. Contrasts between the Interactive phase and the Reengagement phase showed that infants smiled less ( $F = 28.03, p < .001$ ) and looked to mother less ( $F = 17.25, p < .001$ ) in the Reengagement phase compared to the Interactive phase. Consistent with numerous previous studies of

similar aged infants (see Adamson & Frick, 2003; Mesman et al., 2009), a Still Face effect was observed in the sample.

### **Infant and mother variables**

Table 3 shows the means, *SDs*, and ranges for infant and mother variables across phases of the Still Face procedure. Square root transformations were conducted on the social smiling and social bid scores because of skewness of the distributions. Table 4 shows the correlations among these variables and attachment security. No infant or mother Still Face variables were related to infant attachment security. Infant age and sex were included because differences in infant age could be related to infant or mother behaviour during the Still Face procedure (Gusella, Muir, & Tronick, 1988; Toda & Fogel, 1993) and sex differences have been found in past Still Face studies (Carter et al., 1990; Mayes & Carter, 1990; Weinberg, Tronick, Cohn, & Olson, 1999). A recent study by David and Lyons-Ruth (2005) also showed sex differences in infant Strange Situation behaviour. Neither infant age nor sex was correlated with any of the variables.

### **Tests of Hypotheses**

#### **Maternal Contingent Responsiveness**

No significant correlations were found between maternal contingent responsiveness in either the initial interactive phase ( $r = -.11$ , ns) or the reengagement phase ( $r = .06$ , ns) and infant attachment security. As a result, no further analyses were conducted.

#### **Infant social bids**

Infant social bids in the still face phase were not related to later attachment security ( $r = -.12$ , ns). No further analyses were conducted.

### **Exploratory analyses to assess infant behaviour in the Reengagement phase**

Infant time to reengage was negatively correlated with infant social smiles in the initial interactive phase ( $r = -.54, p \approx 0$ ) and the reengagement phase ( $r = -.85, p \approx 0$ ), maternal contingent responsiveness in the initial interactive phase ( $r = -.44, p \approx 0$ ) and the reengagement phase ( $r = -.47, p \approx 0$ ), mother social smiles in the reengagement phase ( $r = -.47, p \approx 0$ ) and infant contingent responsiveness in the reengagement phase ( $r = -.79, p \approx 0$ ). Infant time to reengage was not related to maternal social smiles in the initial interactive phase ( $r = -.05, ns$ ), infant contingent responsiveness ( $r = -.32, ns$ ) or infant social bids ( $r = -.31, ns$ ).

## DISCUSSION

Similarities between the Still Face procedure in early infancy and the Strange Situation at one year have been noted by a number of researchers (e.g., Cohn, 2003). To date, however, only a few studies have investigated whether mother and infant behaviour in the Still Face procedure is predictive of later attachment security. The present study tested three hypotheses with respect to relations among mother and infant behaviour in the Still Face procedure at 4-5 months and attachment security at 12 months. Contrary to expectations, maternal contingent responsiveness to infant behaviour either in the initial interactive phase or the reengagement phase of the Still Face procedure was not correlated with attachment security at 12 months. Similarly, and in contrast to previously published findings, no correlation was found between infant social bids to their mothers during the still face phase and later attachment security. In an exploratory analysis of the Still Face procedure data, a number of correlations were found between mother and infant behaviour across phases of the Still Face procedure with respect to the timing and frequency of infant social behaviour in the reengagement phase. Possible interpretations of these findings and suggestions for further investigation are discussed below.

With respect to the lack of support for the study's main hypotheses, the sample size of the present study, although similar to or larger than the published Still Face and maternal contingent responsiveness studies described above, was smaller than anticipated. Thus, the power to detect possible correlations among mother and infant behaviour in the Still Face procedure and later attachment security was reduced. The lack of variability in the infant attachment classifications also made it difficult to test the

study's hypotheses. Although the proportion of insecure infants in the sample ( $n = 19$ , 26.4%) compared to secure infants ( $n = 53$ , 73.6 %) is similar to community samples reported by other researchers, the number of infants classified as insecure-disorganized ( $n = 9$ ) is unusually high for a community sample. Infants classified according to Main and Solomon's (1990) coding criteria for disorganization also receive an alternate classification according to Ainsworth's (Ainsworth et al., 1978) system (i.e., secure, avoidant, or resistant). In the present study, eight of the nine infants classified as disorganized received an alternate classification of secure. Thus, the number of infants who received a secure classification, whether organized or disorganized, was 61 (85%) compared to 11 infants without a secure classification (15%), possibly further reducing variability in the sample.

Only a few studies have investigated differences among disorganized infants, but the results of those studies suggest that infants classified as disorganized but who also rely somewhat on a secure attachment strategy are different in significant ways from infants classified as disorganized-avoidant or disorganized-resistant (Lyons-Ruth, Repacholi, McLeod, & Silva, 1991). Disorganized infants in low-risk community samples such as the present study are typically classified as disorganized-secure whereas infants in high-risk or clinical samples typically receive disorganized-insecure classifications (i.e., alternate classification of avoidant or resistant) (Lyons-Ruth, Bronfman, & Parsons, 1999). The developmental outcomes of these sub-groups of infants have also been shown to differ, with disorganized-secure infants apparently less at risk for later problems than disorganized-insecure infants and, possibly, also organized avoidant and resistant infants (Lyons-Ruth, et al., 1991). Although little is known about clinically significant differences among the sub-classifications of disorganized attachment at 12 months of age, and the sample size of the present study did not allow for exploration of

this interesting research question, it is possible that similarities between organized and disorganized secure infants may have further reduced variability in the present sample.

Variability in attachment classifications is often low in community samples and researchers have attempted to address this issue in a number of ways. In Ainsworth et al.'s (1978) coding system there are four sub-classifications for secure infants and two each for resistant and avoidant infants. Different combinations of the sub-classifications have been used by researchers (e.g., Braungart-Rieker et al., 2001) although interrater reliability has only been established for the categorical classifications (i.e., secure, avoidant, and resistant). The behavioural ratings from which the attachment classifications are made (e.g., proximity seeking and contact maintenance) have also been used to explore individual differences in attachment behaviour at 12 months of age (Sroufe et al., 2005). Post hoc analyses using the sub-classifications and behavioural ratings for the infants in the present study did not reveal greater magnitudes of correlations with the independent variables.

Although the lack of variability in the dependent variable, and lack of power of the statistical tests using those variables, makes it difficult to speculate about the meaning of the study's finding that no mother or infant variables in the Still Face procedure were related to later attachment security, this finding is also considered in relation to theory and previously published research findings. Cohn et al. (1991) found that the social bids of 6- but not 4-month-old infants were predictive of later attachment security and suggested that infants' social expectations may not be stable enough prior to six months of age to predict later security of attachment. In Bowlby's (1969/1997) theorized stages of attachment, the phase of attachment proper (i.e., when infants begin to display separation anxiety and are thought to be beginning to form internal working models) only begins at six to eight months of age. It is possible that the infants in the present study

were too young to have developed stable expectations about their caregivers' way of being with them. In Tronick et al.'s (1982) pilot study, 6-month-old infants, but not 3- or 9-month-old infants who made social bids to their mothers were found to be securely attached. It is difficult to draw conclusions about this finding given the small sample sizes involved, but it is possible that face-to-face interaction at six months is more indicative of the quality of the mother-infant relationship than earlier in infancy when social expectations are only beginning to be formed and later in infancy when infants are more interested in play that involves objects than face-to-face interaction.

Although they did not assess social bids during the still face phase of the procedure, Fuertes et al. (2009) found a correlation between 3-month-old infants' affect across all three phases of the procedure and later attachment security. With respect to the Fuertes et al. and the Cohn et al. studies, it is notable that both had samples with much higher than typical proportions of infants classified as insecure-avoidant. In the Fuertes et al., study 17 of 48 infants were classified as avoidant and in the Cohn et al. study, 25 of 66 infants were. Furthermore, the infants in the Fuertes et al. study were healthy infants born prematurely and in the Cohn et al. study half of the mothers had suffered from postpartum depression. It is possible that greater variability in these samples allowed for correlations between infant Still Face behaviour and later attachment security to be detected.

With respect to the maternal contingent responsiveness hypotheses, no previously published Still Face studies have investigated whether maternal contingent responsiveness assessed with respect to the timing and consistency of maternal behaviour in relation to infant behaviour is related to attachment security at 12 months of age. However, one study (Braungart-Rieker et al., 2001) that used a rating scale to assess maternal sensitivity that included a less precise assessment of contingent

responsiveness than the present study found that infants of mothers who were judged to be sensitive at four months were more likely to be classified as securely attached at 12 months compared to mothers who were judged to be less sensitive. Additionally, Bigelow et al. (2010) assessed maternal contingent responsiveness in the same quantitative way as the present study and found that mothers who responded to their infants' vocalizations in a highly contingent manner in a face-to-face interaction at four months of age were more likely to have securely attached infants at 30 months of age. Given that the Braungart-Rieker et al. and the Bigelow et al. findings are consistent with theories of the development of attachment, it is possible that a more qualitative approach to the assessment of maternal contingent responsiveness such as Braungart-Rieker et al.'s better captures the nature of the mother-infant relationship than a quantitative method such as the one used in the present study, or that mothers' responsiveness to vocalizations compared to smiles is more indicative or predictive of the developing attachment relationship.

The recently published findings of an extensive study on relations among mother and infant behaviour in face-to-face interaction (but not in a Still Face procedure) at four months of age and attachment security at 12 months at age suggest that it is possible to detect such relations using a micro-analytic approach (Beebe et al., 2010). The Beebe et al. study used a second-by-second micro-analysis of mother and infant behaviour that included, among other variables, facial and vocal affect, touch, and head orientation and position in relation to the other in the first 2 ½ minutes of a videotaped play interaction. For the purpose of discussion of the present study, it is significant that correlations were detected among a number of aspects of both mother and infant behaviour as assessed in relation to the other at four months of age and attachment security at 12 months. Three aspects of the findings in particular contribute to the present discussion. First, the

findings suggest that given sufficient variability in the independent and dependent variables (i.e., a number of aspects of the mother-infant interaction were analyzed in addition to smiles and vocalizations and 56 % of infants were assessed as secure versus 44 % insecure in the Beebe et al. study), it is possible to predict future attachment security from dyadic behaviour as early as four months of age. Second, mother-infant interaction was assessed across several categories of communication including attention, affect, touch, and spatial orientation in a free play situation. It is possible that maternal contingent responsiveness as assessed in the present study does not capture enough of the complexity and subtleties of mother-infant face-to-face interaction to be able to predict future attachment security.

Third, results of the Beebe et al. study suggest that a moderately high degree of responsiveness to infant behaviour (i.e., not too high as an intrusive mother may be or too low as a withdrawn mother may be) is associated with secure attachment. In the present study, maternal contingent responsiveness was defined as maternal smiles that followed an infant smile within 30 video frames (i.e., one second), and therefore no distinction was made between a mother's smile that followed her infant's smile by 1 video frame (i.e., 1/30 of a second) and a mother's smile that followed her infant's smile by 29 video frames (i.e., 29/30 of a second). In order to assess the possibility that different rates of maternal responsiveness may be associated with later attachment security, a post hoc analysis was conducted on the present study's data. A computer program was written to detect correlations with  $\alpha$  set at .01 among different maternal contingent responsiveness scores with time frames ranging from 1 to 60 frames (i.e., 1/30 of a second to 2 seconds). No correlations were observed. It is difficult to interpret this finding given the lack of variability in the attachment classifications, but given the

ease with which such analyses can be conducted on micro-analytically obtained data, future research may benefit from such analyses.

In addition to the limitations related to lack of variability described above, several other limitations should be considered in relation to discussion of the present study and potential directions for future research. The frequency of the behaviour that comprised the independent variables of interest was low. The number of infant social bids and mothers' smiles in the initial interactive and reengagement phases was low. Although there was variability in infant social bids, it could be increased by expanding the definition of social bids to include other behaviour such as vocalizations or gestures to the mother. The length of the still face phase could also be extended. One minute was chosen for the present study because infants display the still face "effect" in this time span but do not typically become too distressed (Toda & Fogel, 1993). The length of the still face phase in the studies described above ranged from 90 to 120 seconds (Fuertes et al. did not report the length of their still face phase). It is possible that a two-minute still face phase is more distressing for infants and that their behaviour during a longer period of disruption in social interaction may be more indicative of their ability to self-regulate and their expectations of their mothers to help them do this. With respect to maternal contingent responsiveness, variability in mothers' smiles was reduced because they were long in duration. In future studies, a more refined coding system for mother smiles, that includes smile increases and expressions of surprise, for example, may yield more variability and also a more accurate reflection of mother smiling responsiveness.

Finally, the present study used a community sample. Research on non-clinical samples is important to identify patterns in typical infant development. Extending this type of research to clinical or at-risk samples may make it possible to detect important individual differences in early mother-infant interaction and subsequent infant

development and also evaluate other research questions such as whether maternal contingent responsiveness has a moderating effect on at-risk infants' developing social expectations. Such a finding could have important implications for intervention work with at-risk infants and their caregivers.

Despite the lack of variability in the outcome measure of the present study, my exploratory analyses of the Still Face data add to the evidence that maternal contingent responsiveness assessed in a micro-analytic and quantitative way does capture something of the nature of the mother-infant relationship at an age when infants' preference for face-to-face interaction is at its peak. Mother and infant behaviour in the reengagement phase of the Still Face procedure has been relatively ignored by researchers compared to the initial interaction and still face phases despite what this behaviour might reflect about dyads' ability to reconnect following a somewhat distressing rupture in interaction. This ability to reengage is thought to represent an important aspect of dyadic regulation that is one of the foundations of healthy infant development (e.g., Fonagy et al., 2002). In the present study, maternal contingent responsiveness in the initial interaction phase was related to the time it took for infants to reengage with their mothers (i.e., smile and look at them) following the still face phase. Infants of highly contingent mothers reengaged more quickly than infants of less contingent mothers. Mothers' social smiles in the initial interactive phase were not related to infants' time to reengage suggesting that the timing and consistency of mothers' smiles to their infants is more indicative of the quality of the mother-infant relationship than smiles alone. This finding is consistent with the finding of the earlier phase of the present study that maternal contingent responsiveness in the initial interactive phase was related to infant social bids in the still face phase but mother social smiles were not related to infant social bids.

Infant contingent responsiveness to the mother was calculated and included in the analyses of the present study because capturing the relational nature of infant development is increasingly thought to be important in developmental research (e.g., Beebe et al., 2010; Carpendale & Lewis, 2004). The finding that maternal contingent responsiveness but not infant contingent responsiveness in the initial interactive phase is related to infant social bids during the still face phase and infant time to reengage in the reengagement phase can be interpreted as being consistent with previous findings (e.g., Cohn & Tronick, 1987) that prior to six months of age, it is the mother who shapes mother-infant interactions. Within these early exchanges, the mother's contingent responses to the infant's displays of affect form infants' social expectations.

In summary, the present study attempted to address some gaps in the research on mother and infant behaviour in the Still Face procedure in relation to infant attachment security at 12 months of age. Although early experience is thought to be important, infant development is highly variable and rapidly changing in the first year of life and the issue of variability in development early in infancy is a challenge for research involving prediction of later developmental outcomes (Sroufe, Coffino, & Carlson, 2010). Research that attempts to capture aspects of early infant development at a dyadic rather than individual level is increasingly seen to offer the most promise with respect to understanding developmental pathways that lead to both healthy and pathological outcomes. The present study represents an attempt to assess infant development at a dyadic level. Although the present study was limited by the lack of variability in the outcome variable, it was able to extend the Still Face research to reveal relations among mother and infant variables in the interactive and still face phases of the procedure and the previously neglected reengagement phase.

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Table 1

*Descriptive Statistics for Duration of Infant and Mother Behaviour across Phases of the Still Face Procedure*

Behaviour	Interactive Phase (2 mins)			Still Face Phase (1 min)			Reengagement Phase (2 mins)		
	<i>n</i>	Mean (SD)	Range	<i>n</i>	Mean (SD)	Range	<i>n</i>	Mean (SD)	Range
<b>Infant Behaviour</b>									
Gaze to mother	72	54.20 (37.01)	1.27-118.63	65	15.54 (17.35)	.6-60	69	40.35 (33.74)	.67-116.17
Smiles	69	23.24 (18.89)	.37-69.57	43	3.45 (7.06)	.03-45.83	59	13.37 (13.91)	.5-58.73
Frowns	3	.04 (.23)	.63-1.63	4	.86 (4.66)	6.57-37.27	14	1.44 (5.62)	.3-36.7
Pos. Vocs.	47	2.56 (4.44)	.13-22.3	39	1.54 (2.66)	.17-12.53	46	2.38 (3.98)	.27-20.3
Neg. Vocs.	3	.09 (.46)	1.17-3.03	7	.64 (2.48)	.43-16.17	14	1.3-4.44	.4-25.5
<b>Mother Behaviour</b>									
Gaze to Infant	72	119.75 (.64)	117.53-120	72	59.94 (.18)	59.07-60	72	119.57 (1.21)	112.6-120
Smiles	71	63.64 (26.23)	6.73-116.13		-----		72	55.96 (26.22)	1.9-106.73
Pos. Vocs.	72	58.84 (15.56)	22.03-96.4		-----		72	53.32 (17.59)	15-98.43

*Note.* Duration = time in seconds behaviour was displayed within a phase. Mother and infant behaviour is while looking to the other. For descriptive purposes, *n* indicates the number of mothers and infants that displayed the behaviour, however all analyses were conducted on the total sample (*N* = 72). Mothers did not frown or make negative vocalizations.

Table 2

*Descriptive Statistics for Frequency of Infant and Mother Behaviour across Phases of the Still Face Procedure*

Behaviour	Interactive Phase (2 mins)			Still Face Phase (1 min)			Reengagement Phase (2 mins)		
	<i>n</i>	<i>Mean (SD)</i>	<i>Range</i>	<i>n</i>	<i>Mean (SD)</i>	<i>Range</i>	<i>n</i>	<i>Mean (SD)</i>	<i>Range</i>
Infant Behaviour									
Gaze to mother	72	9.24 (5.74)	1-27	65	4.22 (3.41)	1-16	69	7.63 (4.46)	1-20
Smiles	69	8.06 (5.31)	1-21	43	1.82 (2.47)	1-11	59	4.99 (4.17)	1-18
Frowns	3	.07 (.35)	1-2	4	.32 (1.48)	3-9	14	.69 (2.08)	1-12
Pos. Vocs.	47	4.63 (6.87)	1-34	39	2.31 (3.59)	1-15	46	3.31 (4.55)	1-18
Neg. Vocs.	3	.1 (.48)	2-3	7	.72 (2.8)	1-18	14	1.25 (3.84)	1-23
Mother Behaviour									
Smiles	71	10.99 (4.04)	4-20		-----		72	8.89 (3.74)	1-21
Pos. Vocs.	72	55.68 (11.46)	28-80		-----		72	50.26 (12.67)	11-86

*Note.* Mother and infant behaviour is while looking to the other; therefore these values are also the untransformed duration of mother and infant social smiles and infant social bids. For descriptive purposes, *n* indicates the number of mothers and infants that displayed the behaviour, however all analyses were conducted on the total sample ( $N = 72$ ). Mothers did not frown or make negative vocalizations. Frequency of mother gaze is not included because mothers almost never looked away from their infants.

Table 3

*Means, SDs, and Ranges for Infant and Mother Variables across Phases of the Still Face Procedure*

Variable	Securely Attached ( <i>n</i> = 53)	Insecurely Attached ( <i>n</i> = 19)
	Mean (SD) Range	Mean (SD) Range
Interactive Phase		
Infant social smiles	2.58 (1.07) 0-4.58	2.8 (1.05) 1-4.58
Mother social smiles	3.17 (.76) 0-4.47	3.42 (.54) 2.24-4.36
Infant contingent responsiveness	.43 (.21) 0-.77	.39 (.13) .07-.62
Maternal contingent responsiveness	.24 (.2) 0-.82	.29 (.18) 0-.6
Still Face Phase		
Infant social bids	.93 (.88) 0-3.32	1.05 (1.15) 0-3
Reengagement Phase		
Infant social smiles	1.82 (1.13) 0-3.32	2.15 (1.25) 0-4.24
Mother social smiles	2.89 (.69) 1-4.58	2.97 (.61) 2-4.12
Infant contingent responsiveness	.35 (.21) 0-.71	.39 (.22) 0-.71
Maternal contingent responsiveness	.16 (.19) 0-.57	.13 (.17) 0-.5
Infant time to reengage	37.51 (46.31) 0-120	27.92 (43.72) 0-120

*Note.* Infant and mother social smiles scores and infant social bids scores are square root transformations. Infant time to reengage is in seconds.

Table 4 *Correlation Matrix for Infant and Mother Variables across Phases of the Still Face Procedure and Attachment Security*

Variable	1	2	3	4	5	6	7	8	9	10	11
Interactive Phase	1. Infant social smiles										
	2. Mother social smiles	.25									
	3. Infant contingent responsiveness	.44*	.10								
	4. Mother contingent responsiveness	.64*	.35	.07							
Still Face Phase	5. Infant social bids	.37*	.13	-.10	.58*						
Reengagement Phase	6. Infant social smiles	.63*	.09	.27	.54*	.42*					
	7. Mother social smiles	.29	.26	.29	.22	.11	.46*				
	8. Infant contingent responsiveness	.39*	-.06	.22	.38*	.24	.74*	.30			
	9. Mother contingent responsiveness	.32	.03	-.02	.42*	.45*	.66*	.31	.29		
	10. Infant time to reengage	-.54*	-.05	-.32	-.44*	-.31	-.85*	-.47*	-.79*	-.47*	
Strange Situation	11. Infant attachment security <sup>a</sup>	-.09	-.16	.08	-.11	-.06	-.12	-.06	-.09	.06	.09

\* $p < .001$ . This per comparison  $\alpha$  reflects a Bonferroni correction for 13 pairwise correlation tests with familywise error rate fixed at .1. Infant age and sex are not included because they were not significantly correlated with any of the infant or mother variables. <sup>a</sup>Secure = 1, insecure = 2.