

**RELATIONSHIP BETWEEN MATERNAL CONTINGENT
RESPONSIVENESS AND INFANT SOCIAL
EXPECTATIONS**

by

Nancy Mcquaid
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APPROVAL

Name: Nancy Mcquaid
Degree: MA
Title of Thesis: Relationship Between Maternal Contingent Responsiveness and Infant Social Expectations

Examining Committee:

Chair: Cathy McFarland
Professor

Jeremy Carpendale
Senior Supervisor
Professor

Marlene Morretti
Supervisor
Professor

Susan Birch
External Examiner
Assistant Professor
University of British Columbia

Date Defended/Approved:

Oct 22, 2007



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ABSTRACT

This study investigated the relationship between maternal contingent responsiveness and 4- and 5-month-old infants' (N = 61) social expectation behaviour in a Still Face procedure. 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. Mother and infant behaviour was assessed for the frequency of infant and mother smiles, mother smiles that were contingent to infant smiles during the Interactive phase, and infant social bids to mother during the Still Face phase. Hierarchical regression showed that mother contingent smiles during the Interactive phase accounted for unique variance in infant social bids during the Still Face phase beyond that accounted for by the frequency of mother and infant smiles during the Interactive phase. These results support the theory that infants' social expectations and sense of self-efficacy are formed within their interactions with their caregivers.

Keywords: infant development; mother-infant interaction; social interaction; emotional responses; social expectations

Subject Terms: Infant Psychology; Developmental Psychology; Social Interaction in Infants

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INTRODUCTION

Infants' early social, emotional, and cognitive development is intimately tied to their interactions with their caregivers (Carpendale & Lewis, 2004; Hobson, 2002; Stern, 1985). The importance of early face-to-face interactions with caregivers for infant development has been attributed to the reciprocal, contingent nature of these interactions (e.g., Bigelow, 1999, 2001; Gergely & Watson, 1999; Stern, 1985, 1999). Caregiver-infant interactions in the first months of life are characterized by caregiver responses that are close imitations of infant behaviour that caregivers perceive to be of an emotional nature (Gergely & Watson, 1999; Stern, 1985). Such responses from caregivers, which reflect infants' own behaviour, facilitate early social and emotional development and sense of self-efficacy because infants 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 learn to use their facial and vocal behaviour in an instrumental manner, as a means to elicit anticipated contingent responses from their caregivers (Stern, 1999).

Caregivers' level of contingent responsiveness to their infants has been shown to be stable within dyads but to vary across the normal population (Stern, Hofer, Haft, & Dore, 1985). This stability within dyads is thought to be established early in the first year of life (Watson, 1985). Within such dyadic interactions, infants develop social

expectations, which include expectations about their caregivers' ability to soothe them when they are distressed and engage with them when they are playful (Stern, 1985). Thus, these early social expectations are closely related to young infants' developing regulatory abilities (Fonagy, Gergely, & Jurist, 2002; Stern, 1985) and sense of self-efficacy (Bigelow, 1999; Tronick, Ricks, & Cohn, 1982).

Evidence from studies that have investigated individual differences in maternal contingent responsiveness and infant social expectations suggests a causal link between infants' expectations for social interaction and the quality of their relationships with their caregivers. 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 social expectations are formed through infants' interactions with their mothers. That is, infants' social expectations develop to be congruent with the social environment provided to them by their caregivers (e.g., maternal contingent responsiveness).

Studies employing the Still Face procedure (Tronick, Als, Adamson, Wise, & Brazelton, 1978) have also demonstrated individual differences in the quality of the mother-infant relationship and young infants' social expectations (for a review see Adamson & Frick, 2003). The Still Face procedure consists of three phases in which the mother is instructed to (a) initially interact with her infant as she normally would, (b)

become physically still and facially and vocally unresponsive, and (c) reengage her infant in normal interaction. Infants' response to the disruption of face-to-face interaction with their mothers, referred to as the Still Face effect, is characterized by initial bids to reengage their mothers followed by a decrease in positive affect and a corresponding increase in gaze aversion, negative affect, self-comforting behaviour, and autonomic arousal. Additionally, infants continue to display the effects of the disruption of the still face phase during the reengagement phase, with reduced positive affect and gaze to mother relative to the initial interactive phase (Adamson & Frick, 2003; Toda & Fogel, 1993). The Still Face effect is thought to reflect infants' distress at the failure of their initial attempts to re-establish expected reciprocal interaction (Braungart-Rieker, Garwood, Powers, & Notaro, 1998; Papousek, 2007; Tronick, et al., 1982). The violation of their expectation for reciprocal social interaction is considered to be a stressful event for infants, to which they respond with a range of regulatory behaviour.

Findings from a number of studies suggest that individual differences in maternal contingent responsiveness are related to individual differences in infant behaviour during the Still Face procedure. Braungart-Rieker, et al. (1998) investigated the relationship between mothers and fathers' sensitivity, 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 regard to parental contingent responsiveness. First, in the Braungart-Rieker et al. study, parental 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. Furthermore, 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. Second, the exact operational definition of contingency is not clearly specified in either study. Despite these limitations, the findings of these studies suggest that infants of parents who respond to them in a highly contingent manner may have greater expectations that their parents will resume reciprocal interaction, as prolonged looking to the parent during the still face phase may be indicative of infants' expectation that the parent will resume interaction.

Although infant gaze during the still face phase is suggestive of infants' expectations for social interaction, even more suggestive are infant bids to reengage the caregiver (e.g., simultaneously looking and smiling or vocalizing to the caregiver) as infants of caregivers who respond to them in a highly contingent manner learn more readily that their own behaviour is associated with changes in their caregivers' behaviour. It is reasonable to expect that maternal contingent responsiveness during the initial interactive phase would be related to infant social bids during the still face phase because infants with a greater sense of efficacy in eliciting responses from their caregivers would

be more likely to initiate a repair of the disruption in interaction compared to infants of less contingently responsive caregivers. This relationship, however, has rarely been investigated. In a pilot study, Tronick et al. (1982) investigated the relationship between maternal interactive style during the initial interactive phase and infant bids during the still face phase. Three patterns of infant bidding behaviour during the still face phase were identified: (a) positive bids, which included smiles and positive vocalizations while looking at the mother; (b) negative bids, which included fussing or crying but no positive bids; and (c) no bids, which included looking at the mother but no positive or negative bids. Mothers were characterized along three dimensions of interactive style: (a) elaboration, reflecting the extent to which the mother was responsive to the infant's actions, imitated her infant's social actions, and withdrew briefly when the infant looked away; (b) overcontrolling, reflecting the extent to which the mother intruded on the infant's activities or persisted in engaging the infant when the infant was looking away from her; and (c) undercontrolling, reflecting the extent to which the mother was hesitant or withdrew during the interaction. Highly elaborative mothers respond in a highly contingent manner to their infants by allowing them to initiate social interaction and also break interaction when overstimulated. In contrast, highly overcontrolling mothers do not allow their infants to initiate or withdraw from interaction whereas highly undercontrolling mothers do allow infants to initiate social interaction but do not respond in a reciprocal manner. Tronick et al. found that 6-month-old infants of highly elaborative mothers made positive bids to reengage their mothers whereas infants of mothers who were extremely over- or undercontrolling made no bids. These findings suggest that infants of highly over- or undercontrolling mothers do not have the same expectations for

reciprocal interaction with their mothers as infants of mothers who respond to them in a highly contingent manner. Additionally, these findings support the view that infants of highly over- or undercontrolling mothers do not learn that their actions are associated with changes in others' behaviour as readily as infants of highly contingently responsive mothers. Overall, the findings of Tronick et al.'s pilot study are consistent with the view that infants' social expectations are formed within their interactions with their mothers.

In a comparable study using a modified still face procedure, Carter, Mayes, and Pajer (1990) investigated the relationship between maternal affect assessed during an initial interactive play phase and 3- and 4-month-old infants' gaze and social bids (i.e., smiling while looking) to their mothers during the still face phase. They found that infants of mothers who displayed more positive affect during the initial play phase looked more at their mothers during the still face phase than infants of mothers who displayed less positive affect; however, no relationships were found between maternal affect and infant social bids. Although the observed lack of a relationship between maternal affect and infant social bids in this study is counter to what would be expected theoretically, there is a possible explanation for this finding. Maternal positive affect during the initial interactive play phase may be broadly construed to reflect the quality of the mother-infant relationship. Although the degree of contingency of mothers' positive affect to infant behaviour was not directly assessed in this study, it is likely that many of the mothers' displays of positive affect were contingent responses to their infants' behaviour. Consequently, by pooling maternal affective responses that were and were not contingent, this study was unable to detect a relationship between maternal affect and infants' social bids. Nonetheless, this study is consistent with other studies that have

found a relationship between maternal contingent responsiveness in the initial interactive phase and infant gaze during the still face phase (Braungart-Rieker et al., 1998; Haley & Stansbury, 2003). It is difficult, however, to interpret Carter et al.'s finding with regard to infant social expectations, as they did not directly assess whether mothers' displays of positive affect were contingent responses to infant behaviour. Without such an assessment of the mother-infant interaction in the initial phase, it is not clear (a) what the direction of effect is or (b) whether the correlation reflects a third variable such as shared maternal and infant temperament. Therefore, it is not possible to make inferences based on this study about the relation between mothers' interactions with their infants and the infants' social expectations.

The purpose of the present study is to assess whether the finding that individual differences in maternal contingent responsiveness are related to individual differences in infants' social expectations (e.g., Bigelow, 1998) is supported by mother and infant behaviour in a Still Face procedure. Despite theoretical reasons and some empirical evidence for positing that maternal contingent responsiveness during the initial interactive phase of the Still Face procedure ought to be predictive of infant bids to reengage their mothers during the still face phase, this claim has yet to be adequately investigated.

As discussed above, the consistency and timing of caregivers' responses to infants' behaviour, in particular their expressions of affect, are thought to be essential to infants' learning that their own actions are associated with changes in their caregivers' behaviour. Infants' developing social expectations and sense of self-efficacy are dependent on the contingency between their own actions and their caregivers' responses to them (Bigelow,

1998; Gergely & Watson, 1999). 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). Although previous studies (e.g., Braungart-Rieker et al., 1998; Haley & Stansbury, 2003) have assessed maternal contingent responsiveness in the initial interactive phase of the Still Face procedure, they have done so without an exact measure of the timing of mother responses in relation to infant behaviour. If maternal contingent responsiveness is investigated without respect to timing of the responses, mothers' responses to their infants' behaviour may be contingent but delayed in time such that the infants are not able to make associations between their own and their mothers' behaviour and therefore not able to detect the effectiveness of their behaviour. Consequently, it is possible that maternal contingent responsiveness scores derived without respect to timing would not predict infant social bids in the still face phase, because contingent responses that are distant in time may not represent meaningful social responses for sensorimotor infants. Thus, timing is critical to empirical evaluations of the theory that infants develop social expectations within their interactions with caregivers. To overcome this shortcoming of previous research, in the present study, I precisely define contingent responsiveness as maternal affective behaviour that followed similar infant affective behaviour within one second.

The hypothesis of the present study is that infants of mothers who score high on contingent responsiveness during the initial interactive phase will make more bids to reengage their mother during the still face phase than infants of mothers who score low on contingent responsiveness. Specifically, I expect that maternal contingent responsiveness will predict infant social bids over and above the frequency of mother and infant affective behaviour, which may be attributable to mother and infant temperament.

METHOD

Participants

Participants were 61 4- and 5- month-old infants (35 girls and 26 boys) and their mothers. The mean age of the infants was 139 days ($SD = 14$ days, range: 120 to 178 days). An additional nine dyads were excluded from the study because five infants became too upset to complete the procedure and four infants did not smile or vocalize during the initial interaction phase. The participants were from a city in Western Canada. They were recruited with advertisements in local newspapers and were paid \$30 for their participation.

Socioeconomic status of the infants' families was measured by a Canadian index (Blisshen, 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 80% Euro-Caucasian, 10% Asian, 2% First Nations, 1% Black, and 7% mixed.

Procedure

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 facial expressions, vocalizations and gaze in each of the three phases and mother facial expressions, vocalizations and gaze in the Interactive and Reengagement phases using the Interact observational data analysis program. Facial expressions were scored as smiles (raised cheeks and upturned mouth), frowns (furrowed brow and downward turned mouth), or neutral. Vocalizations were scored as positive, negative, or nil. Digestive sounds such as burps and hiccups were excluded. Infant gaze was scored as looking to or away from mother. Mother gaze was

scored as looking to or away from infant. Scoring was done in separate passes for each infant and mother category of behaviour. Behaviour was scored for its onset.

Interrater reliability was assessed for a subsample of 13 (20%) of the mother-infant dyads using the Interact observational data analysis program. The time interval used for the reliability calculations was very conservative (1 frame = 1 thirtieth 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.

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; Fogel, Diamond, Langhorst, & Demos, 1982; 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

Social Smiles refer to infant and mother smiles that occur while looking to the other. This measure is operationally defined, for the infant, as the total frequency of co-occurrences of smiling and looking to mother and, for the mother, as the total frequency of co-occurrences of smiling and looking to the infant. Social Smiles scores were calculated for the infant in all three phases and for the mother in the Interactive and Reengagement phases. Definitionally, infant Social Smiles are similar across phases but may be considered conceptually different during the Still Face phase. The Still Face phase is an unsettling disruption in social interaction for most infants. Infants' response to this disruption is considered to be due to the violation of their expectations for their face-to-face interactions with their caregivers (see Adamson & Frick, 2003). A number of researchers have referred to infant smiling and looking 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, et al., 1990; Cohn, Campbell, Ross, 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 and Reengagement phases are referred to as Social Smiles.

Maternal Contingent Responsiveness

A Maternal Contingent Responsiveness score for the Interactive phase was generated for each dyad, reflecting the contingency of mother smiles to infant smiles. Mother smiles were defined as contingent if they followed, within one second, a smile by

the infant. 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.

RESULTS

Descriptive Analyses

Table 1 shows the means, *SDs*, and ranges for duration of infant and mother behaviour across phases. Table 2 shows the means, *SDs*, and ranges for frequency of infant and mother behaviour across phases. 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 (Bigelow, et al., 1996; Fogel, et al., 1982; Stack & Muir, 1992), few infants (range $n = 2-6$) displayed negative facial or vocal affect across the phases. More infants ($n = 44$) made positive vocalizations; however, these were infrequent (cf. Bigelow & Birch, 1999). Thus, analyses were conducted on the infant and mother smiles and gaze data.

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 ($F = 101.96, p < .001$) and looked to mother less ($F = 123.1, p < .001$) 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 ($F = 61.36, p < .001$) and looked to mother more ($F = 74.98, p < .001$) in the Reengagement phase than in the Still Face phase. Contrasts between the Interactive phase and the Reengagement phase showed that infants smiled less ($F = 19.46, p < .001$) and looked to mother less ($F = 11.92, p < .001$) in the Reengagement phase compared to the Interactive phase. Consistent with numerous previous studies of similar aged infants

(see Adamson & Frick, 2003), a Still Face effect was observed in the data. No further analyses were conducted on the Reengagement phase.

Infant and Mother Variables

Table 3 shows the means, *SDs*, and ranges for Maternal Contingent Responsiveness, infant and mother Social Smiles, and infant Social Bids. 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. Infant Social Smiles were significantly related to mother Social Smiles ($r = .33, p < .01$), Maternal Contingent Responsiveness ($r = .65, p < .001$), and infant Social Bids ($r = .42, p < .001$). Mother Social Smiles were also significantly related to Maternal Contingent Responsiveness ($r = .42, p < .001$), but not infant Social Bids ($r = .08, ns$). Maternal Contingent Responsiveness was related to infant Social Bids ($r = .51, p < .001$). 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 studies (Carter, et al., 1990; Mayes & Carter, 1990; Weinberg, Tronick, & Cohn, 1999). Neither infant age nor sex was correlated with any of the variables.

Test of Hypothesis

Table 4 shows the results of the hierarchical regression conducted in order to determine whether Maternal Contingent Responsiveness in the Interactive phase predicted infant Social Bids in the Still Face phase. Infant age and sex were entered in the first block as basic controls, infant and mother Social Smiles were entered in the

second block as covariates, and Maternal Contingent Responsiveness was entered in the final block. This analysis revealed that Maternal Contingent Responsiveness accounts for 11% of the variance in infant Social Bids above and beyond the variance (19%) accounted for by the frequency of infant and mother Social Smiles, $F(1,55) = 8.98, p = .004$.

DISCUSSION

Infant expectations for reciprocal social interactions and sense of self-efficacy within social interactions are thought to develop most readily within caregiver-infant interactions that are highly contingent to infant affective behaviour (Bigelow, 1999; Gergely & Watson, 1999; Stern, 1985). Within such highly contingent face-to-face interactions, infants form expectations for highly reciprocal social interactions and learn that their behaviour is associated with changes in their caregivers' behaviour. It is well established that mothers' suddenly adopting a still face when interacting with their infants is a violation of social expectations for most infants (Toda & Fogel, 1993). Investigations of individual differences in mother-infant interaction using the Still Face procedure have shown that maternal behaviour in the initial interactive phase is related to infant behaviour in the still face phase (e.g., Braungart-Riker et al., 1998; Carter et al., 1990; Haley & Stansbury, 2003; Tronick et al., 1982). Thus, in the present study, I expected that infants of mothers who scored high on Maternal Contingent Responsiveness, when assessed with respect to the timing of responses, during the initial Interactive phase of a Still Face procedure would make more Social Bids to reengage their mothers in the Still Face phase compared to infants of mothers who scored low on Maternal Contingent Responsiveness. The results of the hierarchical regression support this hypothesis. Maternal Contingent Responsiveness in the initial Interactive phase predicted infant Social Bids in the Still Face phase over and above the frequency of mother and infant Social Smiles during the initial Interactive phase.

This finding is in line with that of Bigelow (1998) and provides support for the theory that young infants are highly sensitive to social contingency and that their expectations for interactions with others are formed within their interactions with their primary caregivers. The results of the present study are also consistent with those of a prior pilot study that explored individual differences maternal interactive style in the initial interactive phase of the Still Face procedure and infants' bids to reengage their mother during the still face phase (Tronick et al., 1982).

With regard to more recent studies (Braungart-Rieker et al., 1998; Haley & Stansbury, 2003) that investigated maternal contingent responsiveness during the initial interactive phase and infant regulatory behaviour during the still face phase, the present study expands on their findings as they relate to infant social expectation. Those studies found that high ratings of maternal contingent responsiveness were related to longer infant gaze to mother during the still face phase relative to infants of mothers with low ratings of contingent responsiveness whereas the present study found that maternal contingent responsiveness was predictive of infant gaze while smiling to mother. Infant social bids (i.e., gaze while smiling to mother) during the Still Face phase provides stronger evidence of infant social expectation than gaze alone as it is not clear what gaze alone indicates about infants' expectations for their interactions with their caregivers. Infant smiles while looking to the mother during the Still Face phase suggest that infants not only have expectations about how social interactions should unfold but also that they will be successful in initiating social interaction.

Similar to Carter et al. (1990), maternal smiles during the initial interactive phase were not correlated with infant social bids during the still face phase in the present study.

In contrast to the Carter et al. study, that predicted a relationship between maternal affect and infant social bids, the present study found that mother smiles that were contingent to infant smiles did predict infant social bids. This finding suggests that although maternal affective behaviour alone may represent some characteristic of the mother in interaction with her infant, such as warmth, in order for the behaviour to be meaningful for the infant, the infant must be able to detect its temporal relation to the infant's own behaviour.

A strength of the present study is the more precise methodology used to assess maternal contingent responsiveness. In order to provide empirical support for the claim that infants develop social expectations about their caregivers' responsiveness to them and their own ability to initiate such responses, within their interactions with caregivers, a measure is required that assesses the directional and temporal relation of maternal behaviour to infant behaviour. In the present study, Maternal Contingent Responsiveness referred to (a) mother smiles that followed infant smiles, in keeping with the view that infants develop a sense of self-efficacy by having their behaviour responded to by their caregivers, (b) within one second, in keeping with the view that maternal responses to infant behaviour must occur within a brief a period of time in order for infants to detect the contingency between their own action and their caregiver's response to that action. Thus, instances of Maternal Contingent Responsiveness began with onset of an infant smile and terminated with a mother smile that followed the infant smile within one second. Unlike simple correlations in which the direction of effect cannot be determined, contingency scores are inherently directional.

In the Interactive phase of the present study, infant and mother were both assessed for social smiling. Infant Social Smiles during the interactive phase were correlated with infant Social Bids. This finding is not surprising because the correlation is between two analogous measures assessed within subjects. Nonetheless, the Still Face manipulation check demonstrates that there was a significant change in infant behaviour from the initial interaction phase to the still face phase with respect to social smiling. Mothers' Social Smiles in the interactive phase were not correlated with infant Social Bids in the Still Face phase, suggesting that the relation between Maternal Contingent Responsiveness and infant Social Bids is unlikely to result just from shared mother and infant temperament. Moreover, both mother and infant Social Smiles during the Interactive phase were entered as covariates in the hierarchical regression, accounting for variance in infant Social Bids in the Still Face phase. Various factors including temperament may contribute to this result. However, the remaining variance in infant Social Bids in the Still Face phase represents that variance accounted for by the directional and temporal relation between mother and infant Social Smiles not the individual contributions of mother or infant Social Smiles to the Initial interaction. Finally, as the direction of the Maternal Contingent Responsiveness scores was from infant to mother and predicted infant Social Bids when entered in the last step of the hierarchical regression, the results of the present study support the view that infant expectations for social interactions and their ability to initiate such interactions are formed within caregiver-infant interactions.

An additional methodological strength of the present study is its coding of mother and infant behaviour in separate streams, from which the Maternal Contingent

Responsiveness scores were then computed. This method results in a more objective derivation of contingent responsiveness scores relative to studies in which the unit of analysis is contingency (e.g., Haley & Stansbury, 2003). When the unit of analysis is dyadic behaviour, there is a greater risk of biased coding because coders must attend to the infant and the mother at the same time. In the present study, the units of analysis were mother and infant social smiles, which were coded separately, and therefore the maternal contingent responsiveness scores represent a mathematical property of the data set.

The limitations of the present study are several. First, the direction of contingent responsiveness was only assessed for mothers' responses to infant behaviour. In order to capture more fully the reciprocal nature of mother-infant face-to-face interaction it would be necessary also to assess infant responses to mothers' behaviour. It is possible that the timing and consistency of mother and infant sequences of turn-taking is more predictive of infant social expectation and self-efficacy behaviour than maternal contingent responsiveness alone. Second, the frequency of infant Social Bids in the Still Face phase was low. Although there was variability in infant Social Bids, future studies could expand the definition of social bids to include other infant behaviour such as vocalizations and gestures to the mother. Related to the second limitation, the frequency of mother Social Smiles was also low. This is because mothers' smiles were long in duration. In future studies, a more refined coding system for mother smiles may yield more variability and a more accurate description of mother smiling responsiveness. For example, the coding system could be expanded to include smile increases and expressions of surprise.

Finally, the present study used a community sample. Research on normative samples is important to identify patterns in typical infant development. However, given the implications of these and other findings for infants who are less likely to experience highly contingent interactions with their caregivers, such as infants of depressed mothers, future research should include at-risk infants and their caregivers. In particular, it would be beneficial to evaluate whether maternal contingent responsiveness has a moderating effect on at-risk infants' social expectations and sense of self-efficacy. Such a finding would have important implications for intervention work with at-risk infants and their caregivers.

With regard to future research, an assessment of external validity for the present finding is also needed. Such assessments should include measures of social expectation and self-efficacy at other developmental time points. These measures could include attachment security at 12 months of age and self-efficacy in toddlerhood. Given that infants' early social expectations are closely related to their developing regulatory abilities (e.g., Fonagy et al., 2002; Stern, 1985), mother and infant behaviour in the Still Face procedure may be an indicator of young infants' mental health status (see also Cohn, 2003). This possibility could be investigated by assessing both the mother-infant relationship and the infants' mental health status concurrently with the Still Face procedure assessment and at other developmental time points.

In summary, the results of this study indicate that microanalytic coding of mother and infant behaviour in the Still Face procedure is a valuable technique for investigating individual differences in mother-infant interaction and infant social expectation behaviour. Mothers' contingent responsiveness to their infants, assessed in the two

minutes of face-to-face interaction during the initial Interactive phase, was predictive of infants' efforts to engage their mothers during the Still Face phase, indicating that individual differences in these important developmental achievements may be captured in a brief laboratory procedure. As hypothesized, infants of mothers who responded to them in a highly contingent manner during the initial Interaction phase made more bids to reengage their mothers during the Still Face phase. This study provides further evidence that young infants' social expectations and sense of self-efficacy are formed within their interactions with their caregivers.

TABLES

Table 1 Descriptive Statistics for Duration of Infant and Mother Behaviour across Phases

Behaviour	Interactive Phase		Still Face Phase		Reengagement Phase	
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Infant Behaviour						
Gaze to mother	n = 61 60.86 (37.39)	2.07-118.63	n = 58 15.73 (17.34)	0-57.80	n = 59 46.30 (34.68)	0-116.17
Smiles	n = 61 26.77 (20.01)	.37-82.00	n = 37 3.09 (5.15)	0-20.43	n = 57 16.22 (14.58)	0-58.73
Frowns	n = 2 .02 (.13)	0-.93	n = 2 .68 (4.79)	0-37.37	n = 6 .78 (4.68)	0-36.07
Pos. Voccs.	n = 44 2.23 (3.76)	0-22.30	n = 32 1.47 (2.75)	0-12.53	n = 44 2.92 (5.12)	0-30.97
Neg. Voccs.	n = 2 .01 (.05)	0-.30	n = 2 .34 (2.14)	0-16.17	n = 6 .56 (2.80)	0-20.97
Mother Behaviour						
Gaze to infant	n = 61 119.75 (.64)	117.53-120	n = 61 59.94 (.18)	59.07-60	n = 61 119.57 (1.21)	112.6-120
Smiles	n = 61 68.86 (24.03)	18.23-116.13	-----	-----	n = 61 65.39 (22.98)	6.7-106.73
Pos. Voccs.	n = 61 57.65 (14.98)	22.03-96.40	-----	-----	n = 55.14 (15.99)	15.0-98.43

Note. Infant and mother behaviour is while looking to other. Mothers did not frown or vocalize.

Table 2 Descriptive Statistics for Frequency of Infant and Mother Behaviour across Phases

Behaviour	Interactive Phase		Still Face Phase		Reengagement Phase	
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Infant Behaviour						
Gaze to mother	n = 61	8.64 (4.94) 2-25	n = 58	3.95 (2.64) 0-12	n = 59	7.93 (4.12) 0-20
Smiles	n = 61	8.92 (5.67) 1-24	n = 37	1.75 (2.14) 0-8	n = 57	6.1 (4.29) 0-19
Frowns	n = 2	.05 (.28) 0-2	n = 2	.16 (1.16) 0-9	n = 6	.34 (1.50) 0-10
Pos. Vocs.	n = 44	4.10 (5.49) 0-27	n = 32	2.13 (3.44) 0-14	n = 44	4.07 (5.85) 0-36
Neg. Vocs.	n = 2	.03 (.18) 0-1	n = 2	.38 (2.38) 0-18	n = 6	.64 (3.11) 0-23
Mother Behaviour						
Gaze to infant	-----	-----	-----	-----	-----	-----
Smiles	n = 61	10.8 (3.75) 4-20	-----	-----	n = 61	9.21 (3.16) 2-21
Pos. Vocs.	n = 61	56.72 (10.97) 28-80	-----	-----	n = 61	51.54 (11.52) 11-86

Note. Infant and mother behaviour is while looking to other. Mothers did not frown or vocalize.

Table 3 Means, SDs, and Ranges for Maternal Contingent Responsiveness Scores, Infant and Mother Social Smiling in the Interactive Phase, and Infant Social Bids in the Still Face Phase

Variable	<i>Mean</i>	<i>SD</i>	<i>Range</i>
Interactive Phase			
Maternal contingent responsiveness	.29	.19	0-.68
Infant social smiles	2.83	.96	1-4.9
Mother social smiles	3.23	.58	2-4.47
Still Face Phase			
Infant social bids	.97	.91	0-2.83

Note. Infant and mother social smiles scores and infant social bids scores are square root transformations.

Table 4 Correlation Matrix for Covariates, Maternal Contingent Responsiveness, and Infant Social Expectation Behaviour

Variable	1	2	3	4	5	6
1. Infant Sex						
2. Infant Age	-.06					
3. Infant social smiles	.03	.07				
4. Mother social smiles	-.09	.03	.33*			
5. Mother contingent responsiveness	.09	-.002	.65**	.42**		
6. Infant social bids	.02	-.12	.42**	.08	.51**	

* $p < .01$. ** $p < .001$.

Table 5 Results of Hierarchical Regression to Determine Whether Maternal Contingent Responsiveness Predicts Infant Social Bids in the Still Face phase

Variable	<i>B</i>	<i>SE B</i>	β	ΔR^2
Block 1				.014
Age	.001	.01	.01	
Sex	-.21	.24	-.17	
Block 2				.19**
Infant social smiles	.43	.12	.45**	
Mother social smiles	-.10	.19	-.07	
Block 3				.11*
Maternal contingent responsiveness	2.25	.75	.46*	

* $p < .01$. ** $p < .001$.

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