Four- and 7-Month-Old Infants' Sensitivities to Contingency during Face-to-Face Social Interactions

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ABSTRACT

Four- and 7-Month-Old Infants' Sensitivities
to Contingency during Face-to-Face Social Interactions

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Although infants' abilities to perceive contingencies within perceptual-cognitive contexts have been established, their sensitivities to contingency during social interactions are less well delineated. The present research consisted of three experimental and two control studies. Studies 1 and 2 confirmed that 7- and 4-month-olds could perceive and learn a contingent relationship during social adult-infant interactions. Infants in the contingent condition were reinforced through standardized tactile stimulation for gazing at an experimenter's neutral face. Yoked infants in the noncontingent condition received the same tactile stimulation regardless of their behaviours. Infants in the contingent condition learned the contingency; their level of gazing at the face was higher, and gazing away was lower, relative to infants in the noncontingent condition. Study 3 extended these results into more natural touch-alone interactions with 4- and 7-month-olds and their mothers. Mothers in the contingent condition played naturally with their infants using only touch. Mothers in the noncontingent condition imitated the touching of mothers in the contingent condition. Reliability measures and control studies confirmed that mothers in the noncontingent condition successfully imitated mothers in the contingent condition. Results revealed that 4- and 7-month-olds in the noncontingent condition displayed higher and more variable amounts of gazing away than infants in the contingent condition who exhibited lower, more stable, gazing away. Infants in the noncontingent condition displayed a linear increase in their fretting whereas infants in the contingent condition displayed low, stable amounts of fretting. During the normal period following the contingent or noncontingent interaction period, infants in the noncontingent condition spent more time fretting than infants in the contingent condition, and they exhibited a decrease in their fretting, indicating slower re-engagement with their mothers. In contrast, infants in the contingent condition displayed low, stable amounts of fretting. These results indicate that by 4 months of age infants are capable of perceiving, and respond differently to, the presence or lack of contingency during social interactions. Further, infants' motivations to engage in subsequent interactions after participating in noncontingent interactions may be compromised. Implications for infants' social awareness and the optimal contexts for their normal socio-emotional development are discussed.

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CHAPTER 1: INTRODUCTION

In the past, young infants were often considered to be unaware of their physical and social environments, and thus less able to learn from either their surroundings or their caregivers. More recently, researchers and clinicians have realized that infants, even as early as their second month of life, appear to be much more aware than was previously thought (e.g., Murray & Trevarthen, 1985; Vos, van Wulfften Palthe, De Roos, & Hopkins, 1990). Research examining infants' reactions and communicative responses to a variety of interactions and stimulation (e.g., to adults' facial, vocal and tactile expressions, Kaye & Fogel, 1980; Field, 1977; Stack & LePage, 1996; Stack & Muir, 1990, 1992; Stifter & Moyer, 1991; Symons & Moran, 1987) has furthered our understanding of young infants' abilities and involvement, particularly their abilities to communicate during social interactions.

For example, studies examining mother-infant face-to-face social interactions have documented several means by which infants are able to communicate their desires and needs (Field, 1977; Symons & Moran, 1987; Tronick & Cohn, 1989). Direction of gaze, for instance, appears to be used by infants to regulate their affect, to coordinate their behaviours with those of their mothers, and to initiate or greet mothers during social interactions (e.g., Field, 1977; Kaye & Fogel, 1980; Stifter & Moyer, 1991; Symons & Moran, 1987; Tronick & Cohn, 1989). Stifter and Moyer (1991) found that infant gaze and affect are often coordinated such that infants of 5 months of age will gaze away when they are experiencing intense positive affect. This gaze aversion was considered potential evidence that by 5 months of age infants are actively regulating the amount of positive arousal they can endure by turning themselves away from the arousing stimuli (Stifter & Moyer, 1991).

In addition to regulating affect, infant gaze has also been found to coordinate with infants' manual hand movements. Toda and Fogel (1993) proposed that developmental changes in infants' cognitive and motor abilities were associated with changes in their emotional self-regulation. These authors found that, under a mildly stressful situation, 3-month-old infants use less distal gaze away than 6-month-old infants. The gazing away appeared to be associated with negative or neutral affect, whereas moderately positive affect was associated with gazing towards their mothers' faces. Further, when they did gaze away from their mothers only the 6-month-olds directed their gaze at the object that they were manipulating with their hands, whereas the 3-month-olds appeared to show no such coordination in their gaze and hand behaviours (Toda & Fogel, 1993).

Thus, young infants appear to exhibit various forms of communication through their gazing patterns, their manual hand actions, and their affective displays. Even in newborns there exist patterns of behaviour, such as crying and limb movements, which communicate needs or desires to adults (e.g., Fogel, 1992). These behaviours appear to be somewhat coordinated in the young infant, although this coordination increases as the infant ages. Therefore, the young infant does not appear to be as helpless and uncommunicative as was once thought.

Indeed, social interactions between young infants and adults are now considered bi-directional by many researchers (e.g., Murray & Trevarthen, 1985; Vos et al., 1990), and some of this evidence suggests that infants as young as 2 months are actively participating in their social interactions through their vocalizing, gazing patterns, and affective displays (e.g., Vos et al., 1990). Although 2-month-olds are considered to play more active roles during social interactions, their proficiency in interacting with others during face-to-face interchanges is still relatively poor. For example, although 2-month-olds will respond to their mothers' greetings, they will not begin to initiate greetings or interactions themselves until they are about 3.5 months of age (Kaye & Fogel, 1980). Thus, at 2 months of age infants are only beginning to learn the skills they will need later on in life to both initiate and maintain successful interactions. While researchers have determined when infants begin to learn some of these social skills, the importance of specific components of social interactions in aiding infants' learning, such as the type or amount of stimulation, have yet to be delineated.

One component of any social interaction appears to be a high level of contingency, or coordination, between the interacting partners (e.g., Alessandri, Sullivan, & Lewis, 1990; Fogel, 1988, 1992; Hains & Muir, 1996a; Tronick & Cohn, 1989). Contingency has been defined in general terms as the perceived causal relationship between a person's behaviour and some event or behaviour following (Suomi, 1981). Infants as young as 3 months of age appear to respond more positively when some level of contingency, or causal relationship, is included during their interactions with adults (e.g., Dunham, Dunham, Hurshman, & Alexander, 1989; Hains & Muir, 1996a). For example, studies have shown that infants at 6 months of age and younger display more positive affect and are more likely to maintain attention within the experimental situation when contingency is present (e.g., Hains & Muir, 1996a; Glenn, O'Brien, Cunningham, & Schofield, 1994).

Further, 3-month-olds have been shown to be less likely to seek out or engage in social interactions if they have previously experienced interactions in which contingency was lacking (e.g., Dunham et al., 1989; Suomi, 1981). On the basis of these findings and others, contingency appears to be an important component of early (and later) social interactions. Since contingency appears to be a salient factor in social interactions for infants, the value of further examining when infants are able to perceive and respond to contingencies within social interactions, and of obtaining some indication of the importance of contingency within these early interactions, becomes clear.

Contingency Learning in the Perceptual-Cognitive Realm

In the past, the abilities of young infants to perceive, learn, and remember contingencies were studied within primarily perceptual-cognitive frameworks that contained few social aspects such as face-to-face interactions with adults (e.g., Millar, 1990; Greco, Rovee-Collier, Hayne, Griesler, & Earley, 1986; Rovee-Collier, 1984; Rovee-Collier, Patterson, & Hayne, 1985; Watson, 1984, 1985). Often these studies used an operant-learning paradigm where a specific response or behaviour from the infant was differentially reinforced by a specific stimulus. For example, when infants move their heads on a pillow, a mobile situated above their heads may rotate (contingent condition) or remain stationary (noncontingent, or extinction condition; Watson, 1972; Watson & Ramey, 1972). The change in the rate of infants' head-turning behaviours between the baseline (rate of head turns with no stimulus present), contingent, and extinction conditions is then taken as an index of infants' perceptions and reactions to the contingency. Given the above definition of contingency, if the infants in the contingent condition perceived and learned the causal relationship between their behaviour and that of the mobile, they would increase their rate of head turning relative to their baseline rate.

Use of the operant learning paradigm has provided evidence for contingency learning in human infants (e.g., Millar, 1990; Rovee-Collier et al., 1985; Watson, 1984, 1985). In studying infant memory, for example, Rovee-Collier and her colleagues found that infants of 2 to 3 months of age will learn a contingent relationship between kicking and a mobile's subsequent movement by increasing their kicking from baseline (Rovee-Collier, 1984). Interestingly, the presence of a contingent relationship between infants' behaviours and some event appears to facilitate the retention of the memory for that event (Rovee-Collier, 1984). Rapid forgetting of events seems more likely to occur when infants are tested in paradigms that do not include contingencies, whereas those paradigms and procedures that include contingent relationships can be remembered up to 1 week later (Rovee-Collier, 1984). Furthermore, by showing infants a mobile similar to the one on which they were trained, this memory can be reactivated up to 28 days after the last trial (Greco et al., 1986; Rovee-Collier, 1984; Rovee-Collier et al., 1985). Based on these studies and others it is clear that the inclusion of a contingent relationship is important for infants and enables them to retain the memory of events for longer periods of time. Thus, infants as young as 2 to 3 months of age appear to have the ability to learn and remember operant contingencies, at least within a perceptual-cognitive realm.

While an important first step, these studies examining infants' abilities to learn and remember contingencies within perceptual-cognitive paradigms do not address infants' reactions to contingencies within social interactions. Although the findings may be applicable, without specific studies designed to discover exactly what infants perceive and to what they are attuned during social interactions, that assumption that components such as contingency are important for infants' social and emotional development remains untested.

According to Fogel (1992), many of the skills developed in infancy arise during social interactions with adults. In his theory of social dynamics, Fogel (1992) maintains that the information necessary for the development of skills during infancy, even those as motorically based as walking, are all acquired within social contexts. Presuming this theoretical premise to be valid, it then follows that skills that are thought to be social in nature would largely be acquired during social interactions with others. Further, several researchers maintain that human social interactions provide infants with the most exposure to contingencies (e.g., Dunham & Dunham, 1990; Rovee-Collier, 1987; Watson, 1979). Thus, to better understand infants' sensitivities to contingency an examination of infants' responses to varying levels of contingent relationships within social interactions is warranted.

Contingency Learning in Social Situations: Indirect Evidence

Studies examining infants' responsiveness during social interactions have demonstrated their sensitivities to changes in maternal behaviours (e.g., Cohn, Campbell, Matias, & Hopkins, 1990; Field, 1987; Muir & Hains, 1993; Stack & LePage, 1996). Further, studies have demonstrated infants' active participation in the natural give-and-take that occurs during interchanges (turn-taking) as well as the coordination of their behaviours with those of their mothers during social interactions (e.g., Tronick & Cohn, 1989). These coordinated mother-infant behaviours have indicated the responsiveness of infants to social interactions, but studies have not yet adequately addressed the importance of contingency within these interactions, or systematically pursued infants' sensitivities to a lack of contingency and their subsequent reactions.

The importance of contingency in social interactions with infants has been indirectly demonstrated through studies examining infants' perceptions to nonsocial stimuli. For example, in a study examining the habituation of human infants to a series of lights and sounds, Dunham et al. (1989) found, somewhat surendipitously, that infants' performances on the habituation task depended on whether they had experienced a previous contingent or noncontingent social interaction. The 3-month-old infants had just previously participated in a study examining the effects of contingent social stimulation on infants' vocalizations (Bloom, Russell, & Wassenberg, 1987). During the contingency study infants were placed in a crib, on their backs, while a female experimenter stood over them, maintaining eye contact but not speaking to them until they vocalized. When the infants in the contingent group vocalized, the experimenter would smile, touch them on the stomach, and say "Hi (baby's name)" (Bloom et al., 1987). The noncontingent infants were matched and yoked with the contingent infants such that they each received the same reinforcement schedule as their counterpart, so that the reinforcement was delivered regardless of, and therefore was not contingent with, their vocalizations.

Although there were no differences in the total amount of vocalizations uttered by the infants in the two groups, Bloom et al. (1987) did find that infants in the contingent condition responded with more syllabic sounding vocalizations, which are more indicative of adult speech, whereas infants receiving noncontingent social stimulation exhibited more vocalic sounds, or sounds not associated with speech. This result suggests that infants perceived the difference in the interactions and that the inclusion of contingency had effects on the quality and pattern of the young infants' vocalizations.

In Dunham et al.'s (1989) subsequent study, which immediately followed Bloom et al.'s (1987), it was found that if the infants had previously experienced a contingent social interaction they showed longer fixation towards, and less gaze away from, the habituation stimuli than those infants who had been in the noncontingent group. This unexpected finding lead the researchers to conclude that the infants in the noncontingent group were subjecting themselves to a lower amount, or reduced density, of nonsocial stimulation than infants in the contingent group. Interestingly, the habituation stimuli were also contingent on infants' behaviours; the lights and sounds would come on only when infants fixated towards the centre of the screen. Thus, infants appeared to reduce the density of nonsocial *contingent* stimulation when they had previously received social, noncontingent stimulation.

Dunham et al. (1989) discussed their results in terms of a contingency hypothesis, which consists of two assumptions included in most theories of contingency; (a) infants exposed to contingent stimulation will exhibit positive affect and increased motivation and sensitivity to future contingent experiences, while (b) infants exposed to noncontingent stimulation will exhibit negative affect and decreased motivation and sensitivity to future contingencies (e.g., Lamb, 1981; Suomi, 1981; Watson, 1985). Dunham et al.'s (1989) results appeared to support these assumptions in that infants who had previously received noncontingent stimulation appeared less motivated to attend to future contingent stimulation. Thus, the inclusion of contingency appears to be important for infants' motivation to seek out contingent experiences, and possibly for their future perceptions of contingency.

Although Dunham et al. (1989) did not examine the affective responding of the infants, studies examining infant displays of affect during learning in operant-learning conditioning paradigms have found that differences exist in infants' affective responding during contingent and noncontingent conditions (e.g., Alessandri et al., 1990; Bloom et al., 1987; Millar, 1988; Sullivan & Lewis, 1989). Most of these studies have found that positive affect is associated with contingent experiences, whereas neutral or negative affect is associated with noncontingent experiences. Indeed, Watson coined the term game hypothesis whereby infants, upon discovering a contingent relationship between their behaviour and that of another, would begin to smile and coo, even to nonsocial stimuli (Watson, 1972; Watson & Ramey, 1972). These reactions, according to Watson, indicated that the infants were perceiving the nonsocial object as social, based on the contingent relationship that they had learned. Thus, according to Watson, the initial perception of a contingent relationship between infants' actions and the events that follow is a method for infants to organize their world into social versus nonsocial objects. The infant is therefore responding to a cognitive appraisal of the situation, and inferring from that appraisal (Watson, 1972).

Although the game hypothesis is not overwhelmingly accepted, the idea of the infant smile as reflective of a cognitive or perceptual process has been adopted by many (e.g., Murray & Trevarthen, 1985; Papousek, Papousek, & Koester, 1986; Zelazo, 1972; Zelazo & Komer, 1971). To develop a more complete understanding of the impact of contingency and, more importantly, the lack of contingency, on the social development of the young infant, an examination of the types and patterns of emotional responses of infants to contingent and noncontingent situations would appear warranted.

Sullivan and Lewis (1989) examined the types and patterns of different emotional responding during learning by 4- and 6-month-old infants. Using a paradigm in which an arm-pull would elicit a slide of an infant's smiling face accompanied by the theme song from Sesame Street, the researchers first examined the learning curves of the infants. They included matched contingent and noncontingent groups in their study, and they found that infants in the two groups displayed different arm-pull response curves. Infants in the contingent group exhibited an increase to a maximum rate of arm-pulls that was greater than their baseline, whereas infants in the noncontingent group did not exhibit any systematic changes in their rates of arm-pulls, nor did they exceed their baseline for this behaviour. Thus, Sullivan and Lewis concluded that infants in the contingent condition learned the relationship. They then examined the types of emotional responding that occurred throughout the learning process. When analysing the patterns of affective displays over the learning curve, different trends in infants' emotional expressions were found for the contingent and the noncontingent groups. Emotions such as excitement and enjoyment (indicated by intense interest and smiling) were shown to increase throughout the sessions in the contingent, but not in the noncontingent subjects. Fear responses (indicated by lowered eyebrows and grimacing) were shown to decrease in the contingent subjects, but increase in the noncontingent subjects. The patterns of fear responses might indicate that all the infants were initially afraid of the sudden appearance of the stimuli, however, this fear decreased and turned to enjoyment for the contingent group once they had learned the task, whereas the noncontingent infants may have been reacting to the unpredictability of the stimuli (Sullivan & Lewis, 1989).

Millar (1988) also noted differential affective displays when he examined 7- and 10-month-old infants' social responses during a contingency learning paradigm. In Millar's study, when infants touched a cylinder manipulandum their mothers' faces appeared from behind a curtain. The 10-month-old infants learned the contingency by showing both an increase in responding from baseline and higher rates of responding during the contingent compared to the noncontingent condition. While the 7-month-olds showed more responding during the contingent condition, this was the case only when compared to the noncontingent condition. Thus, the differential responding from the 7-month-old infants appeared to be due to a decrease in responding during the noncontingent condition, rather than an increase in responding over baseline during the contingent condition. Differences were also found in the socio-affective responses between the two age groups, and, overall, the predicted responses were found for the 10-month-olds, but not for the 7-month-olds (Millar, 1988). The 10-month-old infants exhibited more positive social responses (i.e., smiling and vocalizing) during the contingent than the noncontingent condition, whereas the responses from the 7-month-old infants were more variable. This age difference in responding was hypothesized by Millar to be attributable to the fact that the younger infants did not adequately understand the means/ends implications in the causal sequences.

It is surprising that the 7-month-olds in this study did not learn the contingency given that infants even younger have learned contingencies in a similar context (e.g., Sullivan & Lewis, 1989). However, the fact that the infants' reinforced responses were nonsocial in nature and yet the reinforcing stimulus was social may have confused the younger infants. This might have made learning more difficult to achieve, and thus their subsequent responses to the stimuli were more variable (Millar, 1988). It may be that the 7-month-old infants would have shown reliable increases in responding and reliable affective displays to the different conditions had the paradigm included only social or only nonsocial stimuli and responses (Collis, 1981).

Studies that include only social responses and reinforcers are relatively rare. As discussed above, a more direct examination of infants' perceptions of contingencies within social contexts is warranted. Only then can the importance of contingency during social interactions with infants be evaluated, and the effects of contingency on infants' social responses, such as gaze and affect, during current and subsequent interactions be determined.

Although contingency in standard face-to-face interactions has not been extensively examined, studies in which contingency was absent from these interactions can shed some insight on this issue. For example, Tronick, Als, Adamson, Wise, and Brazelton (1978) examined young infants' reactions to the still-face (SF) paradigm. This paradigm consists of three face-to-face interaction periods in which mothers are asked to interact with their infants normally for the first and third periods, but to remain silent with a neutral facial expression and not to touch their infants during the second period. Thus, the first and last periods presumably involve natural contingency, whereas the second period involves no contingent interaction at all. It is during this SF period that infants' reactions to perturbations in typical face-to-face interactions have been documented (e.g., Mayes & Carter, 1990; Tronick et al., 1978). During the SF period all stimulation and contingency is removed from the interaction, and infants generally respond with decreased positive affect, some negative affect, and increased gaze away from the interaction (Tronick et al., 1978). Examining studies including the SF period might further elucidate whether infants are responding to the lack of stimulation, or the lack of contingency, or both.

Murray and Trevarthen (1985) included a SF period in their study that examined infants' differential emotion-regulation strategies during mother-infant interactions in which infants' expectations were violated. Mothers were asked to participate in several perturbations of the face-to-face procedure with their 6- to 12-week-old infants. Along with a SF period, a televised replay period was included during which the responses of the mothers during normal interactions with their infants were delayed by 30 s, thus effectively removing any contingencies between the mothers' and infants' behaviours. Their results revealed that the young infants exhibited positive affect during the normal period and negative affect during both the SF and the 30-s delay interactions. These latter interactions were considered to be lacking in contingency between the mothers' and infants' behaviours, although it was difficult to tease apart the lack of stimulation and the lack of contingency during the SF period. The negative reactions of the infants to the 30-

s delay, however, suggest that contingent relationships during social interactions are important for infants' positive responsiveness (Murray & Trevarthen, 1985).

While this study was an important first step in understanding the role of contingency during adult-infant social interactions, it remains unclear to what components of the interactions the infants were reacting (Murray & Trevarthen, 1985). For example, mothers were displayed to their infants over a video monitor and thus were not present in the room during that period. Thus, important aspects of the mother-infant interaction (e.g., touch), were missing. It could be that the infants were responding to the unusual interaction situation, as well as, or instead of, the lack of contingency, during the 30-s delay. As suggested by Marian, Neisser, and Rochat (in press), it is possible that a televised display of mothers interacting with their infants is not an effective procedure during which the sensitivity of infants to changes in their mothers' behaviours can be demonstrated.

In a more recent study with older infants, Hains and Muir (1996a) used televised displays of mothers interacting with their 5-month-olds throughout their study. Similar to other studies (e.g., Marian et al., in press), Hains and Muir did not find differences in infants' responding that would suggest they were sensitive to the lack of contingency during the replay presentation of their mothers. In contrast, Bigelow, MacLean, and MacDonald (1996), using a similar procedure to that of Hains and Muir, found that the 4-, 6-, and 8-month-old infants in their study responded to the noncontingent (televised replay) interaction with a decrease both in attention and smiling. The results from Bigelow et al.'s study suggested that infants, at least older than 12 weeks, were sensitive to the difference between contingent and noncontingent televised interactions with their mothers.

Although Bigelow et al.'s (1996) findings are certainly intriguing, the discrepant results between their study and Hains and Muir's (1996) examination of infants' responses to televised replays of their mothers are difficult to consolidate. The 4-month-old infants in Bigelow et al.'s study appeared sensitive to the noncontingent televised replay of their mothers such that they decreased attention and smiling, whereas the older, 5-month-old infants in Hains and Muir's (1996) study did not exhibit this sensitivity. Thus, it is still not clear whether and when infants are sensitive to contingencies, or the lack of, during social contexts. Consequently, studies directly examining infants' responses to a lack of contingency remain necessary to elucidate further the role contingency plays during social interactions. To this end, use of the operant-learning paradigm within more ecologically-valid social contexts is warranted.

Contingency Learning in Social Situations: Direct Evidence

To date, operant-learning paradigms that use social stimuli and social responses to address contingency have been rare. Recently, however, several studies directly examining infants' abilities to perceive social contingencies, including both social responses and social reinforcers, have been conducted. For example, Reeve, Reeve, and Poulson (1993) examined 86- to 119-day-old infants' abilities to learn social contingencies when a delay was presented between their responses and the reinforcing stimulus. Both the response required from infants (vocalizations) and the reinforcing stimuli (mothers' interactive face, voice, and touching behaviours) were social in nature.

The researchers found that infants were still able to learn the contingencies when there was a 5-s delay between the response and reinforcer.

These results are intriguing given recent research by Millar (1990) that suggests that 6- to 8-month-old infants are unable to learn a relationship between their behaviour and that of a reinforcer if there is a 3-s delay between the two events. It is worthwhile to note, however, that both the reinforcer and the reinforced behaviour in Millar's study were nonsocial in nature. Thus, the discrepancy between Millar's and Reeve et al.'s (1993) studies leads one to suggest that infants are better able to learn during social rather than nonsocial learning contexts. It is also possible, however, that the reinforcing stimuli (the infants' mothers) in Reeve et al.'s study were more salient to the infants, thus maintaining their interest and attention, and thereby engendering learning. In any case, Reeve et al.'s results suggest that young infants are capable of perceiving and learning contingencies in social contexts.

Although Reeve et al.'s (1993) study provided interesting information about infants' abilities to learn contingent relationships between their social behaviours and those of another, there remain some difficulties with the social aspect of the study. For example, the mothers were not visible to their infants until the infants vocalized. Mothers were seated behind a blind, and when the infants vocalized, mothers would open the blind and interact with them for a specific amount of time. Thus, the procedure, although including social responses and reinforcers, was somewhat removed from a more natural social interaction in which the mother is visibly present at all times. Studies using more ecologically valid settings are required to establish clearly infants' capabilities to perceive social contingencies.

One way to improve the ecological validity of contingency procedures is to make use of the SF paradigm developed by Tronick et al. (1978). As discussed above, during the SF period all stimulation and contingency is removed from the interaction and infants generally respond with decreased positive affect, neutral to negative affect, and increased gaze away from the interaction (Mayes & Carter, 1990; Tronick et al., 1978). By using this type of noncontingent interaction period an operant-learning paradigm can be devised within a social face-to-face situation in which the abilities of infants to perceive and learn social contingencies, and their reactions to the lack of contingency in a social context, can be more directly examined.

For example, Peláez-Nogueras et al. (1996) used the SF procedure to set up an operant-learning paradigm designed to examine infants' preferences for social interactions in which touch was included versus those in which touch was absent. In their paradigm, whenever infants made eye-contact with a female experimenter, the experimenter would respond contingently by breaking her still face and silence and responding socially to the infant (i.e., simultaneously vocalizing and smiling, and sometimes touching). Differences in infants' response levels (i.e., amount of eye contact towards the experimenter) were compared during periods in which the experimenter would respond contingently with her face and voice, and when she would respond with her face, voice, and touch. By noting that infants looked more at the experimenter during those conditions when touch was included as part of the reinforcing stimuli relative to when touch was not included, the researchers concluded that infants were showing a preference for stimuli that included tactile stimulation. Although Peláez-Nogueras et al.'s study did not directly examine infants' abilities to learn a contingent relationship, use of the SF procedure within an operant-learning paradigm was demonstrated.

Importance of Touch in Early Interactions

The Peláez-Nogueras et al. (1996) study is one of only a few studies that include a direct examination of the effects of tactile stimulation on infants' social and emotional responses. In general, research examining infants' responses to face-to-face interactions with their mothers has primarily focused on the more distal features of the mothers' behaviours, such as their facial and vocal expressions, with only some research directly examining the effects of mothers' tactile expressions with their infants (e.g., Stack & LePage, 1996; Stack & Muir, 1990, 1992). Further, many contingency studies have used more distal responses from adults (such as primarily vocal expressions; e.g., Reeve et al., 1993) as the social reinforcers rather than the more proximal modality of touch.

While the distal modalities are indeed important during social interactions, the coordinated behaviours and actions that occur during social interactions between adults and infants involve multiple modalities (e.g., Weinberg & Tronick, 1994). The proximal, nonverbal, tactile modality is also a large part of the repertoire of adult social behaviours with their infants (Koester, Papousek, & Papousek, 1989). Placing an emphasis on only one or two of the communicative modalities, such as the adults' facial and vocal expressions, to the exclusion of others, such as tactile-gestural behaviour, imparts an incomplete picture. More information is needed about adults' use of tactile stimulation when interacting with infants in various contexts.

Recent studies have more closely examined the role touch may play in adult-infant face-to-face social interactions by examining infants' reactions to a SF period in which touch is included (Stack & Muir, 1990, 1992). Through various systematic manipulations it has been demonstrated that, not only can maternal touch modulate infant reactions during a standard SF period, but when mothers were asked to obtain specific responses from their infants, using only touch, they were successful (Stack & LePage, 1996). For example, when mothers were asked to obtain the most smiling from their infants, using touch alone, they obtained more smiling than in other SF with touch periods.

In a subsequent study examining infant's reactions to touch-alone interaction periods infants were again found to respond differently, in terms of their gazing and affect, depending on instructions given to their mothers (Stack & Arnold, in press). Stack and Arnold included an examination of gestural hand movements in their study and found that mothers used gestural hand movements, along with touch, frequently during the touch-alone interactions with their infants. These authors then concluded that maternal touch and gestural behaviours are able to maintain communication with infants even when used in isolation (Stack & Arnold, in press).

From this study it is clear that mothers add hand gestures to their touch-alone interactions with their infants. For the purposes of clarity and brevity, however, although gestural movements likely occur, the interaction periods during which the adults use only their hands to communicate with infants in the following text will be labelled 'touch-alone'.

Although the different types of maternal hand gestures have not been thoroughly explored, recently the different types of touches mothers use with their infants have been examined more comprehensively. In a subsequent analysis of the study by Stack and LePage (1996), the different qualities, or types, of touch used by the mothers were examined. It appeared that mothers varied the types of touch they used with their infants when they were asked to obtain different responses (Stack, LePage, Hains, & Muir, 1996). For example, during the period in which mothers were asked to obtain maximum smiling from their infants, mothers tended to use more kinesthetic types of touch (e.g., moving the infants' limbs), whereas they tended to use softer types of touch (e.g., stroking) during periods in which they were merely told they may touch their infants (Stack et al., 1996). Thus, maternal touch appears to be a versatile, dynamic modality with which mothers are able to communicate to their infants.

Finally, a sequential analysis conducted on infant and mother responses in Stack and LePage's (1996) study revealed that there was a reliable sequence of mother-infant behaviours that indicated some level of predictability during these touch-only interactions (LePage & Stack, 1998). The reliable sequences of mother-infant behaviours, however, were only present for the SF with touch periods in which mothers were asked to play with their infants, or to get the maximum smiling from their infants. The period in which mothers were constrained in their touching by being instructed to touch their infants in only one area of the body did not show the predictable sequencing of behaviours (LePage & Stack, 1998). Examinations of this period revealed that mothers also tended to use only one type of touch with their infants, and there was evidence of greater amounts of infant fretting (Stack & LePage, 1996). Therefore, it was suggested that contingency was lacking in this period, an interpretation which the sequential analyses supported.

That the sequential analyses supported the hypothesis that contingency was lacking during the period in which mothers touched only one area of their infants' bodies indicates the sensitivity of these analyses in confirming the presence of predictability between mother-infant behaviours. Further, the sequential analyses confirmed that standard SF with touch interactions, where mothers' behaviours are not constrained, appear to include a similar amount of contingency as those interactions where mothers are able to use all modalities of communication with their infants (LePage & Stack, 1998). This predictability, coupled with the apparent high level of communication between the mothers and infants during touch-alone interactions, implies that contingency was present during these SF with touch periods. Therefore, a study in which infants' responses to contingent or noncontingent social interactions were examined could make use of these SF with touch interactions.

Sensitivity to Contingency through Touch

While infants at young ages do appear able to perceive contingencies, and they are sensitive to their mothers' tactile behaviours, few studies have examined both of these capabilities within social contexts. Peláez-Nogueras et al.'s (1996) results suggest that infants are able to learn contingencies within social settings, however, only over an extended period of time. In addition, there was no comparison with a noncontingent group or condition to examine if infants' responses were indeed elicited by the reinforced response in their study. Although an ABAB design was used, there were no baseline measures of infant gazing at experimenter's face, and thus it is unclear whether the infants were indeed gazing more at the experimenter's face during either condition than they would have normally. Thus, it remains to be determined whether the infants did indeed learn the contingencies presented to them.

Furthermore, the infants in Peláez-Nogueras et al.'s (1996) study may have been responding to something other than the tactile stimulation during the conditions where touch was included. Both vocal and facial expressions of the experimenter were included as reinforcers throughout the study. Touch was never used alone, and as a result the importance of touch cannot be fully delineated. It is possible that touch may have merely increased the salience of these conditions, for example, as there might have been increased action (e.g., possibly the experimenter moved forward to touch the infants), as well as an increased amount of stimulation overall. Thus, infants could have been reacting to the increase in stimulation, and not necessarily to the touch or the contingency presented to them. As there were no baseline scores to indicate whether the infants were gazing at the experimenter for a longer period of time during the contingent conditions than during a normal SF interaction, it is difficult to establish exactly why the infants were gazing more at the experimenter. Consequently, it has yet to be adequately demonstrated that infants are able to learn, and are sensitive to, contingencies under more subtle, social circumstances. Further, the role of touch in these interactions remains unclear. It remains to be determined whether touch when used by itself is capable of eliciting learning and accompanying positive social responses from infants.

Therefore, while it appears that touch is maintaining some level of contingency during adult-infant face-to-face interactions, this specific hypothesis has not been directly examined. Given the importance of the tactile modality and contingency during early adult-infant interactions, studies examining both components would add substantially to our current understanding of infants' sensitivities during social interactions with adults.

The Present Research: General Objectives

In the present set of studies 4- and 7-month-old infants' responses during adult-infant social interactions with and without the inclusion of contingency were examined. In each study, both the infants' reinforced responses and the adults' reinforcing behaviours were considered social in nature during interactions that included varying levels of contingency. Moreover, all of this was accomplished within the tactile modality alone to establish further the role touch can play during adult-infant social interactions. By examining infants' reactions during these different interactions, such as their gazing and patterns of affect, infants' abilities to learn and their sensitivities to contingency, as well as the importance of contingency for the young infant, were addressed. Further, by examining infants of different ages within the same interactions a developmental basis for infants' perceptions of, and sensitivities to, contingency, as well as the importance of contingent relationships during social interactions, was enabled.

The first objective, achieved in the first two studies, was to examine infants' abilities to learn a contingent relationship between their behaviour and that of an adult's touch within a social interaction. As infant gaze has been found to be an important form of communication for the young infant (e.g., Toda & Fogel, 1993), this behaviour was chosen as the reinforced social response. Therefore, during the first two studies, infants in the contingent condition were required to maintain their gaze toward a still-faced female experimenter's face to receive social, tactile stimulation. An examination of infants' abilities to make the connection between their behaviour and that of an adult's within the social context was thus achieved.

The abilities of infants to perceive a lack of contingency were also demonstrated by examining the infants' gazing away from the experimental situation. Gazing away has been linked with various infant states, such as the regulation of positive affect and distress (e.g., Stifter & Moyer, 1991; Tronick & Cohn, 1989). It was of interest to observe whether infants in the present studies displayed higher amounts of gazing away when presented with a social interaction in which no contingency was present. Higher amounts of gazing away during noncontingent interactions would indicate infants' sensitivities to the lack of contingency, and the importance of contingency in maintaining infant gaze within the social situation.

The second objective, also achieved in Studies 1 and 2, was to establish further the importance of contingency by examining the trends in infant affect during the social contingent and noncontingent interactions. An examination of the trends in infant affect throughout the social interchanges provided an indication of how infants respond emotionally when they are given the chance to learn a relationship between their behaviour and that of another. Much of the previous research examining infants' affect simply compared more global measures such as the frequency or duration of infant affect between the contingent and noncontingent groups (e.g., Millar, 1988). In the present study, however, it was decided to follow the example of Sullivan and Lewis (1989) and examine the patterns, or trends, of affective displays that accompanied the learning. If infants responded differently during the interactions, for example by displaying a linear increase in positive affect during contingent interactions and/or a linear increase in negative affect during noncontingent interactions, evidence of infants' affective patterns that accompany their gazing during these social interactions, and their sensitivity to contingent and noncontingent social events, would be provided.

Further, if there were overall differences in the amount of affect displayed between infants receiving contingent interactions and those receiving noncontingent interactions, the relative importance of one type of interaction over another would be demonstrated. If the contingent interactions were more positive (or less negative) than the noncontingent interactions, it might be concluded that contingency serves an important role in social interactions for young infants. While it is possible that infants can continue learning while displaying negative affect during interactions (Fogel, 1992), it is more likely that infants will learn more during positive social interactions, when their levels of attention and positive affect are high. Thus, if positive affect is maintained or increased during contingent interactions (or negative affect is reduced) infants will be more susceptible to learning new social skills, such as vocalic speech patterns, within an interaction that is contingent on their behaviours. In summary, the first objective was to discover if infants could learn contingencies within a social interaction, whereas the second objective was designed to establish the patterns of affect that accompany this learning.

The third objective was to bring the knowledge obtained from the first two studies into a more ecologically valid social interaction in which infants were presented with a more elaborate and complex tactile social interaction. The first two studies were designed to answer the question of whether infants could learn a simple contingency presented within a social context, and the patterns of affect that accompanied that learning. Although an important first step, it was of further interest to establish infants' sensitivities to contingency by examining their responses during more natural social interactions from which contingency was then removed. By making use of the SF with touch paradigm this more ecologically-valid question of infants' reactions to the presence or lack of contingency during more natural social interactions could be answered without adding potentially extraneous confounds such as television monitors on which the adults are displayed (e.g., Bigelow et al., 1996; Hains & Muir, 1996a; Marian et al., in press; Murray & Trevarthen, 1985). Therefore, during Study 3, infants participated in a SF with touch interaction with their mothers who were asked to play with their infants using only touch. Mothers were not constrained as to how they played with their infants, and infants were thus receiving varied, although assumed naturally contingent (LePage & Stack, 1998), tactile stimulation. The responses of those infants receiving noncontingent interactions from their mothers (who were imitating a contingent mother) were compared with the infants receiving contingent interactions, and an overall demonstration of infants' reactions to these different situations was obtained. Thus, Study 3 was designed to bring us closer to an understanding of infants' abilities to perceive, and be sensitive to, the presence or lack of contingency during more natural face-to-face social interactions.

A fourth objective, evaluated during all three studies, was to demonstrate further the importance of contingency in social interactions by examining a normal interaction (where face, voice, and touch were used by the adult to play normally with the infant) following the contingent or noncontingent interaction. Given the results from Dunham et al.'s (1989) study, infants' reactions to contingent situations may vary depending on whether they previously received a contingent or noncontingent interaction. Although in Dunham et al.'s study infants' responses were examined during a nonsocial situation, the present set of studies was designed to determine infants' reactions to normal social interactions after they had received social contingent or noncontingent interactions in the tactile modality alone. In this way, the importance of contingency during social interactions on infants' willingness to seek out and participate in future social interactions was illustrated.

A fifth objective, again to be achieved in all three of the present studies, was to examine further the effectiveness of the tactile modality in maintaining communication between infants and adults. By using touch-alone social interactions in which the levels of contingency were varied, evidence for the capacity of adult touch to communicate to infants was extended. Further, by using only one modality, touch, during the contingent or noncontingent social interactions, the effects of contingency could be better isolated. Therefore, the confounds of more than one communicative modality, for example, in Peláez-Nogueras et al.'s (1996) study, were controlled for in the present series of studies, and the effects of contingency and of touch during social interactions were more directly demonstrated.

If infants responded differently during contingent versus noncontingent touch-alone social interactions, as well as during the following normal period, it would suggest that: (a) infants can learn specific contingent relationships between their behaviours and those of an adult within a social context, (b) infants are sensitive to and can perceive contingencies, or the lack thereof, within more natural social, touch-alone interactions with their mothers, (c) the inclusion of contingency during social interactions is important to infants, and (d) touch, even when used alone, is capable of communicating information, such as varying levels of contingency, to infants.

The Studies

These five objectives were achieved through three studies where infants participated in several SF with touch periods, which varied in their levels of contingent stimulation. In Study 1, 7-month-old infants' abilities to learn a simple contingency within a social context with a tactile reinforcer were examined. Based on past research infants at 7 months of age were expected to be able to learn simple contingencies (e.g., Rovee-Collier et al., 1985) and thus it was important to establish if they could learn contingencies during social interactions, and examine their affective responses while learning.

After establishing the learning capabilities and affective patterns of 7-month-old infants, Study 2 examined infants of 4 months of age using the identical procedure as in Study 1 to determine if infants younger than 7 months were able to learn the contingencies presented to them. At 4 months of age it has been documented that infants are able to learn contingencies presented within a more perceptual-cognitive context (e.g., Sullivan & Lewis, 1989) and it is also at this age that infants show more observable displays of affect (Lewis, Alessandri, & Sullivan, 1990). Therefore, an examination of these younger infants' abilities to learn contingencies within a social context, and a measurement of their affective responding during the conditions, provided information as to when and how infants are beginning to learn and respond differentially to varying levels of contingencies within social contexts.

Study 3 combined and extended the results from Studies 1 and 2 by examining both 4- and 7-month-old infants' responses during social interactions that varied in their levels of contingency. The objectives of this study were to bring the contingent and noncontingent touch-alone periods in the first two studies into a more naturalistic setting by having mothers play (naturally) with their infants using only touch, while asking other mothers to imitate the actions of the contingent mothers. While Studies 1 and 2 were important in establishing infants' abilities to *learn* a specific tactile contingency within a social context, the third study was important in demonstrating 4- and 7-month-old infants' sensitivities and their ability to *perceive* the presence or lack of contingency during a more natural social interaction. Thus, infants' overall social behaviours in response to their mothers' responsive or contingent tactile behaviours, as well as infants' social responses to their mothers' unresponsive or noncontingent touching, could be compared and established.

To establish potential extraneous effects of the manipulations on infants' responses in Study 3, two control studies were conducted. These control studies, described in Chapter 4, demonstrated Study 3's generalizability to face-to-face adult-infant interactions, and ensured that the only difference between the two conditions during the touch-alone period in Study 3 was the amount of contingency between the mothers' and infants' behaviours. Therefore, the infants' responses to the contingent or noncontingent interactions could be attributed to the presence or lack of contingency, and not to other variables, such as differences in the mothers' behaviours.

Summary

In the present series of studies the abilities of 4- and 7-month-old infants to perceive and learn contingencies within that context of social interactions were delineated. Further, infants' differential reactions and sensitivities to contingent versus noncontingent social interactions were revealed, extending present knowledge of the role that contingent relationships play in the development of infants' social and emotional responses. Implications for the lack of contingency in relation to other aspects of infant social and emotional development (e.g., infant attachment to social caregivers; Cohn, Campbell, & Ross, 1991), were thus further extended. Finally, additional information about the communicative capacity of the tactile modality was obtained.

CHAPTER 2: STUDIES 1 AND 2

Objectives one, two, four, and five of the present series of studies were addressed in Studies 1 and 2. Study 1 was an examination of the abilities of 7-month-old infants to learn a specific contingency between their behaviour and that of a female experimenter during a social interaction. Infants in the contingent condition were reinforced for maintaining their gaze towards the still-faced experimenter's face through standardized tactile stimulation. Infants in the noncontingent condition were yoked to infants in the contingent condition such that they received the same tactile stimulation at the same time during the period regardless of where they were gazing. An examination of infants' gazing at the experimenter's face or away from the experimental situation established their capacity to learn the contingency, thus addressing the first objective. The second objective was addressed through an examination of the patterns or trends of the infants' affect during the contingent or noncontingent social interactions with the adult. Infants' gazing and affect were further examined in a normal interaction period occurring after the touch-alone period to establish their responses during interactions following either contingent or noncontingent interactions, thus addressing the fourth objective. Finally, by using only touch in communicating the contingency, or lack thereof, to the infants, the functional capacities of touch during social adult-infant interactions were further defined, thus addressing objective five.

Study 2 addressed the same objectives as Study 1, using 4-month-old infants. Thus, a perspective on the abilities of younger infants was obtained, and an indication of when infants are able to learn contingencies during social interactions, and their accompanying affective displays to contingent versus noncontingent interactions, was acquired.

Study 1

Study 1 was designed to examine 7-month-old infants' abilities to learn contingencies within a social context. At this age infants are capable of learning various contingencies (e.g., Greco et al., 1986; Rovee-Collier et al., 1985), however, it has yet to be established whether they are able to learn a contingent relationship during a social interaction. It would also be interesting to establish whether infants at 7 months of age could learn social contingencies given the difficulty they appeared to have in learning the contingencies presented to them in Millar's (1988) study, where a nonsocial response was reinforced with social stimuli. Since, in the present study, both the required response and the reinforcing stimuli were considered social in nature, 7-month-olds were hypothesized to demonstrate the learning that was expected to exist, given previous studies (e.g., Reeve et al., 1993; Rovee-Collier et al., 1985). Thus, the first objective was to determine whether infants at this age could learn contingencies in a purely social context.

Infants participated in three face-to-face interaction periods with a female experimenter. The first (greeting) and third (reunion) periods involved the experimenter playing normally with the infants, using her face, voice and touch. During the second period the experimenter remained still faced and silent, and used only touch when interacting with the infants (manipulation period). During the manipulation period, when infants in the contingent condition (CON) directed their gaze towards the experimenter's still face, the experimenter moved their legs up and down in a standard scissor-kick fashion. Infants in the noncontingent condition (NON) received the same amount and type of tactile stimulation from the experimenter as infants in the CON condition, but this stimulation was not contingent on their behaviours. A third condition, during which the still-faced and silent experimenter played contingently with the infants using only touch (SF+T), as the mothers did in Stack and LePage's (1996) original study, was included as an additional comparison group. If infants in the CON condition could learn the contingent relationship presented to them it was expected that they would gaze more at the experimenter's face relative to the gazing at the face exhibited by infants in either the NON or the SF+T conditions during the manipulation period. This was the primary hypothesis for Study 1.

A second hypothesis, also supporting the premise that infants could learn the contingent relationship, and indicating their sensitivity to a lack of contingency, was that infants in the NON condition would gaze away from the experimental situation, which included the experimenter, infant seat, and infant's self (see Dependent Measures and Coding section below) more than infants in the CON and the SF+T conditions during the manipulation period. The argument for this hypothesis was that by including contingency in the touch-alone social interactions infants' interest in the interaction would be maintained. This hypothesis was based in part on studies examining infants' responses to habituation paradigms during which stimuli were repeatedly presented to infants (not contingent on their behaviour). During these paradigms, infants gradually decreased their attention towards the stimulus indicating that they had habituated and were now looking elsewhere for stimulation (e.g., Kisilevsky & Muir, 1984; Millar & Weir, 1992; Stack & Bennett, 1990).

In addition to these habituation studies, Hains and Muir (1996a) revealed that 5-

month-old infants receiving noncontingent stimulation averted their gaze more quickly from, and gazed less overall towards, the stimulation relative to infants in the contingent group. Because the stimulation for the infants in the NON condition in the present study was the same repetitious movement of their legs throughout the period, and it was not contingent on their behaviours, it was assumed that more gaze aversion would occur for these infants during the manipulation period. Conversely, if infants in the CON condition learned the contingent relationship, they would exhibit less gazing away from the experimental situation, even though they were receiving the same repetitive stimulation as infants in the NON condition. This lower amount of gazing away from the experimental situation would indicate the importance of contingency in maintaining infant interest within social interactions.

The second objective for Study 1 was to further assess the importance of contingency for 7-month-old infants by examining the patterns, or trends, of affective responses that accompanied their gazing during the manipulation period. While examining overall durations of infants' behaviours provides a more global measure of their reactions, an examination of the trends in infants' affect enables a more sensitive measure of the fluctuations in their responses throughout the social interactions. Because most studies examining infants' affect during contingency learning have not included an analysis for trends of affect accompanying learning, the hypotheses generated were more general. Overall, if infants in the CON condition learned the contingent relationship presented to them (e.g., as evident in their durations of gazing at the experimenter's face) it was hypothesized, based on literature suggesting infants' positive responses during contingency learning (e.g., Dunham et al., 1989; Lamb, 1981; Suomi, 1981; Watson, 1985), that they would show a gradual increase in smiling and a low, stable amount of fretting during the manipulation period. In contrast, infants receiving a noncontingent interaction were hypothesized to show a decrease in smiling and an increase in fretting throughout the manipulation period. These trends in smiling and fretting might indicate infants' dislike of an interaction that does not include high amounts of contingency. Infants in the SF+T condition, however, based on research examining infants' responses during touch-alone interactions (e.g., Stack & LePage, 1996), were expected to vary in their levels of smiling throughout the manipulation period, as they responded to the different touches they were receiving from the experimenter. They were also expected to exhibit low, stable levels of fretting during the manipulation period. An examination of the different trends in affective responding between the three conditions would further elucidate infants' reactions to social interactions that include or do not include contingent relationships between their behaviour and that of the adult, as well as their affective responses during learning experiences.

The third objective of Study 1 was to explore the importance of contingency in social interactions on infants' responses to future social interactions. It was hypothesized that having had a previous noncontingent interaction infants would be less willing to re-engage in a new contingent interaction with the experimenter (Dunham et al., 1989; Glenn et al., 1994), again as measured by their levels of gazing and patterns of affect. Specifically, it was hypothesized that those infants who had previously received a contingent or SF+T interaction would spend more time gazing at the experimenter's face and less time gazing away than those infants who had previously received a noncontingent interaction, as they would still be interested and involved in the interaction with the experimenter. In contrast, infants in the NON condition might show less gazing at the face and more gaze away as, based on theories of contingency summed up in the contingency hypothesis (Dunham et al., 1989), the previous noncontingent interaction might influence them to be less willing to engage in subsequent interactions. Furthermore, infants in the NON condition were hypothesized to exhibit higher amounts of fretting than infants in the CON and SF+T conditions, which might gradually decrease somewhat throughout the period, whereas their smiling was anticipated to be lower with a possible gradual increase as the infants slowly re-engaged with the now-contingent experimenter. Infants in the CON and SF+T conditions, however, were expected to show lower and stable levels of fretting, with higher and stable levels of smiling throughout the reunion period, as they would still be engaged with the experimenter. These trends in the infants' gazing and affective responses would be a further indication of the importance of contingency for 7-month-olds during social interactions. If infants in the NON condition exhibited the hypothesized gazing away and fretting during the manipulation and reunion periods, this might indicate their sensitivities to a lack of contingency, and the negative impact of a previous noncontingent interaction on 7-month-olds' motivations to engage in future social interactions, at least with the same individual.

Once an examination of infants' responses to contingent and noncontingent social interactions had been conducted, the fourth objective of Study 1 was accomplished. This final objective was to extend results indicating that adults are able to maintain communication with infants in touch-alone interactions by using the tactile modality as the social reinforcer for the infants. If infants were able to learn the contingencies presented to them, even though they were delivered through the tactile modality alone, the ability of touch towards maintaining communication between adults and infants would be further supported and extended.

By examining infants' responses to this tactile contingency, specifically the duration of gazing at the experimenter's face and gazing away, as well as their affective trends (smiling and fretting), an indication of 7-month-old infants' abilities to learn tactile contingencies and their behavioural reactions to a contingent over a noncontingent interaction would be obtained.

Method

Participants

The names of potential participants were obtained from the birth records of a community teaching hospital (Montreal, Quebec) and parents were contacted and recruited by telephone. The sample consisted of 57 full-term, healthy infants of 7 months of age. Twenty-one infants were excluded from the analyses due to stranger wariness (11), dislike of the chair (1), noise interrupting the session (2), insufficient gazing at the experimenter's face during the first normal period (2), inaccurate amounts of experimental stimulation during the yoked control condition (1), and because they became engaged with the video monitor behind their heads (4). The final sample consisted of 36 full-term healthy infants (mean age = 7 months, 6.5 days, sd = 6.05 days) and their parents. The majority of the participants were white (92%), and middle-class (94%; see

Appendix A for more detailed demographic information). There were equal numbers of boys and girls in each of the three experimental conditions (CON, NON, SF+T). The infants in the CON condition were randomly selected. The sex and age of the infants in the NON and SF+T conditions were based on the sex and age of the infants in the CON condition. Ages of infants in the NON and SF+T conditions were matched to within 3 days before or 3 days after the ages of the infants in the CON condition. Power analyses conducted before the commencement of participant recruitment confirmed that sufficient power would be obtained with 26 participants (Cohen, 1977).

Apparatus

Infants were seated in an infant seat mounted on a custom-made box (75 cm high x 46 cm wide x 51 cm long) facing a female experimenter who was seated on an adjustable stool at eye level with each infant. The testing chamber was enclosed by one black partition and one black shelving unit placed in a semi-circle around the experimenter and infant. A mobile cart with a shelf was located behind the box on which the infant seat was located. A Sony 8 mm video-cassette player with remote control was placed on the shelf of the cart. A video monitor was situated on a box on the top of the cart, such that the bottom of the monitor was just above, but well behind, the infants' heads. The height of the video monitor was such that the experimenter was able to continue looking at the infant while also viewing the monitor.

An Hitachi camera was located behind and to the right of the experimenter, and recorded the infant's face and body as well as the experimenter's hands. This camera was connected to an 8 mm video-cassette recorder located in the control room. A time-line was recorded on each video record, and was used to score the duration of each response in minutes, seconds, and milliseconds, when the video records were subsequently coded. In addition, a second camera (Sony) was located beside and to the right of the infant on a tripod. This camera was connected to a video monitor which was located behind the black partition. Each infant's parent was seated behind the partition and was thus able to view the entire interaction on the monitor.

An audio-cassette player was located behind the experimenter, out of sight of the infant, and was used to signal the beginning and end of each period through an earphone placed in the experimenter's right ear. Figure 1 illustrates the set-up of the experimental situation.

For purposes of coding the infant behaviours, each video record was examined frame-by-frame using an adjustable speed remote control with shuttle function. In this way both the frequency and the duration of each of the infants' behaviours could be assessed.

Design

Each infant participated in three interaction periods. The first and third periods were 1 min each, while the second period was 3 min in duration. Inter-period intervals of 20 s were included between each period, consistent with previous face-to-face studies using the SF with touch procedure (e.g., Stack & LePage, 1996). There were three experimental conditions. For all infants the first (greeting) and third (reunion) periods consisted of a normal interaction between the experimenter and infant, where the experimenter used facial expression, voice, and touch to play with the infant. The second

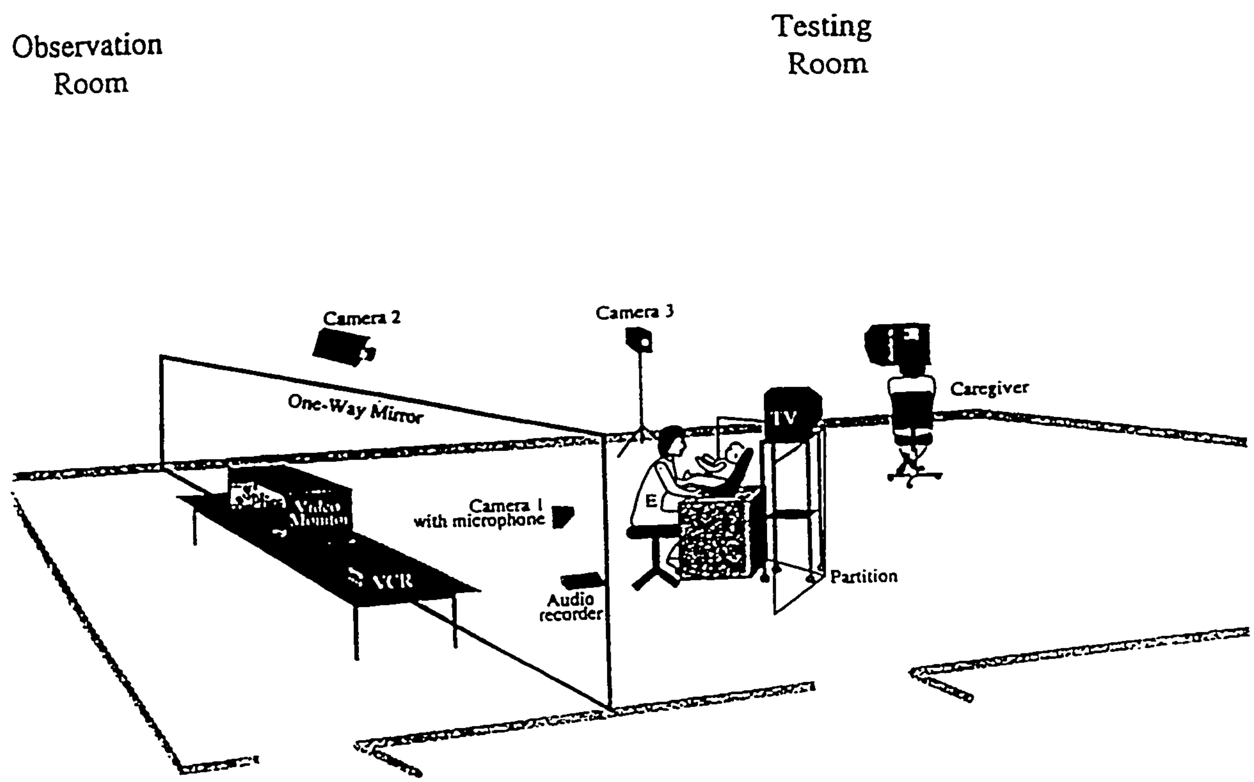

Figure 1. Schematic diagram of testing set-up.

(manipulation) period for all conditions consisted of a modified SF period in which the experimenter remained silent and still faced throughout the period while interacting with the infants using only touch. During the CON experimental condition when the infant made eye-contact with the experimenter she moved the infant's legs up and down, alternating left and right legs, in a standardized scissor-kick fashion until the infant broke eye contact with her. The scissor-kick movement of the infants' legs was chosen as the reinforcing tactile stimulation based on pilot studies in which infants' reactions to different types of touch (e.g., stroking/rubbing the infants' legs) were assessed. Further, based on previous research it was established that: (a) mothers more often touched their infants' feet and legs when playing with them during SF with touch interactions (LePage & Stack, 1993), and (b) kinesthetic movements were used more often by mothers when they were asked to obtain smiling from their infants (Stack et al., 1996). Therefore, the scissor-kick movement of the infants' legs was deemed stimulating for the infants, and considered to be a positive reinforcer for the contingent relationship. Finally, the scissor-kick movement was considered a social reinforcer for infants' gazing at the experimenter's face as it was delivered to the infant during a social face-to-face interaction.

For the NON experimental condition, during the manipulation period, each infant was yoked to an infant in the CON condition (matched for sex and age) such that they received the same amount and type of tactile stimulation from the experimenter and at the same time as their yoked partner. Therefore, the stimulation was not contingent on any response and was delivered regardless of the infants' behaviours. In the NON condition, the recorded image of the matched infant from the CON condition was played on the video monitor located above and behind the head of the infant. Thus, the experimenter was able to move the legs of the infant in the NON condition at the same time as she had originally moved the legs of the infant in the CON condition. In this way the only difference between the two conditions was the level of contingency between the infant's and the experimenter's responses.

Infants in the third experimental condition (SF+T), matched for age and sex with infants in the CON condition, received a SF period during which the experimenter played with the infants using only touch. Table 1 illustrates the design of the study.

Procedure

Upon arrival, the parent(s) and infant were met and escorted to a waiting room where the experimenter briefly summarized the procedures of the study. The parent was then asked to sign an informed consent form (Appendix B). Once the parent and infant were relaxed and comfortable they were escorted to the testing room. The infant was placed in the infant seat, and the parent was seated behind the black partition. All infants participated in the three interaction periods described above (i.e., greeting, manipulation, reunion). The experimenter was seated on the stool in front of the infant and began the audio-cassette player, which indicated when each period began and ended. During the 20-s intervals between the periods the experimenter interacted normally with the infant. A reliability check was made on 1/3 of the participants and ensured that the experimenter was maintaining a still-face throughout the manipulation period. At the end of the testing session the parent and infant were escorted back to the waiting room where the

Table 1

Design Table for Studies 1 and 2

	Condition								
	CON			NON			SF+T		
Period	G	Man	R	G	Man	R	G	Man	R
		boys n = 6			boys n = 6			boys n = 6	
		girls n = 6			girls n = 6			girls n = 6	

Note. CON = contingent condition; NON = noncontingent condition; SF+T = SF with touch condition; G = greeting period; Man = manipulation period; R = reunion period.

experimenter asked the parent a number of questions concerning the infant's history and family demographics (Appendix C). Each parent then received an "Infant Scientist Award" as a token of appreciation for participating in the study. They were informed that when the study was completed, and the video records were scored and analyzed, a letter would be mailed to them outlining the general findings of the study.

If any infant was distressed during any of the periods, and cried for more than 20 consecutive seconds the session was interrupted (n = 1) and resumed once the infant was calm.

Dependent Measures and Coding

The behaviours examined from the video records were: (a) experimenter movement of infants' legs during the manipulation period for the CON and NON conditions, (b) experimenter touch, (c) infant gaze at the experimenter's face, (d) infant gaze away from the experimental situation, (e) infant smiling, and (f) infant fretting.

A criterion of at least 25% time gazing at the experimenter's face during the greeting period was required so that a reliable amount of infant gaze provided a baseline for comparisons with the manipulation and reunion periods. This criterion was determined from results of past studies (e.g., Stack & Arnold, in press; Stack & LePage, 1996; Stack & Muir, 1992) examining infant gazing at adults' faces during normal face-to-face interactions. The criterion of 25% gaze at the face was 4 SDs below the calculated mean of infant gaze at face from these past studies. Therefore, any infants that did not meet this criterion were considered to be unrepresentative of the typical population, and were replaced (n = 2).

Experimenter movement of infants' legs was coded when the experimenter alternately lifted the infants' legs up and down in a standardized manner during the manipulation period for the CON and NON conditions. Once the coder judged that the experimenter had begun to lift the infant's legs the behaviour was coded until the experimenter began to release the legs at the end of the lifting bout. This measure was used to establish that the matched infants in these two conditions were indeed receiving the same amount of stimulation from the experimenter. Experimenter touch was defined as any physical contact between the experimenter and the infant. This measure was included to establish the amount of touch occurring between the experimenter and infants across the three periods, as well as to confirm that infants in the CON and NON conditions were receiving the same amount of touch during the manipulation period.

Infants' gaze at face was coded when gaze was directed at the experimenter's face. Infant gaze away was coded when the infant was not gazing at either the experimenter's body or face, nor at the infants' own body, nor at the chair. This measure was similar to Toda and Fogel's (1993) distal away variable, in a study in which they examined 3- and 6-month-old infants' responses to the standard SF situation. Distal away was defined as gaze directed away from the mother, from the infants' clothes or selves, and away from the infant seat (Toda & Fogel, 1993). Toda and Fogel found that the infants exhibited a decrease in gazing at their mothers' faces, which was contrasted by an increase in the amount of distal away (as opposed to other measures of gaze such as proximal away, defined as infants' gazing at their selves, their clothes or the infant seat). Since infant gaze at face and distal away appeared to contrast one another in Toda and

Fogel's work, they were both included in the present study, with gaze away operationally defined in a similar fashion to distal away.

A smile was coded if the infant's mouth was upturned, either open or closed, and a fret was coded if the infant's mouth was turned down, curled, or the infant was crying. The operational definitions for coding infant gaze at face, smiling, fretting, and adult touch have been reliably used in past studies (e.g., Stack & LePage, 1996; Stack & Muir, 1990, 1992).

Observers were trained on videotape examples prior to scoring the present data until they achieved high reliability ($r > .90$) with experienced coders. Coders were blind to the experimental condition in which the infant participated, and all coding was conducted with the sound off to diminish any external cues as to the infants' responses. As a further precaution, reliability coders were blind to the hypotheses of the study. Inter-rater reliability was assessed for 1/3 of the records upon completion of coding. Intraclass correlation coefficients (Shrout & Fleiss, 1979) conducted on variables analyzed with planned comparisons (see below) were all above $r = .98$ (touch = .98; gaze at face = .99; gaze away = .99). Cohen's kappa coefficients, designed to assess the reliability of points of transition (Cohen, 1968; Hunter & Koopman, 1990), were conducted on the variables involved in the trend analyses (see below), and these were all acceptable, ranging from $r_k = .66$ to $r_k = .85$ (gaze at face = .74; smile = .85; fret = .66).

Data Reduction and Preparation

For the infant gaze behaviours (i.e., gaze at face and gaze away), although the manipulation period was 3 min in duration, only infants' responses during the last minute of this period were compared to their responses during the greeting and reunion periods (both 1 min in length). The manipulation period was designed to be 3 min in length to provide the infants in the CON condition with adequate time to learn the contingency presented to them. Since it was expected that they would spend the first part of that period learning the contingency, only the last third of the period was deemed appropriate for analysis. For the experimenter behaviours (i.e., touch and movement), however, all 3 min of the manipulation period were analyzed to ensure that the infants in the CON and NON conditions were receiving the same amount of stimulation throughout the period. Further, for the infant affect behaviours (i.e., smiling and fretting) the entire 3 min of the manipulation period were included in a trend analysis to examine patterns in infant affect accompanying their gaze throughout the period.

The data for the infant gaze behaviours were further reduced for analysis by obtaining difference scores for the manipulation and reunion periods in which the infants participated. These difference scores were calculated by subtracting the percent duration of the behaviour obtained during the greeting period from the percent duration obtained during the last minute of the manipulation period. This same calculation was conducted to obtain difference scores for the reunion period, using the entire 1-min bout of interaction. Thus, the greeting period was used as a baseline of responding for each individual infant, and the differences in infant responding between the greeting and the following manipulation and reunion periods were then examined to obtain a more accurate indication of each infant's level of responding during these two periods.

The data obtained for infant affect were also reduced in preparation for analysis.

The data for the greeting and reunion periods were split into three 20-s time units. Twenty-second time units were selected as adequate amounts of time during which a reliable amount of infant behaviour would occur, whereas time units smaller than 20 s (e.g., four 15-s time units) were judged to be too short. Time units greater than 20 s (i.e., two 30-s time units) would yield only one degree of freedom, and thus only the presence or absence of a linear trend in infant behaviour could be ascertained, whereas by including one more time unit (of 20 s) it could be established whether a linear or a quadratic trend would better describe the data.

Since the manipulation period was 3 min in length, it was split into six 30-s time units. These longer time units were selected because in creating shorter time units (e.g., nine 20-s time units) the number of units would be so large that the trend analysis results would become meaningless (e.g., a sectile trend). Following the method for data preparation for the infant gaze measures, the raw data for each time unit were converted into percent durations. Therefore, although the length of the time units differed slightly between the normal (i.e., greeting and reunion) and manipulation periods, because percent durations were analyzed, the weights of the data became essentially equivalent between all of the interaction periods.

Results

The primary objective of this study was to determine whether 7-month-old infants were capable of learning a simple contingent relationship delivered through touch during a social interaction. The first section of results focuses on addressing this question, using data from experimenter movement and touch, and the infant gaze measures. The second section of results addresses the trends in affect that accompanied the infants' gaze responses during the interaction periods. Thus, the trends in affect that accompanied infants' gaze during a social interaction when they were learning a contingent relationship, or when they were presented with a low level of contingency, were delineated.

Infants' Abilities to Learn the Contingent Relationship

Four orthogonal dependent variables were analyzed to address the question of infants' learning abilities. These variables consisted of percent durations of: (a) experimenter movement of infants' legs, (b) experimenter touch, (c) infant gaze at experimenter's face, and (d) infant gaze away from experimental situation. Each dependent variable is discussed separately, beginning with experimenter movement and touch, and followed by infant gaze at face and gaze away.

Descriptive statistics designed to assess the normality of the distribution were first conducted on each dependent variable for each period to determine if significant non-normality and/or outliers were present necessitating transformation of any of the variables. These analyses revealed no non-normality or outliers in the data and thus no transformations were necessary for any of the dependent variables.

Infant sex has not previously been found to have significant main or interaction effects in face-to-face studies with touch (Stack & LePage, 1996; Stack & Muir, 1990), thus no differences in sex were expected in the present study. However, any potential sex effects were tested for each variable prior to final analyses, and, if no effects were found, the data were collapsed across this variable for subsequent analyses. The analyses for sex effects consisted of a split-plot ANOVA with sex (boy, girl) as the between-subjects variable, and period (GC, CON, RC, GN, NON, RN, GT, SF+T, RT; see Table 2 for descriptions of acronyms) as the within-subjects variable. As subjects in the three conditions were matched for age and sex, their data were statistically treated as repeated-measures (Stevens, 1996). No sex main effects or interactions were found for any of the dependent variables, and thus the data were collapsed across this variable for the remaining analyses.

Following the analyses for sex, reliability (intraclass correlation and kappa coefficients) was conducted on the movement variable to establish that the infants in the CON and NON conditions were receiving the same amount of stimulation at the same time within the manipulation period.

The final set of analyses for experimenter touch, infant gaze at face and infant gaze away consisted of planned comparisons between the within-subjects variable, period. Since period had nine levels (GC, CON, RC, GN, NON, RN, GT, SF+T, RT), only eight planned comparisons were conducted for each dependent measure to maintain an appropriate error rate (Tabachnick & Fidell, 1989; see Table 3 for summary of planned comparisons). Therefore, while comparisons for the greeting and manipulation periods were comprehensive, comparisons for the reunion period were focused on the contingent periods (RC and RT) compared with the noncontingent (RN) period, and no comparison was conducted between RC and RT for any of the dependent measures.

It was decided to use planned comparisons to analyze experimenter touch and the infant gaze measures so that specific, a priori hypotheses for these variables could be

Table 2

Descriptions of Acronyms for Studies 1 and 2

Acronym	Descriptions
GC	Greeting period for the CON Condition
CON	Manipulation period for the CON Condition
RC	Reunion period for the CON Condition
GN	Greeting period for the NON Condition
NON	Manipulation period for the NON Condition
RN	Reunion period for the NON Condition
GT	Greeting period for the SF+T Condition
SF+T	Manipulation period for the SF+T Condition
RT	Reunion period for the SF+T Condition

Table 3

Summary of Planned Comparisons for Infant Gaze at Face, Infant Gaze Away, and Experimenter Touch: Studies 1 and 2

Comparison	Description
GC_GN	Greeting period for CON condition compared to greeting period for NON condition
GC_GT	Greeting period for CON condition compared to greeting period for SF+T condition
GN_GT	Greeting period for NON condition compared to greeting period for SF+T condition
CON_NON	Manipulation period for CON condition compared to manipulation period for NON condition
CON_SF+T	Manipulation period for CON condition compared to manipulation period for SF+T condition
NON_SF+T	Manipulation period for NON condition compared to manipulation period for SF+T condition
RC_RN	Reunion period for CON condition compared to reunion period for NON condition
RN_RT	Reunion period for SF+T condition compared to reunion period for NON condition

examined. The hypotheses and relevant planned comparisons for the duration of experimenter touch were: (1) no difference in touch between the conditions during the greeting period (GC_GN, GC_GT, GN_GT), (2) no difference in touch between the CON and NON conditions during the manipulation period (CON_NON), (3) increased or greater amounts of touch during the manipulation period for infants in the SF+T relative to the CON and NON conditions (CON_SF+T, NON_SF+T), and (4) no difference in touch between the conditions during the reunion period (RC_RN, RN_RT).

The hypotheses and relevant planned comparisons for the infant gaze measures were: (1) no difference between conditions in infant gaze during the greeting period (GC_GN, GC_GT, GN_GT), (2) increased or greater infant gaze at face for infants in the CON condition during the manipulation period than infants in the NON and SF+T conditions (CON_NON, CON_SF+T), (3) decreased or less infant gaze away for infants in the CON and SF+T conditions during the manipulation period relative to infants in the NON condition (CON_NON, NON_SF+T), (4) more gaze at face and less gaze away during the reunion period for infants in the CON and SF+T conditions relative to infants in the NON condition (RC_RN, RN_RT). Appendix D contains the planned comparison summary tables for experimenter Touch and infant gaze at face and gaze away.

A critical alpha level of .05 was chosen as the criterion for statistical significance. The more stringent Greenhouse-Geisser Adjusted F-score was used when assessing significance. Main effects of period were revealed for all of the planned comparisons, as can be seen in Appendix D, however these effects are not discussed in the results below as the a priori hypotheses are addressed through the specific planned comparisons.

Experimenter movement. Intra-class correlation coefficients were used to determine that the duration of movement was the same for the CON and NON conditions during the manipulation period (Shrout & Fleiss, 1979). The intraclass coefficient obtained was $r = .99$, indicating that matched infant pairs were receiving the same amount of stimulation during the manipulation period. To assess the reliability of points of transition rather than merely overall duration, Kappa coefficients were also computed on movement. The start and stop times of each movement of the infants' legs were compared between the two conditions. Any difference of 1 s or more was considered a disagreement. Even with this very stringent criterion, the Kappa coefficient was $r_k = .72$ for the two conditions, indicating that the infant pairs were receiving the stimulation at essentially the same time within the period. Taken together, these reliability results indicated that the matched infants in the CON and NON conditions were receiving equivalent stimulation during the manipulation period.

As a further precautionary measure, the onset times of infant gaze at face and experimenter movement of the infants' legs were compared for the NON condition, to ensure that a low amount of inadvertent contingent experience occurred during the manipulation period. A frequency count was conducted for each infant that consisted of each onset of infant gaze at face, which was followed, within 1 s, by experimenter movement. A percentage of this frequency count was then obtained by dividing the frequency by the total number of infant bouts of gazing at face for each infant in the NON condition. From these calculations, the mean percentage of time that infant gaze at face was followed within 1 s by experimenter movement of infants' legs was $M = 13.56\%$.

Therefore, it appears as though there was only a low proportion of the time that infants in the NON condition were receiving contingent reinforcement for looking at the experimenter's face during the manipulation period, and thus these infants were indeed receiving noncontingent tactile stimulation from the experimenter.

Experimenter touch. Planned comparisons on touch revealed that there were no differences in the amount of time the experimenter spent touching the infants in each of the conditions during either the greeting or reunion periods. There were also no differences in the amount of time the experimenter spent touching the infants in the CON and NON conditions during the manipulation period, indicating that infants in these two conditions were receiving an equivalent amount of tactile stimulation. The experimenter spent more time touching the infants in the SF+T condition ($M = 90.84\%$) than in either the CON ($M = 60.31\%$), $F(1, 11) = 40.18$, $p < .001$, or the NON ($M = 57.22\%$) conditions during the manipulation period, $F(1, 11) = 38.37$, $p < .001$ (Table D1).

Based on the results from both the experimenter movement and touch variables, infants in the CON and NON conditions were receiving the same amount of stimulation at the same time in the manipulation period. Therefore, the only difference between these conditions was the level of contingency between the behaviours of the infants and the experimenter.

Infant gaze at face. All of the comparisons of infant gaze at face during the greeting period were nonsignificant, indicating that infants in all conditions were similar at the onset of the study. Further, there were no significant differences between the conditions during the reunion period.

No differences in the amount of infant gaze at face between the NON and the SF+T conditions during the manipulation period were found. This was expected as the infants in both conditions had little reason to look at the experimenter's still face. There were differences, however, in the amount of infant gaze at face during the manipulation period between the CON (M = -27.63%) and the NON conditions (M = -53.38%), $F(1, 11) = 18.97$, $p < .001$, and between the CON and the SF+T conditions (M = -52.63%), $F(1, 11) = 9.40$, $p < .05$ (see Figure 2, Table D2). Infants who received the contingent stimulation gazed more at the experimenter's face than infants in either of the other conditions, indicating that they learned the contingency that the experimenter was presenting to them.

Infant gaze away. All comparisons of the greeting and reunion periods were nonsignificant, indicating that the infants in the three conditions were similar at the onset of the study, and that they did not respond differently during the reunion period.

Analyses conducted on the manipulation period revealed that there were no differences in the amount of infant gaze away from the experimental procedure between the CON and the SF+T conditions (Table D3). As illustrated in Figure 3, however, there were differences between the CON and the NON conditions, such that infants in the CON condition (M = 12.31%) spent less time gazing away from the experimental situation than infants in the NON condition (M = 32.21%), $F(1, 11) = 6.53$, $p < .05$. Likewise, infants in the SF+T condition (M = 6.71%) spent less time gazing away from the experimental situation than those in the NON condition during the manipulation period, $F(1, 11) = 6.75$, $p < .05$.

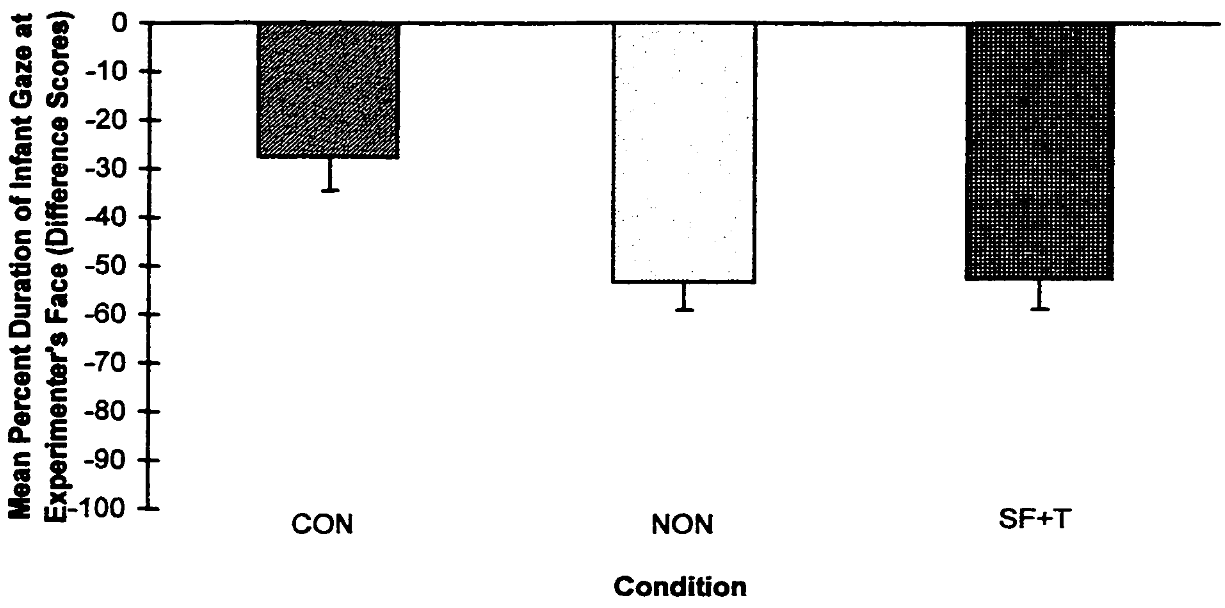

Figure 2. Mean percentage of time infants spent gazing at experimenter's face during the manipulation period as a function of condition (CON, NON, SF+T).
Standard errors are shown by vertical bars.

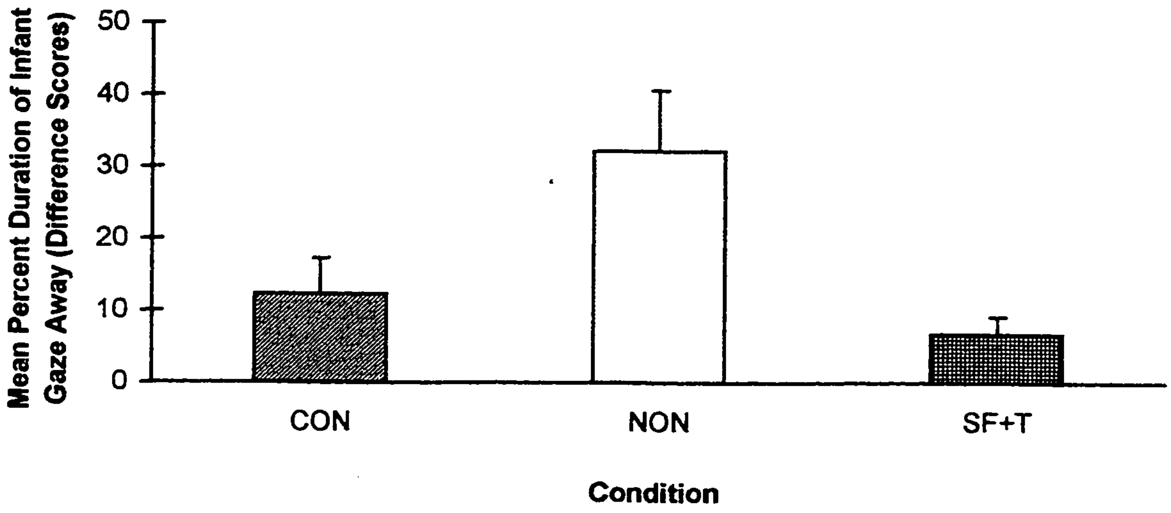

Figure 3. Mean percentage of time infants spent gazing away from experimental situation during the manipulation period as a function of condition (CON, NON, SF+T).
Standard errors are shown by vertical bars.

Affect Trends

Two orthogonal dependent variables were analyzed to determine the trends in infant affect accompanying their gaze responses: percent durations of (a) infant smiling, and (b) infant fretting. Descriptive analyses were conducted as above, and when transformations of the data were necessary to correct for non-normality the specific transformation is mentioned at the relevant point in the text. To facilitate comprehension, when transformations were conducted on the variables, the raw means are cited in the text and figures, while the transformed means are reported in Appendix E. Appendix E also contains means for any main effects of trend. When transformations were conducted, however, the F-scores and p-values cited in the text are taken from the transformed analyses, as these are the findings upon which the interpretations were based.

Trend analyses of the interaction periods were conducted on infant smiling and fretting with sex (boy, girl) as the between-subjects variable and condition (CON, NON, SF+T) and unit of time, with three 20-s time units for the greeting and reunion periods and six 30-s time units for the manipulation period (as explained in the Method section above), as the within-subjects variables. As with the gaze measures, if no sex main effects or interactions were found, the data were collapsed across this measure for the remaining trend analysis. If an interaction was significant, contrast analyses, followed by simple effects analyses where relevant, were conducted to isolate the source of effects contributing to the interaction (Keppel, 1982; Linton & Gallo, 1975; Tabachnick & Fidell, 1989; Winer, 1971). When contrasts between the three conditions were performed a Bonferroni-type adjustment to the alpha level was conducted to maintain the Type I error rate at the .05 level (Tabachnick & Fidell, 1989). Appendix F contains the trend analysis summary tables for infant smiling and fretting.

The general hypotheses for the patterns of infant affect during the interaction periods were as follows: (1) no differences between conditions in the trends of infant smiling or fretting during the greeting period, (2) infants in the CON condition would show a linear increase in smiling and a low, stable amount of fretting during the manipulation period, (3) infants in the NON condition would show a linear decrease in smiling and a linear increase in fretting during the manipulation period, (4) infants in the SF+T condition would display varying levels of smiling and low, stable levels of fretting throughout the manipulation period, (5) infants in the NON condition would show a low level of smiling during the reunion period which might increase linearly by the end of the period, whereas infants in the CON and SF+T conditions would show higher, stable levels of smiling, (6) infants in the NON condition would show higher amounts of fretting during the reunion period, which might decrease gradually in a linear fashion, whereas infants in the CON and SF+T conditions would show low and stable amounts of fretting throughout this period.

A critical alpha level of .05 was chosen as the criterion for statistical significance. As the F-tests for orthogonal trend analyses are valid regardless of whether the sphericity assumption is met, use of the Greenhouse-Geisser Adjusted F-score was not applicable for the present analyses (Dixon, Brown, Engelman, & Jennings, 1990). Although included in the trend analysis summary tables (Appendix F), the pooled results for condition, unit, and the condition by unit interaction are not discussed in the Results section below. While at times they may have been significant, they simply represented overall differences between conditions and over units of time, and as such did not provide information beyond the specific trend results (Dixon et al., 1990).

Infant smiling. The data for infant smiling during the manipulation period was positively skewed and thus a square-root transformation was performed on the data for this period only. A quadratic trend in infant smiling was found during the greeting period, $F(1, 11) = 7.32$, $p < .05$ (Table F1). Smiling for all infants in all conditions appeared to increase towards the middle of the greeting period, and decrease towards the end of that period (see Table E1). There were no condition effects in the greeting period, however, indicating that infants in the three conditions were similar at the onset of the study.

Analyses on the manipulation period revealed a significant quintic trend by sex interaction, $F(1, 10) = 7.31$, $p < .05$, and a significant condition-quadratic trend by unit-quartic trend by sex interaction, $F(1, 10) = 5.40$, $p < .05$, however subsequent contrast and simple effects analyses failed to reveal any significant sex effects. The data were consequently collapsed across sex. Significant condition-linear and condition-quadratic trends were found, $F(1, 11) = 14.42$, $p < .01$ and $F(1, 11) = 15.66$, $p < .01$ respectively (Table F2). As can be seen in Figure 4, more smiling occurred during the SF+T manipulation period ($M = 27.96\%$) than either the CON ($M = 7.58\%$) or the NON ($M = 6.75\%$) manipulation periods (see Table E2 for transformed means). A significant linear trend existed overall during the manipulation period, $F(1, 11) = 18.79$, $p < .01$, whereby smiling decreased over this period for all infants in all conditions (Table E3).

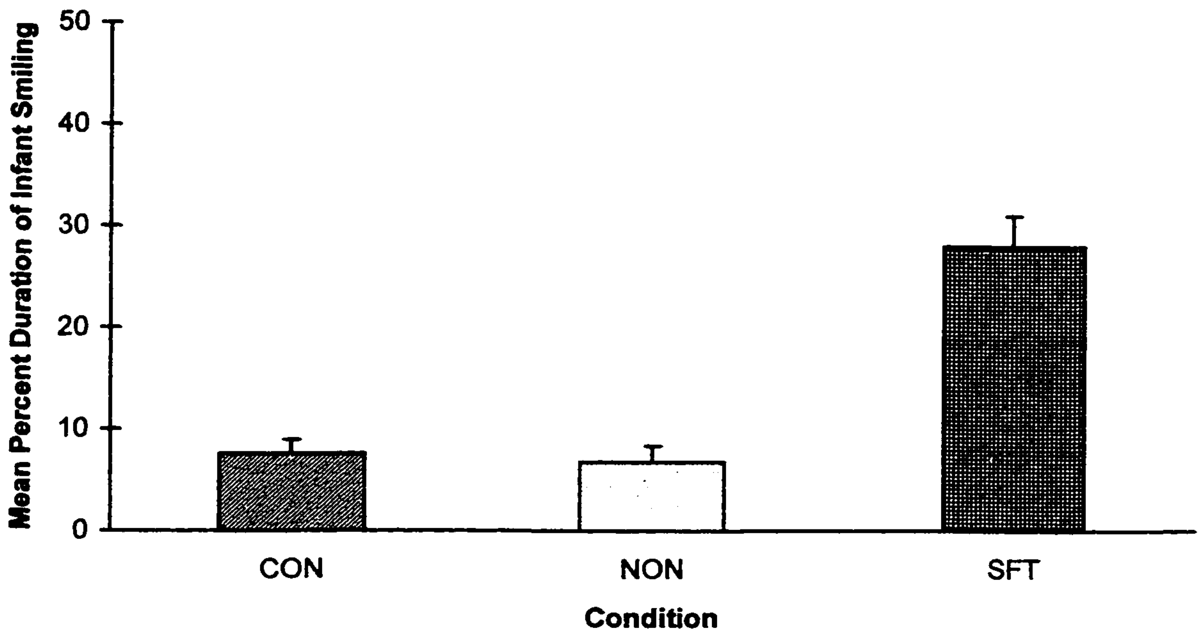

Figure 4. Mean percentage of time infants spent smiling during the manipulation period as a function of condition (CON, NON, SF+T). Standard errors are shown by vertical bars.

A significant condition-linear trend by unit–quadratic trend by sex interaction was found in the data for the reunion period, $F(1, 10) = 7.98$, $p < .05$, however subsequent contrast analyses failed to reveal any sex effects. The data were consequently collapsed across sex for the remaining analyses. No significant trends were found for smiling during the reunion period (Table F3).

Infant fretting. The data for infant fretting during both the manipulation and the reunion periods was moderately positively skewed necessitating a log transformation. There was no infant fretting in the greeting period, and thus no analyses were conducted on this variable for that period.

A significant linear trend in infant fretting was found for the manipulation period, $F(1, 11) = 12.12$, $p < .01$ (Table F4), whereby fretting increased over the six 30-s intervals during this period for all infants in all conditions (see Table E4). There were no differences in infant fretting between conditions during the reunion period (Table F5).

Discussion

The results from the infant gaze and the experimenter touch measures supported most of the hypotheses, indicating that 7-month-old infants are capable of learning and are sensitive to contingencies within a social context. The results from the infant affect measures were not as strong, and thus the importance of contingency, in terms of infants' affective displays, is less clear. The importance of contingency on infants' reactions during future social interactions is also not clear in the present study, as the hypotheses for infants' responses during the reunion period were not supported. Since only touch was used during the manipulation periods, however, and infants appeared to learn the contingent tactile relationship presented to them, the functional capabilities of the tactile modality were further demonstrated by these results.

The experimenter movement results confirmed that the experimenter was moving the legs of infants in the NON condition at the same time as their CON partners. Further, all of the hypotheses for experimenter touch were supported. As hypothesized, the experimenter spent equal amounts of time touching the infants during both the greeting and the reunion periods, indicating that none of the infants were treated differently during any of the normal periods. Also as hypothesized, the experimenter spent equal amounts of time touching infants in the CON and NON conditions, and more time touching infants in the SF+T condition. The results from both the movement and touch measures indicate that the yoked procedure was successful and that infants in the CON and NON conditions were receiving the same amount and type of stimulation at the same time within the manipulation period. Therefore, the only difference in the stimulation between infants in the CON and NON conditions was the level of contingency. Specifically, for the CON infants the stimulation was delivered contingently depending on their gaze at the experimenter's face, whereas for the NON infants the stimulation was delivered depending only on the timing of their CON partner's gaze at the experimenter's face, and was therefore not contingent on their own behaviours.

The results from the infant gaze at face and gaze away measures supported all hypotheses but one, thus providing evidence for 7-month-old infants' sensitivities to, and their ability to learn, a contingent relationship taking place within a social interaction. Infant gazing was not different between the conditions during the greeting period, indicating that all infants were responding similarly at the onset of the study. As hypothesized, infants in the CON condition spent more time gazing at the experimenter's still face during the manipulation period than infants in either the NON or the SF+T conditions. Infants in the SF+T condition were not expected to spend much time gazing at the experimenter's still face based on previous research, which has revealed that during a SF with touch period in which the adult is playing with the infant using touch, infant gaze is directed less at the adult's face, and more at the adult's hands (Stack & LePage, 1996; Stack & Muir, 1990, 1992). That infants in the CON condition gazed more at the experimenter's face than those in the NON condition, however, is strong evidence that infants in the CON condition learned the contingent relationship between their gaze at the experimenter's face and the stimulation that they were receiving (Alessandri et al., 1990; Millar & Weir, 1992; Papousek & Papousek, 1979). Therefore, infants at 7 months of age appear capable of learning a contingent relationship between their behaviour and that of an adult during a social interaction, as measured by their higher amounts of gazing at the experimenter's face in the present study.

The third hypothesis, that infants in the NON condition would spend more time gazing away from the experimental situation than infants in the CON and SF+T conditions during the manipulation period was also supported. The greater amount of gazing away exhibited by infants in the NON condition relative to the infants in the CON condition suggests that, although they were receiving the same amount and type of stimulation as infants in the CON condition, infants in the NON condition were sensitive to the lack of contingency, and thus became less interested in the situation. Further, since there was no difference in the amount of gaze away between infants in the CON and SF+T conditions it appears that infants in the CON condition were just as interested in the situation as infants in the SF+T condition, although infants in the CON condition were not receiving the diverse, playful type of stimulation from the experimenter as infants in the SF+T condition. The sensitivity of infants in the CON condition to the presence of a contingent relationship between their behaviour and that of the experimenter appeared to be sufficient to sustain the infants' attention, at least for a brief period of time (Hains & Muir, 1996a; Millar & Weir, 1992).

The trend analyses on the infant affect measures did not reveal any distinctive patterns that accompanied the learning demonstrated by the gaze measures. As hypothesized, there were no differences between conditions in the patterns of infant smiling or fretting during the greeting period, indicating the similarity of infant behaviour at the onset of the study. The only difference between conditions was that infants in the SF+T condition, where the experimenter was playing with them using touch, smiled more during the manipulation period than infants in either the CON or the NON conditions, where the experimenter was merely moving their legs up and down. The fact that infants in the SF+T condition smiled more was probably due to the variability in the tactile stimulation they were receiving (in addition to the fact that it was naturally contingent on their responses). This result is similar to previous research indicating that the addition of playful tactile stimulation to a standard SF period will increase infant smiling relative to the SF period (Stack & Muir, 1990, 1992). Playful tactile stimulation can even vary the amount of infant smiling found during SF with touch periods in which different instructions are given to mothers, for example to obtain more smiling from their infants using touch alone (Stack & LePage, 1996). This result, although interesting, does not provide evidence for the importance of contingency per se to infants, as the contingency was confounded with the more varied type of tactile stimulation provided to the infants in the SF+T condition.

No support was found for the third objective of the present study. Therefore, the importance of the inclusion of contingency during social interactions on infants' responses during future interactions remains unclear. For example, the final hypothesis for the infant gaze measures was not supported; there were no differences between conditions in the amount of infant gazing away during the reunion period. Furthermore, no differences in infant affect were found between conditions during the reunion period. It may be that infants in the NON condition renewed their interest in the experimenter during the reunion period based on previous experience with contingent, social interactions with other individuals. It is possible that, by 7 months of age, infants have learned that most interactions are contingent in nature, and therefore a brief noncontingent interaction is responded to as more of an anomaly (e.g., Bigelow et al., 1996; Hains & Muir, 1996a; Tronick, 1989). That is, infants might still expect that a future interaction will be contingent, and thus will respond naturally to that interaction. If this were the case, the infants would respond similarly during the reunion period regardless of whether they had just participated in a contingent or a noncontingent social interaction.

Evidence for the final objective was found, in that the only method of communication for the experimenter was through the tactile modality. Even when the touch consisted of merely moving the infants' legs up and down, the infants were still able to learn the contingency presented to them. Further, even though touch was the only form of stimulation they were receiving from the experimenter, infants in both the contingent and the SF+T conditions remained engaged in the interaction, as discussed above. That infants in the SF+T condition also exhibited more smiling provides further evidence of the capacity of the tactile modality to maintain a high level of positive infant affect, as well as attention, even when used alone.

In conclusion, the infant gaze measures strongly indicate that 7-month-old infants can learn a social, tactile-gaze, contingency and that they spend more time attending when a high level of contingency is available to them. An extension of these results to younger infants would help to delineate when this ability to learn a social contingency emerges. Further, by examining infants' affective responses to contingent and noncontingent interactions an indication of the importance of the inclusion of contingency in social interactions for younger infants would be obtained.

Study 2

The results from Study 1 indicated that 7-month-old infants were capable of learning, and were sensitive to, tactile contingencies presented in a social context. It remains to be established, however, whether younger infants have this ability. Although by 7 months of age infants are participating more in social interactions, the bi-directionality of adult-infant interactions has been demonstrated to exist in the younger infant as well (e.g., Vos et al., 1990). By examining the abilities of younger infants to learn the same tactile contingency as the 7-month-olds some indication of developmental timing and emergence of this ability would be documented.

Thus, Study 2 provided an examination of the development of infants' abilities to learn social contingencies by examining 4-month-old infants' learning responses using the same procedure as that used with the 7-month-old infants in Study 1. Four-month-olds were selected because previous research with infants of this age has found that they appear capable of learning contingencies when presented in an operant-learning paradigm within a more perceptual-cognitive context (e.g., Sullivan & Lewis, 1989). It was, therefore, of interest to discover whether 4-month-olds are able to learn contingencies within a social situation.

It is also around 4 months of age that infants are beginning to develop a sense of expectations and a better understanding of contingent relationships (Lamb, 1981). Further, infants at 4 months of age have been found to show fairly reliable differences in their affective responses between contingent and extinction periods (Alessandri et al., 1990). Although infants younger than 4 months do appear to be able to learn contingencies, their affective responding is not as well established, nor as clear as those at 4 months of age (Alessandri et al., 1990). By studying 4-month-olds, a more reliable assessment of when infants begin to respond differentially, both in their gaze and affect, to contingent and noncontingent interactions would be obtained.

Thus, the first objective of Study 2 was to establish whether infants of 4 months of age were capable of learning contingencies presented within a social context. This was accomplished by examining the duration of infants' gazing, both at face and away from the experimental situation, as in Study 1. It was expected that infants in the CON condition would spend more time gazing at the experimenter's still face during the manipulation period than infants in either the NON or the SF+T conditions. In addition, infants in the CON and SF+T conditions were expected to spend less time gazing away from the experimental situation than infants in the NON condition during the manipulation period, further indicating infants' sensitivities to contingencies, or the lack thereof.

The second objective of Study 2 was to explore the importance of contingency for infants by examining the trends or patterns in 4-month-old infants' affective displays that accompany their gazing when they are presented with varying levels of contingency. As in Study 1, it was hypothesized, based on the contingency hypothesis (Dunham et al., 1989) that infants in the CON condition would show a gradual increase in smiling and low, stable amounts of fretting. In contrast, infants in the NON condition would exhibit a decrease in smiling and an increase in fretting throughout the manipulation period. Infants in the SF+T condition would likely demonstrate varying levels of smiling throughout the manipulation period and lower levels of fretting, as they responded to the more diverse tactile stimulation they were receiving from the experimenter.

The third objective of the present study was to establish the importance of including contingency in current social interactions on infants' responses to future contingent social interactions. Although 7-month-olds did not show any differences in responding between the three conditions during the reunion period in Study 1, younger infants might exhibit a difference in their gazing and affect during the reunion period as a result of their reduced exposure to and experience with social interactions (e.g., Bigelow et al., 1996; Dunham et al., 1989). Thus, it was expected that infants in the NON condition would spend more time gazing away from the experimental situation during the reunion period than infants in the CON and SF+T conditions, because they would be slower to become re-engaged with the experimenter. Also during the reunion period, infants in the NON condition were expected to show a higher level of fretting that would decrease linearly, with a slight linear increase in their smiling throughout that period. Infants in the CON and SF+T conditions, however, were expected to show stable levels of both smiling and fretting throughout the reunion period.

The final objective of the present study, as in Study 1, was to extend previous examinations of the role of the tactile modality to include the capability of touch to communicate from adults to infants, by using touch as the social reinforcer with 4-month-olds.

By examining 4-month-old infants' gazing and patterns of affective responses during a social interaction in which a tactile contingency was presented to them, as in

Study 1, it could be established whether infants at this younger age are capable of learning a tactile contingency within the context of a social interaction.

Method

Participants

Participants were recruited using the same procedures as for Study 1. The sample consisted of 39 full-term, healthy infants of 4 months of age. Three infants were excluded from the analyses due to stranger wariness. The attrition rates were different between Studies 1 and 2 primarily due to the fact that by 7 months of age infants are more likely to react to strangers by crying and turning away than infants at 4 months of age (e.g., Lamb, 1988). Further, as infants at 7 months are larger and motorically more capable of turning themselves around in the infant seat, more of the 7-month-olds were able to see the television monitor and become engaged with it, whereas the 4-month-olds were incapable of achieving this feat.

The final sample of 4-month-olds consisted of 36 full-term, healthy infants (mean age = 4 months, 7 days, sd = 5.85 days). The majority of the participants were white (86%), and middle-class (92%; see Appendix G for more detailed demographic information). There were equal numbers of boys and girls in the three experimental conditions (CON, NON, SF+T). The selection and matching of infants in each experimental condition was conducted in the same way as for Study 1.

Apparatus

The apparatus was similar to that used in Study 1. One addition in Study 2 was that infants were seated on a pillow placed on the infant seat. This pillow was included to ensure that the heads of the 4-month-olds would be at the same level as those of the 7-month-olds in Study 1 so that the experimenter could see the video monitor while looking at the infants. Thus, no change in height was introduced to the experimental setting.

Design

The design was identical to that of Study 1 (see Table 1).

Procedure

The procedure was identical to that for Study 1.

Dependent Measures, Coding, and Data Reduction

The data preparations were identical to those conducted for Study 1. Inter-rater reliability was assessed for 1/3 of the records upon completion of coding by observers blind to the experimental conditions and the hypotheses of the study. Intraclass correlation coefficients conducted on variables analyzed through planned comparisons were all above $r = .99$ (touch = .99; gaze at face = .99; gaze away = .99). Cohen's kappa coefficients conducted on variables included in the trend analyses were also acceptable, ranging from $r_k = .70$ to $r_k = .90$ (gaze at face = .90; smile = .73; fret = .70).

Results

The approach and statistical analyses were identical to those conducted on the data from Study 1. The results section is divided into two sections. The first section presents the results of the gaze measures to answer the primary question of the capacity of infants at 4 months of age to learn a social contingency. The second section presents the results from the examination of the patterns of affect that accompanied infant gazing across the three periods and conditions.

Infants' Abilities to Learn the Contingent Relationship

Four orthogonal variables are discussed separately, beginning with experimenter movement and touch, and followed by infant gaze at face and gaze away. None of the data required transformations, and no sex main effects or interactions were found. As in Study 1, the mean values for the gaze measures were derived from difference scores for both the manipulation and reunion periods.

The specific hypotheses and planned comparisons were identical to those in Study 1. Thus, the hypotheses and planned comparisons for touch were: (1) no difference in touch between the conditions during the greeting period (GC_GN, GC_GT, GN_GT), (2) no difference in touch between the CON and NON conditions during the manipulation period (CON_NON), (3) increased or greater amounts of touch during the manipulation period for infants in the SF+T relative to the CON and NON conditions (CON_SF+T, NON_SF+T), and (4) no difference in touch between the conditions during the reunion period (RC_RN, RN_RT).

The hypotheses and relevant planned comparisons for the infant gaze measures were: (1) no difference between conditions in infant gaze during the greeting period (GC_GN, GC_GT, GN_GT), (2) increased or greater infant gaze at face for infants in the CON condition during the manipulation period than infants in the NON and SF+T conditions (CON_NON, CON_SF+T), (3) decreased or less infant gaze away for infants in the CON and SF+T conditions during the manipulation period relative to infants in the NON condition (CON_NON, NON_SF+T), (4) more gaze at face and less gaze away during the reunion period for infants in the CON and SF+T conditions relative to infants in the NON condition (RC_RN, RN_RT). Appendix H contains the planned comparison summary tables for experimenter touch and infant gaze at face and gaze away.

Experimenter movement. The intra-class correlation coefficient obtained for the duration of movement for the CON and NON conditions was $r = .99$, indicating that the matched infant pairs were receiving the same amount of stimulation during the manipulation period. Even with the stringent criteria of a 1-s difference in the start-stop times between the CON and NON conditions, as in Study 1, the Kappa coefficient obtained was $r_k = .70$ for the CON and NON conditions, indicating that the infant pairs were receiving the stimulation at essentially the same time within the period. Further, the mean percentage of time infants in the NON condition were receiving contingent stimulation by chance was $M = 14.17\%$, indicating that experimenter movement of the infants' legs was not contingent on their gazing at face behaviours.

Experimenter touch. As in Study 1, planned comparisons on touch revealed no differences in the amount of time the experimenter spent touching the infants during the greeting and reunion periods. There was also no difference in the amount of time the experimenter spent touching infants in the CON and NON conditions during the manipulation period, indicating that infants in these two conditions were receiving an identical amount of tactile stimulation. As in Study 1, the experimenter spent more time touching the infants in the SF+T ($M = 92.16\%$) than in either the CON ($M = 64.74\%$), $F(1, 11) = 16.32$, $p < .001$, or the NON ($M = 68.05\%$), $F(1, 11) = 12.97$, $p < .001$, conditions during the manipulation period (Table H1).

The results from the analyses of movement and touch were the same as those obtained in Study 1, and indicated that infants in the CON and NON conditions were receiving the same amount of stimulation, at the same time, during the manipulation period. Therefore, the only difference between these conditions was the level of contingency between the behaviours of the infants and the experimenter during the manipulation period.

Infant gaze at face. All of the comparisons of the greeting period were nonsignificant, indicating that the infants in the conditions were similar at the onset of the study. Further, there were no significant differences between the conditions in the reunion period.

As found in Study 1, infants in the NON (M = -52.61%) and SF+T (M = -49.59%) conditions spent the same amount of time gazing at the experimenter's face during the manipulation period (Table H2). Infants in the CON condition (M = -28.42%) spent more time gazing at the experimenter's face during the manipulation period than infants in the NON condition, $F(1, 11) = 5.28$, $p < .05$ (Figure 5). Thus, 4-month-old infants appeared to learn the contingency that the experimenter was presenting to them.

Infant gaze away. All comparisons of the greeting period were nonsignificant, indicating that the infants in the three conditions were similar at the onset of the study. All comparisons of the manipulation period were also nonsignificant.

Analyses conducted on the reunion period revealed differences in the amount of infant gaze away between the conditions. Specifically, infants in the CON condition (M = -4.01%) gazed away less than those in the NON condition (M = 4.52%) during the reunion period, $F(1 ,11) = 4.95$, $p < .05$ (Figure 6, Table H3).

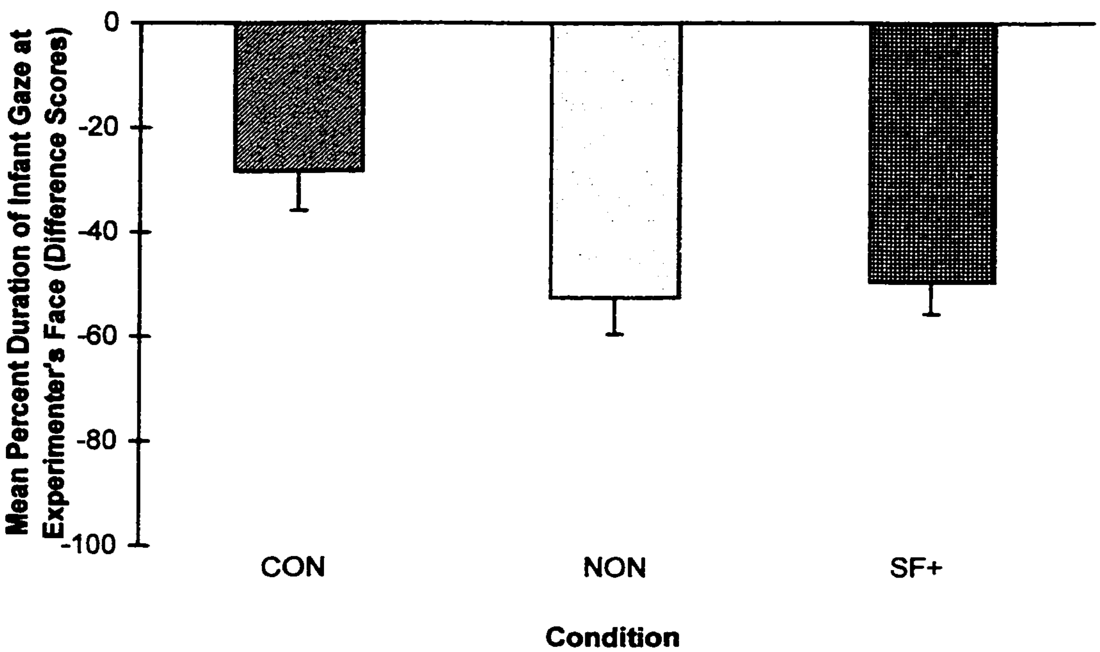

Figure 5. Mean percentage of time infants spent gazing at experimenter's face during the manipulation period as a function of condition (CON, NON, SF+T).
Standard errors are shown by vertical bars.

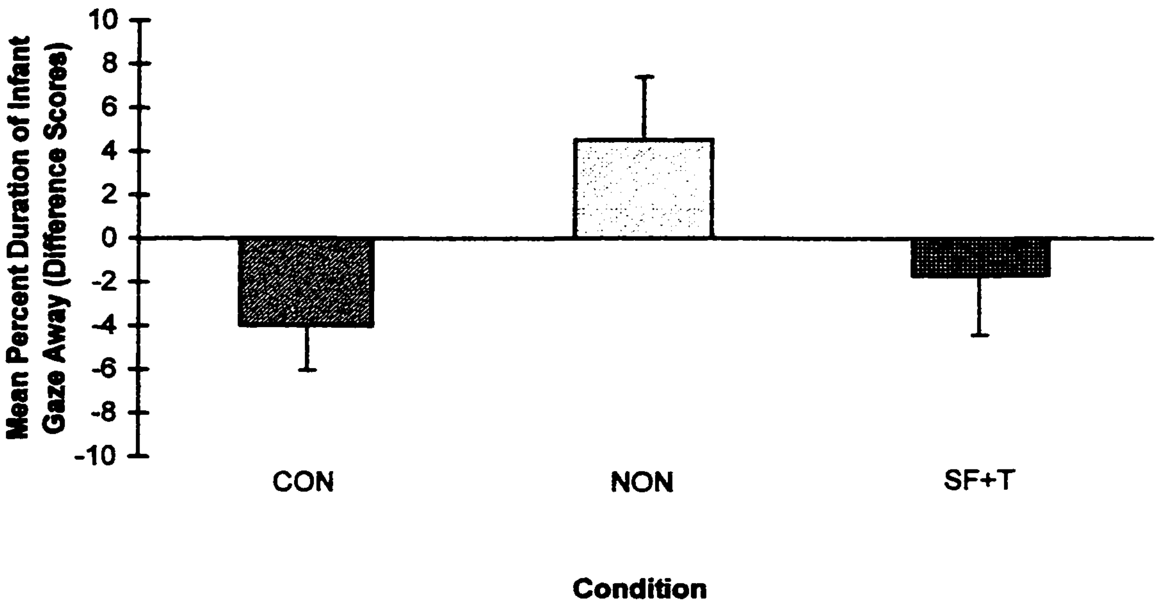

Figure 6. Mean percentage of time infants spent gazing away from experimental situation during the reunion period as a function of condition (CON, NON, SF+T).
Standard errors are shown by vertical bars.

Affect Trends

The two dependent variables (infant smiling and fretting) are discussed separately. Analyses were conducted as in Study 1, and any transformations of the data are indicated at the relevant point in the text. The raw means are presented in the text and figures, while the transformed means and means of main effects are available in Appendix I. The hypotheses for the trend analyses for infant smiling and fretting were identical to those presented in Study 1. Therefore, the general hypotheses for the patterns of infant affect during the interaction periods were: (1) no differences between conditions in the trends of infant smiling or fretting during the greeting period, (2) infants in the CON condition would show a linear increase in smiling and a low, stable amount of fretting during the manipulation period, (3) infants in the NON condition would show a linear decrease in smiling and a linear increase in fretting during the manipulation period, (4) infants in the SF+T condition would display varying levels of smiling and low, stable levels of fretting throughout the manipulation period, (5) infants in the NON condition would show a low level of smiling during the reunion period which might increase linearly by the end of the period, whereas infants in the CON and SF+T conditions would show higher, stable levels of smiling, (6) infants in the NON condition would show higher amounts of fretting during the reunion period, which might decrease gradually in a linear fashion, whereas infants in the CON and SF+T conditions would show low and stable amounts of fretting throughout this period. Appendix J contains the trend analysis summary tables for the infant smiling and fretting variables.

Infant smiling. The data for infant smiling during the manipulation period were positively skewed and thus a square-root transformation was performed on the data for this period only. There was a significant quadratic trend overall in infant smiling during the greeting period, $F(1, 11) = 15.37$, $p < .01$ (Table J1). Infant smiling increased until the middle of the period, and then decreased towards the end of the greeting period (see Table I1). There were no condition differences in smiling, however, indicating that the infants were similar at the onset of the study.

There was a significant quintic trend overall in infant smiling during the manipulation period, $F(1, 11) = 7.03$, $p < .05$ (Table J2), which indicated that smiling alternately decreased and increased throughout that period for all infants in all conditions (see Table I2). During the manipulation period there were also significant condition-linear trend by unit-quartile trend, $F(1, 11) = 6.12$, $p < .05$, and condition-linear trend by unit-quintic trend, $F(1, 11) = 9.34$, $p < .05$, interactions. Subsequent contrast analyses failed to reveal any effects, however. There were no significant trends or effects in the reunion period (Table J3).

Infant fretting. The data for infant fretting in both the manipulation and the reunion periods were moderately positively skewed, necessitating a log transformation. There were no significant trends or differences in infant fretting during the greeting period, indicating that infants were similar at the onset of the study (Table J4).

A significant condition-linear trend by unit-cubic trend by sex interaction was found during the manipulation period, $F(1, 10) = 7.70$, $p < .05$, however subsequent contrast and simple effects analyses failed to reveal significant effects. The data were consequently collapsed across sex for the remaining analyses. A significant linear trend in fretting was found in the manipulation period, $F(1, 11) = 5.77$, $p < .05$ (Table J5), in that infant fretting, while low overall, showed an overall increase during this period for all infants in all conditions (see Table I3). There were also significant condition-linear trend by unit-linear trend, $F(1, 11) = 6.17$, $p < .05$, condition-linear trend by unit-quadratic trend, $F(1, 11) = 6.54$, $p < .05$, condition-quadratic trend by unit-linear trend, $F(1, 11) = 7.19$, $p < .05$, and condition-quadratic trend by unit-quadratic trend, $F(1, 11) = 4.92$, $p <.05$, interactions found during the manipulation period. As illustrated in Figure 7, subsequent contrasts and simple effects analyses revealed that only infants in the CON condition demonstrated significant linear, $F(1, 11) = 8.92$, $p < .05$, and quadratic, $F(1, 11) = 5.52$, $p < .05$, trends in their fretting throughout this period (see Table I4 for transformed means). Figure 8 reveals that a combination of a linear and quadratic trend fits the data for the CON condition best in that fretting appears to be low during the beginning portion of the manipulation period, and, somewhat following a quadratic trend, it increases fairly dramatically so that it becomes more linear in shape, and is higher than the fretting of infants in either the NON or the SF+T conditions by the end of that period (Figure 7). No effects for infant fretting were revealed during the reunion period (Table J6).

Discussion

Although not all of the hypotheses for the infant gaze measures were supported, there was evidence that 4-month-old infants were able to learn the social contingency presented to them. In addition, differences were revealed between the conditions in the patterns of infant affect, which also provide some support for infants' sensitivities to, and

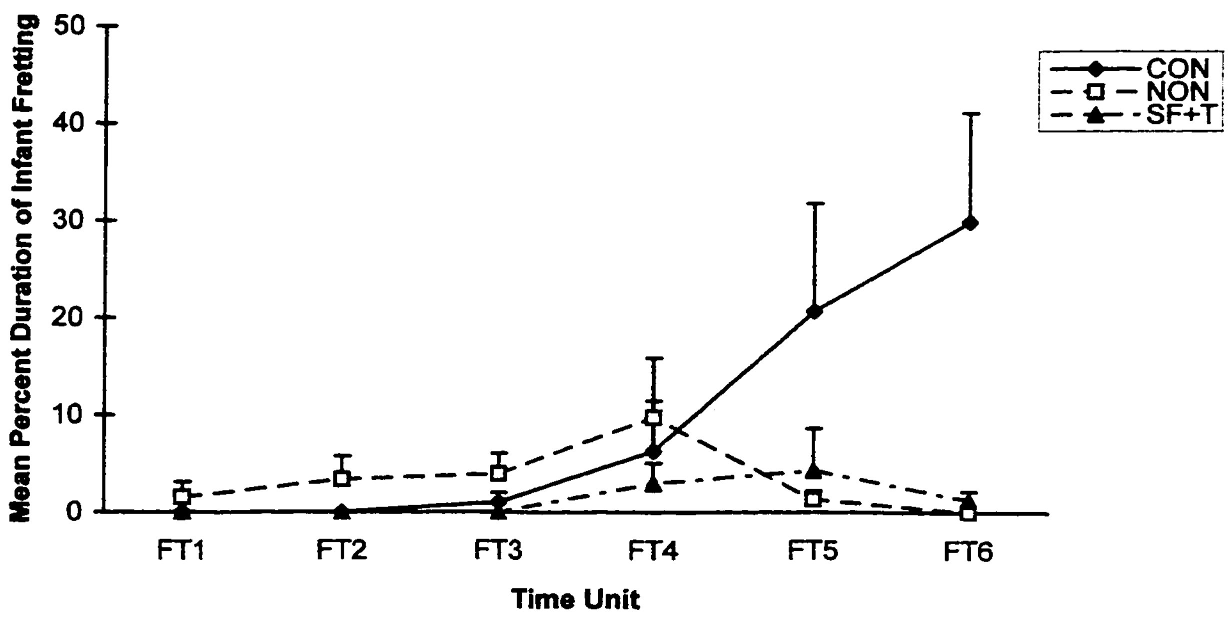

Figure 7. Mean percentage of time infants spent fretting during the manipulation period as a function of 30-s time unit (FT1, FT2, FT3, FT4, FT5, FT6) and condition (CON, NON, SF+T).
Standard errors are shown by vertical bars.

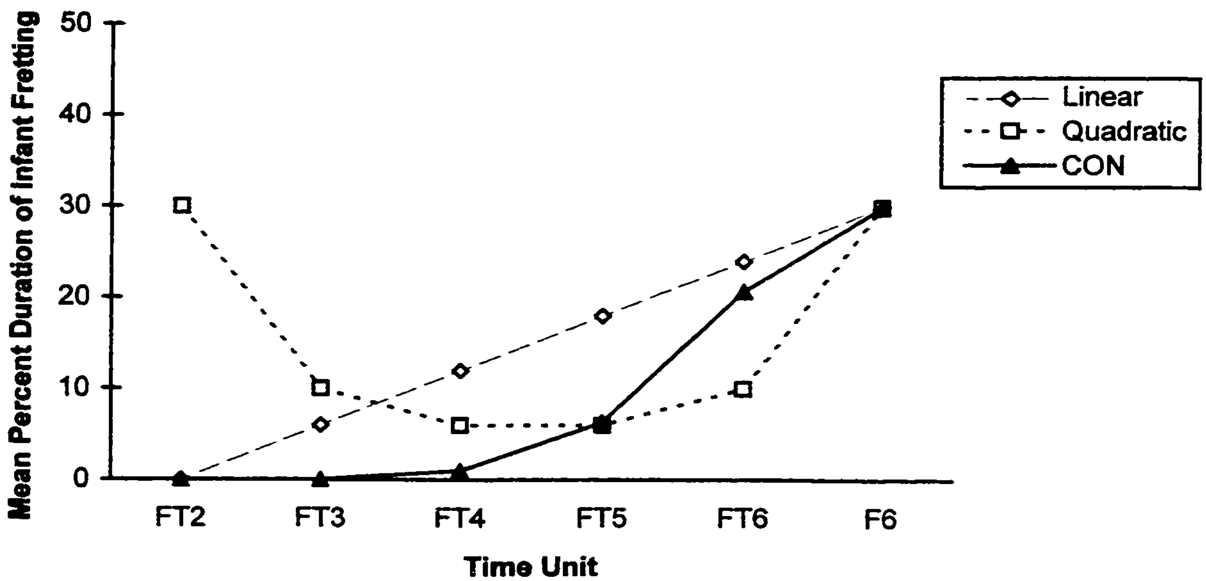

Figure 8. Mean percentage of time infants in the CON condition spent fretting during the manipulation period as a function of 30-s time unit (FT1, FT2, FT3, FT4, FT5, FT6) and type of trend (Linear, Quadratic, Actual Means).

the importance of, contingency during social interactions. During the reunion period it was demonstrated that experiencing a contingent social interaction may have some impact on infants' responses during a subsequent interaction. Finally, since the contingency was presented in the tactile modality, the functional capabilities of touch were further revealed.

As in Study 1, the reliability coefficients for experimenter movement were high, indicating that infants in the CON and NON conditions were receiving the same amount of stimulation at the same time during the manipulation period. Further, all of the hypotheses for experimenter touch were supported; there were no differences in the amount of time the experimenter spent touching the infants in any of the conditions during the greeting period or during the reunion period. The experimenter spent more time touching the infants in the SF+T than the CON or NON conditions during the manipulation period, but she spent the same amount of time touching the infants in CON and NON conditions. Therefore the amount, type, and timing of the stimulation during the manipulation period were virtually identical for the infants in the CON and NON conditions. The only difference between those conditions during the manipulation period was the level of contingency; infants in the CON condition received the stimulation contingent on their gaze at the experimenter's face whereas infants in the NON condition received yoked, noncontingent stimulation from the experimenter.

Many of the hypotheses for infant gaze were supported, indicating that infants at 4 months of age are capable of learning a contingency presented within the context of a social interaction. There were no differences between the conditions during the greeting period in the amount of infant gazing either at the experimenter's face or away from the experimental situation, demonstrating that the infants were similar at the onset of the study. The second hypothesis for this study was partially supported; infants in the CON condition spent more time gazing at the experimenter's still face during the manipulation period than infants in the NON condition, although they were receiving the same amount of stimulation at the same time during the manipulation period. It is this fact that provides evidence that 4-month-olds are able to learn a contingency within a social interaction.

The remaining hypotheses for infant gazing during the manipulation period were not supported, however. For example, there were no differences between the conditions in the amount of gazing away from the experimental situation during the manipulation period. Further, the amount of infant gazing at experimenter's face did not differ as hypothesized between the SF+T and CON conditions. That the infants in the SF+T condition spent the same amount of time gazing at the face than infants in the CON condition may have been due to the fact that at 4 months of age infants are highly responsive to face-to-face interactions (Kaye & Fogel, 1980; Lamb, Morrison, & Malkin, 1987), and thus may be more likely to spend time attending to an adult's face, albeit a still one. Although the hypotheses related to gazing away were not supported, the fact remains that there was a difference in the amount of gaze at face between the CON and NON infants indicating that learning did occur for the CON infants.

Some support for different affect trends accompanying infant gazing during the manipulation period was found. As hypothesized, there were no condition differences for either smiling or fretting during the greeting period indicating that infants were similar at the onset of the study. While there no differential increases or decreases for infant smiling during either the manipulation or reunion periods, fretting was found to increase overall throughout the manipulation period. An interesting difference between the conditions was also found in infant fretting during the manipulation period. Infants in the CON condition exhibited a different pattern of fretting throughout the manipulation period than infants in either the NON or the SF+T conditions. At the beginning of the period infants in the CON condition were exhibiting a low amount of fretting, similar to infants in the SF+T condition. At the end of the period, during the last minute in particular, infant fretting in the CON condition increased dramatically.

This trend in fretting displayed by infants in the CON condition may indicate that, once they had learned the contingency presented to them, the infants became bored with the procedure and perhaps were seeking a different type of stimulation. When they did not receive this stimulation, they became frustrated with the situation and hence increased their fretting (Lewis et al., 1990), possibly attempting to change the experimenter's behaviour. Infants in the NON condition, however, may have been exhibiting a form of learned helplessness (Seligman, 1975) whereby they were not enjoying the interaction, and their social signals (e.g., fretting) had no effect on their environment, and so they possibly "gave up" and remained at a similar level of fretting throughout the period. Infants in the SF+T condition exhibited consistently low levels of fretting, probably due to the fact that they were positively engaged by the more diverse and naturally contingent stimulation they were receiving from the experimenter. Thus, infants displayed different trends in their fretting during the manipulation period depending in which conditions they participated. That the 7-month-old infants did not display differential patterns in their fretting depending on the condition in which they were participating is intriguing, and may be due to the higher levels of expectations the older infants have about social interactions in general, as addressed in the General Discussion to follow.

The hypothesis for infant gaze during the reunion period was partially supported in that 4-month-old infants in the NON condition spent more time gazing away from the experimental situation than infants in the CON condition. These higher amounts of gazing away during the reunion period suggest that after having previously experienced a noncontingent interaction 4-month-old infants are less likely to be easily engaged in interactions immediately following. This appears to be true even if these subsequent interactions are contingent and, as in the present study, include more types of stimulation (i.e., facial and vocal expressions). Although no differential patterns of affect were shown by infants in the CON and NON periods in the reunion period, the gazing away result suggests that having a previous contingent interaction is important for infants at this age.

As in Study 1, the differential infant behaviours during the manipulation and reunion periods provide further evidence for the ability of adults to use the tactile modality to maintain communication between infants and adults during brief social interactions. The contingent and noncontingent relationships between the adult's and infants' behaviours were communicated through the tactile modality alone, and thus, knowledge of the functional abilities of touch was further advanced.

Taken together, the results from Study 2 indicate that infants as young as 4 months of age are capable of learning a specific tactile contingency between their behaviour and another's responses within a social context. Moreover, there was evidence to support the supposition that contingency is important to infants of this age, in terms of their willingness to engage in subsequent social interactions.

General Discussion

The results from Studies 1 and 2 indicate that infants at both 7 and 4 months of age are able to learn a tactile contingency occurring within a social context. Results from the gaze at face and gaze away measures provided evidence for this learning. The affect results also revealed some differences in the trends in fretting for the 4-month-old infants that accompanied their learning, suggesting the importance of contingency in social interactions for infants at this age. Differences between conditions were also obtained in gaze away for the 4-month-old infants during the reunion period, suggesting the importance of contingency for future interactions. Furthermore, the social contingencies were presented within the tactile modality alone, providing further evidence for the ability of adults to use this modality to maintain communication with infants during face-to-face interactions.

Although they were receiving the same stimulation (confirmed by the reliability checks on experimenter movement and touch) the 7- and 4-month-old infants for whom the stimulation was contingent on their behaviour gazed more at the experimenter's still face during the manipulation period than the infants for whom the stimulation was not contingent on their behaviour. This result indicates that young infants, even at 4 months of age, are capable of learning a tactile-gaze contingency within a social interaction, thus confirming the first objective of the present studies.

Based on the overall planned comparisons in the present studies it is clear that the infants in the contingent condition learned the contingency presented to them. A further examination of the learning curves of the contingent response (infant gaze at the experimenter's face) was conducted, however, to establish if a similar pattern of learning occurred when the contingent relationship was presented within a social interaction as when it is presented in more perceptual-cognitive studies (e.g., Sullivan & Lewis, 1989). The data for infant gaze at face for the two studies were reduced and analyzed in the same fashion as the data for infant affect, and the trends are represented in Figures 9 and 10 for Study 1 and Study 2 respectively. As can be seen in the figures, the patterns of gaze at face were different for infants in the CON conditions than infants in either the NON or the SF+T conditions. For infants in the CON conditions at both 7 and 4 months of age, there was an increase in responding that reached a peak, and then gradually decreased towards the end of the period. The learning curve for the CON condition was similar to the learning curve revealed in Sullivan and Lewis' study, even though the contingency was presented within a social interaction in the present studies. Thus, infants appear to exhibit the same types of learning responses to contingencies presented within a social and a nonsocial context.

In contrast to the learning curve shown by infants in the CON condition, infants in the NON condition in the present studies exhibited a linear decrease in the amount of gazing at the experimenter's face, indicating their reaction to the lack of reinforcement for maintaining their gaze at the still face; $F(1, 11) = 22.70$, $p < .001$ and $F(1, 11) = 13.33$, $p < .01$ for Studies 1 and 2, respectively. The 7-month-old infants in the SF+T condition in Study 1 also showed a linear decrease in gazing at the experimenter's face throughout the period, $F(1, 11) = 9.61$, $p < .05$. This result is not surprising given previous research indicating that, during standard SF with touch periods, infants generally decrease the

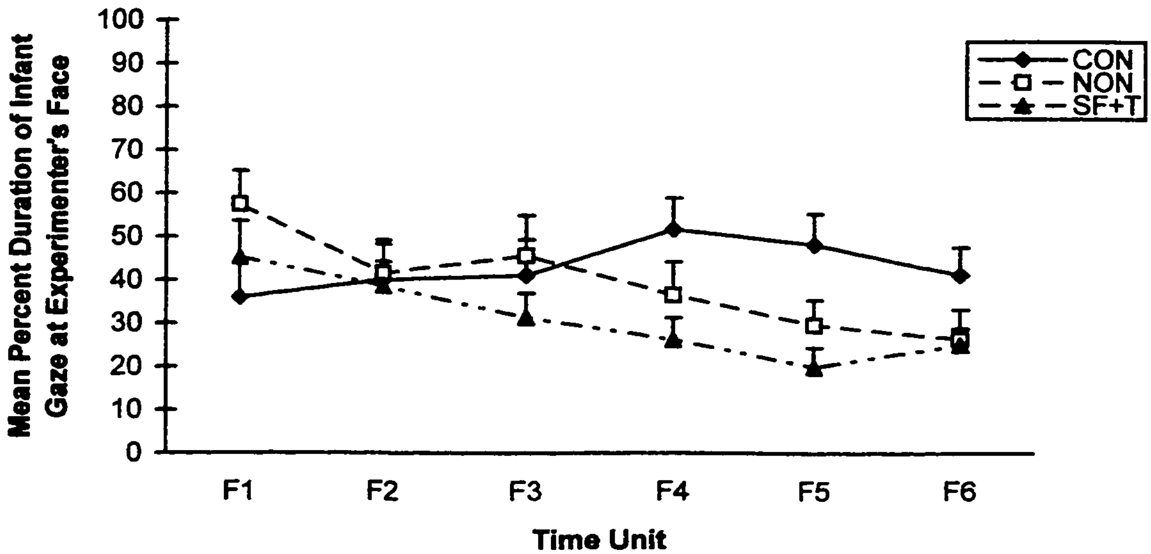

Figure 9. Mean percentage of time 7-month-old infants spent gazing at experimenter's face during the manipulation period as a function of 30-s time unit (F1, F2, F3, F4, F5, F6) and condition (CON, NON, SF+T).
Standard errors are shown by vertical bars.

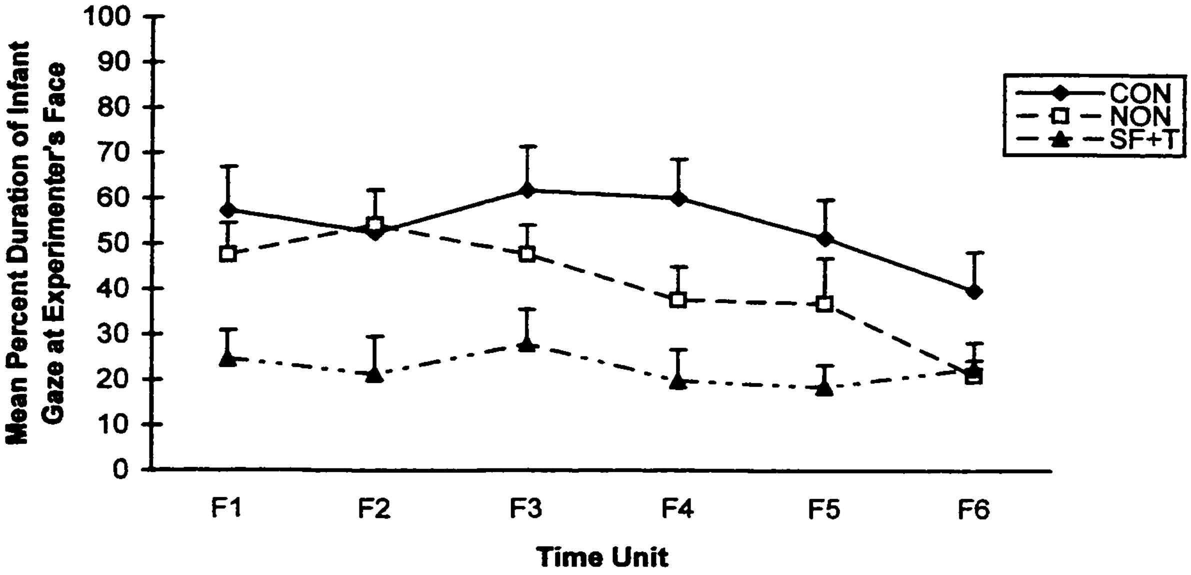

Figure 10. Mean percentage of time 4-month-old infants spent gazing at experimenter's face during the manipulation period as a function of 30-s time unit (F1, F2, F3, F4, F5, F6) and condition (CON, NON, SF+T).
Standard errors are shown by vertical bars.

amount of gaze towards the adult's face in comparison with normal periods (Stack & LePage, 1996; Stack & Muir, 1990, 1992; see Figure 9).

The 4-month-old infants in the SF+T condition in Study 2 exhibited a significant quartile trend in their gaze at the experimenter's face, $F(1, 11) = 5.25$, $p < .05$ (Figure 10). This variable pattern of infant gazing at face could be reflective of the changes in the experimenter's tactile stimulation, and the infants' subsequent reactions to those changes. That the 4-month-old infants exhibited this variable gazing at the experimenter's face as opposed to the linear decrease found with the 7-month-olds may be due to the increased salience of face-to-face interactions for infants at 4 months of age, as suggested in the discussion for Study 2 (Lamb et al., 1987).

Overall, the examinations of the reinforced response from the infants, gazing at the experimenter's face, indicated that infants at both 4 and 7 months of age are capable of learning a tactile contingency presented to them within a social context. They showed higher amounts of gazing at face when reinforced to do so, and they showed similar learning curves to those exhibited by infants who were learning contingencies within more perceptual-cognitive contexts (Sullivan & Lewis, 1989). Thus, infants at both ages in the present studies learned the tactile social contingency presented to them.

When examining the duration of infant gazing away from the experimental situation, however, only the 7-month-old infants in the NON condition responded to the lack of contingency by disengaging from the situation whereas the 4-month-olds did not disengage during the manipulation period. As discussed in Study 1, this result suggests that the 7-month-olds in the NON condition were less interested in, and perhaps bored with, the experimental situation, and therefore spent more time looking around the room. That the 4-month-olds in the NON condition did not increase their gazing away during the manipulation period could indicate that they may have required more time within which to process the information, or lack of relationship, between their behaviours and that of the experimenter (e.g., Zelazo, Kearsley, & Stack, 1995). Indeed, the 4-month-olds did show a difference in the reunion period, such that infants in the NON condition spent more time gazing away from the experimenter during the reunion period than infants in the CON condition. It could be that the 4-month-olds in the NON condition were slower to process the stimulation during the manipulation period, and therefore their gazing away occurred primarily during the subsequent reunion period, whereas the developmentally more mature 7-month-olds reacted more quickly by gazing away during the manipulation period itself. Alternatively, the pattern of stimulation provided, while not contingent with their behaviours, may have still been compelling to the 4-month-old infants, thus maintaining their gaze within the interaction.

The results from the affect measures were also discrepant between the 7- and 4-month-olds in the present studies. The 7-month-olds did not show any differences between conditions in their patterns of affect throughout the study, whereas the 4-month-olds exhibited differential fretting, depending on the condition in which they participated. Thus, the second objective was achieved for the 4-month-old infants only. For example, 4-month-old infants in the CON condition increased their fretting dramatically at the end of the manipulation period. An examination of the trends in 4-month-old infants' gazing at the experimenter's face and their pattern of fretting during the manipulation period, as illustrated in Figure 11, reveals that the increase in fretting for infants in the CON condition is associated with the downward trend in the amount of gaze at face. Thus, the increase in fretting only occurred after the peak of infants' responding to the contingent stimulation.

An examination of the frequencies of the sadness and fussing exhibited by infants in the contingent group in Sullivan and Lewis' (1989) study illustrates a similar increase in these behaviours after the peak of the learned response, as in Study 2 of the present series. Sullivan and Lewis discussed this finding briefly in relation to the sadness in older children that can occur when a pleasurable event ends. They further suggested that, since it appears after the peak of the required response, the sadness is not related to boredom or fatigue, but it is possibly associated with the concept of mastery. As was suggested in the discussion of Study 2 of the present series, perhaps the 4-month-old infants in this study had learned the contingency and they now wanted a different type of stimulation, or a new challenge, from the experimenter.

The fact that only the 4-month-old infants, and not the 7-month-olds, showed these different fretting patterns is curious, and not easily explained. Possibly, some sort of developmental shift may be occurring at 7 months of age that masks the effects of learning on infants' affective responses. According to Lamb (1988) many researchers would agree that between the ages of 6 and 8 months there are major changes that take place in the nature of the social world of the infant. For example, many infants between these ages exhibit stranger and separation anxiety as well as developing social attachments (e.g., Lamb, 1988). The 7-month-olds in this study were interacting with a

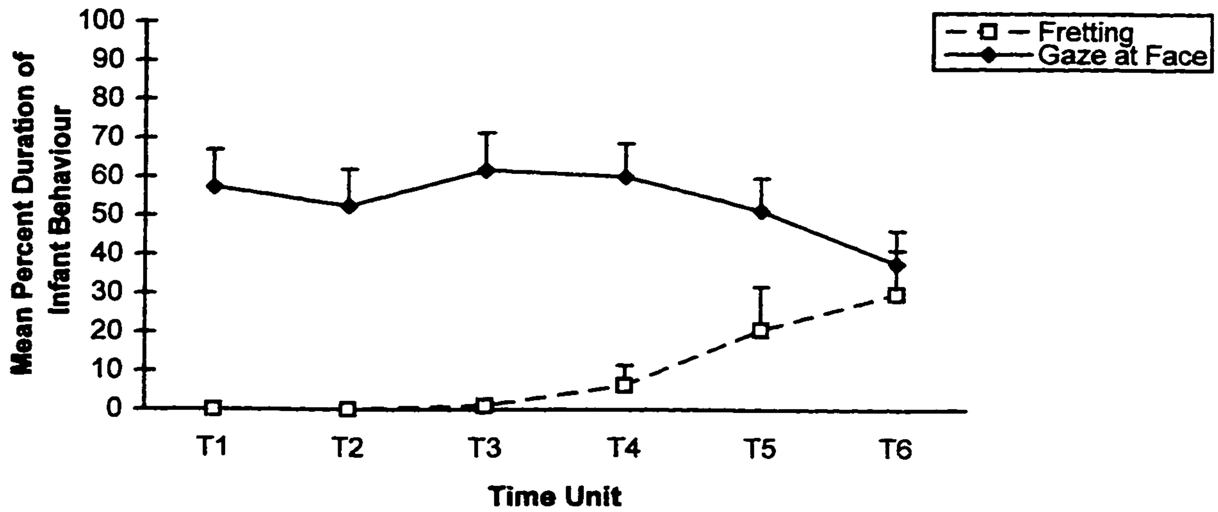

Figure 11. Mean percentage of time 4-month-old infants in the CON condition spent responding during the manipulation period as a function of 30-s time unit (T1, T2, T3, T4, T5, T6) and infant behaviour (Fretting, Gaze at Face).
Standard errors are shown by vertical bars.

stranger and the fairly high attrition rate was primarily due to displays of stranger wariness or separation anxiety. It is possible, then, that the infants that remained in the study were a variable group in that some had moved past this anxiety, some had not yet experienced the anxiety, and some would never experience it. Perhaps the variability in the social backgrounds of the 7-month-olds in the present study, at this potentially crucial point in their social-emotional development, masked any differential affective responses between the conditions. Such variability may account for the lack of different trends in infant affect between the conditions for the 7-month-old infants.

The 7-month-old infants also did not exhibit differences in their affective responding or gaze during the reunion period. Thus, the third objective of the present studies was only obtained for the 4-month-old infants in Study 2; only the 4-month-old infants showed differences in Gaze Away between the conditions during the reunion period. The possible variability of the group of 7-month-olds may have again masked any differential responding between the conditions during this final period, as discussed above, although this result could also be due to their higher levels of expectations during social interactions. The hypothesis that infants in the NON condition would gaze away more during the reunion period than infants in the CON condition was based on results from the study by Dunham et al. (1989) as well as others (e.g., Glenn et al., 1994). The results in Dunham et al.'s study, however, were obtained with infants at 3 months of age, whereas Study 1 was conducted with 7-month-old infants. Perhaps as infants age they tend to build up their expectancies for the levels of contingency that should be present in their interactions with others, and thus are less likely to be influenced merely by one noncontingent interaction, but instead rely on their experience with past interactions (e.g., Bigelow et al., 1996; Hains & Muir, 1996a).

Indeed, several researchers agree with a social expectancy model in which it has been hypothesized that infants build up and form expectancies based on their past experiences (e.g., Glenn et al., 1994; Hains & Muir, 1996a; Murray & Trevarthen, 1985; Papousek et al., 1986; Seligman, 1975; Suomi, 1981; Tronick, 1989). Certainly, within an experimental situation infants have been shown to develop expectancies about the behaviour of an adult or stimulus, as evident in studies examining infants' responses during extinction periods and during contingent periods following noncontingent periods, or vice versa (e.g., Allesandri et al., 1990; Glenn et al., 1994). For example, Hains and Muir (1996a) found that 5-month-old infants showed a decrease in gaze and positive affect only to a noncontingent stranger, while they maintained their levels of gaze and positive affect towards their noncontingent mothers. They discussed this difference in terms of the expectancies that the infants had built up about the types of interactions (specifically, the level of contingency) they usually have with their mothers. The brief period during which their mothers were acting noncontingently was not unusual enough to violate the 5-month-old infants' expectations (whereas a still-faced mother would be a much larger discrepancy for the infants; Hains & Muir, 1996a). In contrast, the 5-month-olds would not have built up any expectations about the behaviour of the stranger as they had had no previous experience with the particular adult (Hains & Muir, 1996a). Therefore, after having received only one positive contingent interaction, the infants demonstrated their disinterest in a noncontingent interaction by decreasing their gaze and positive affect towards the stranger.

Presumably, as infant grow older they would continue to develop their expectancies for interactions not only with their primary caregivers, but also with adults in general. Thus, it would not be too outlandish to propose that the 7-month-old infants in the present Study 1 may have experienced a sufficient number of contingent interactions with different adult strangers to expect most adults to interact contingently with them. Therefore, the relatively brief noncontingent interaction that they experienced in this study might not have been enough to shake their expectancies that most interactions would be contingent, which would have lead them to readily re-engage with the experimenter during the reunion period.

Thus, the finding that the 4-month-old infants in the NON condition in Study 2 showed the hypothesized increase in gaze away during the reunion period could be explained by the fact that they have not yet developed the type of long-term expectancies that older infants may have developed. Infants at 4 months of age might not yet be generalizing from one adult's behaviour to another and therefore might not expect that all adults would respond contingently to them during social interactions. Indeed, if the 5-month-old infants in Hains and Muir's (1996a) study had not yet built up these expectations, we cannot assume that younger infants, with less experience, would have this knowledge. Thus, based on the results from Study 2, 4-month-old infants appear to be influenced more by recent interactions as opposed to generalizing from their more distant prior experiences. Therefore, if they have previously received a noncontingent interaction they will respond to a subsequent contingent interaction similarly to those infants in Dunham et al.'s (1989) and other's studies (e.g., Bigelow et al., 1996; Glenn et al., 1994; Hains & Muir, 1996a) , whereby they appear less motivated to participate in the interaction, even if it is contingent.

The final objective of the present studies was obtained for both ages. Infants at 4 and 7 months of age are able to learn contingencies when the reinforcer is tactile in nature, which indicates the sophistication of young infants' developing abilities, and the versatility of the tactile modality. The only form of communication from the adult to the infant during the manipulation period for each condition was touch, and yet infants who were receiving contingent stimulation remained engaged in the situation, and appeared to have learned the contingent relationship between the tactile stimulation and their gaze. These infants gazed more at the experimenter's face when they were receiving touch as a reward for doing so.

Overall, the results from Studies 1 and 2 provide evidence that infants at 7 and at 4 months of age are sensitive to, and are capable of learning, a contingent relationship between their behaviours and that of a female stranger within a social context. This contingent relationship was delivered within the tactile modality alone, which further indicates the abilities of this modality to maintain communication between infants and adults. The contingency presented to the infants in these two studies was, however, a direct relationship between a single response (infants' gazing at the experimenter's face) and a single reinforcer (the experimenter moving the infants' legs up and down). Extending these results into a more natural social interaction would allow for further examination of the young infant's sensitivity to contingencies, or lack thereof, during social interchanges. Thus, it remains to be determined whether infants at 4 and 7 months of age are able to distinguish between more complex contingent and noncontingent relationships during which more than one response and reinforcer exist.

CHAPTER 3

Study 3

In Studies 1 and 2, 7- and 4-month-old infants' abilities to learn a tactile contingency within a social context were examined. The results from these two studies provided evidence that infants at 4 and 7 months of age are able to learn a simple relationship between their behaviour and that of an adult during a social interaction. While these findings have important implications, as discussed in Chapter 2, the contexts within which learning took place were somewhat constrained in that there was a distinct contingent relationship between a specific response and a specific reinforcer. This type of explicit relationship rarely exists during normal social interchanges and thus a more complete examination of young infants' capabilities within natural social interactions was warranted. Therefore, Study 3 was designed to extend the results from Studies 1 and 2 to a more ecologically-valid context. In Study 3, the levels of contingency presumed to be inherent during more natural social interactions (e.g., Hains & Muir, 1996b) were manipulated, and infants' responses to the manipulations were examined.

Similar to the first two studies, infants participated in three face-to-face social, touch-only, interactions. In the present study, however, infants were interacting with their mothers. Mothers were asked to play normally with their infants during the first (greeting) and third (reunion) periods. During the second (manipulation) period mothers were asked to be still-faced and silent and interact with their infants using only touch. In one condition mothers were simply asked to play with their infants using only touch, as the experimenter did during the SF+T manipulation period in Studies 1 and 2 (CON). In the second condition mothers were asked to imitate the hand and touching actions of the mothers in the first condition (NON). Thus, the mothers in the NON condition were not interacting contingently with their infants, but their infants were receiving the same type and overall amount of stimulation as those infants in the CON condition. This yoked procedure ensured that the principal difference between the conditions was the amount of contingency between the mothers and their infants.

Use of the SF with touch procedure in the present study provided a natural extension from the first two studies. More importantly, however, use of only one modality of maternal responding enabled a more direct examination of the effects of contingency on infants' responses during social interactions than would be obtained if all modalities (i.e., face, voice, and touch) were used. If mothers were using all modalities, it would be difficult to isolate to which aspects of the interaction the infants were responding, and the effects of varying levels of contingency might be masked by the effects of the different modalities on infants' behaviours. Although the interactions were not as natural as those in which mothers use all modalities, it has been established that touch-alone interactions can maintain communication and regulate infants' affect for brief periods of time, and these interactions appear to contain a high level of contingency between the mother and infant (e.g., LePage & Stack, 1998). Therefore, an examination of infants' responses during these touch-alone manipulation periods was expected to provide a clear indication of whether infants were sensitive to the contingency, or lack thereof, in their mothers' touching behaviours.

As a second natural extension from the first two studies, mothers, rather than a stranger, participated in the touch-alone social interactions in the present study. In the first two studies, the operant-learning paradigm necessitated a standardized procedure in which the same adult interacted with each infant. In the present study, however, the generalizability of the results would be increased by examining mothers interacting with their own infants. Parents provide the most opportunities for contingencies as the infant develops, and past studies have primarily examined mothers interacting with their infants (e.g., Dunham & Dunham, 1990; Tarabulsy et al., 1996). Furthermore, infants appear to respond differentially to contingent strangers depending on how similar the stranger's level of contingent responsiveness is to their mothers' levels of contingency during social interactions (Bigelow, 1998). Four- and 5-month-old infants appeared to be more responsive to strangers who interacted at a similar level of contingency as their mothers (Bigelow, 1998). A stranger's level of contingent responsiveness during the social interactions in the present study may not be similar to that of each infant's mother. Therefore, if a stranger were to be used in the present study, the effects of a noncontingent social interaction on infants' reactions might be confounded by the varying levels of infants' responsiveness to the stranger during the initial, contingent, greeting period. Thus, an exploration of infants' reactions and sensitivities to noncontingent social interactions in general should begin with an examination of their responses to their noncontingent mothers. Once infants' reactions to their noncontingent mothers have been established, further examinations of their reactions to different noncontingent adults can be conducted.

Research has suggested that infants will respond differently to noncontingent strangers than to their noncontingent mothers (e.g., Hains & Muir, 1996a). For example, Hains and Muir (1996a) found that 5-month-old infants displayed the hypothesized negative reactions to the noncontingent strangers, but not to their noncontingent mothers. Hains and Muir suggested that by this age infants have developed expectations that social interactions with their mothers would be contingent, and therefore the brief period of noncontingent mother-infant interaction in their study was not enough to elicit negative responses from the infants.

Although the results and interpretations of Hains and Muir's (1996a) research are intriguing, there are some limitations to this study. Specifically, the adults were presented to the infants over a video-monitor, which, besides reducing the opportunity for natural communication (including tactile stimulation), could also have implications for infants' differential reactions to their mothers compared to the stranger. For example, infants may have had opportunities to watch strangers on a similar monitor (e.g., on television), however they would have been less likely to have previously seen their mothers on a video-monitor. Therefore, the novelty of the situation may have been greater during the mother-infant than the stranger-infant interactions, thus maintaining infants' interest and decreasing the likelihood of negative reactions. Further, since the time-frame was relatively brief (90 s), infants may not have had the opportunity to realize that their mothers were interacting in a more unusual fashion than merely being on a video-monitor. Indeed, Bigelow et al. (1996) used 2 min interaction periods and they found that infants as young as 4 months of age responded with decreased attention and smiling to noncontingent, televised replays of their mothers. Given the discrepancies between these studies, more information on infants' reactions to their mothers during contingent and noncontingent social interactions is warranted.

Thus, the first objective of Study 3 was to determine if infants could perceive and were sensitive to the difference between a social interaction with their mothers in which contingency was present, versus one in which contingency was absent. In addition, responses of infants at both 4 and 7 months of age to their contingent or noncontingent mothers were examined, thus extending the first two studies, as well as providing a developmental perspective on infants' capabilities within these social interactions.

Both infants' gazing and affective responses were examined to determine if infants in the two conditions were reacting differently to their mothers. Trend analyses were selected to examine the gazing and affect patterns in the present study. The decision to use trend analyses for the gaze measures in Study 3, whereas planned comparisons were used in the first two studies, was based on the question addressed. In Studies 1 and 2 the specific hypotheses to address the question of whether infants learned the contingency could not be answered solely through an examination of the trends of their gazing behaviours. The question in Study 3, however, was whether infants respond differently during a more natural social interaction with their mothers. Mother-infant social interactions are assumed to be bi-directional (e.g., Vos et al., 1990), and thus it is not possible to label any infant or mother behaviour as the required response or the reinforcer for that response. Thus, an analysis of the duration of the infants' behaviours in the present study would not adequately capture the intricacies of these interactions. In contrast, an examination of the trends of infant gazing and affect throughout the manipulation period would provide a more detailed illustration of the patterns of infants' reactions to their mothers' behaviours during a contingent or noncontingent social, touch-alone interaction.

The primary hypothesis in Study 3 was that infants in the CON condition would exhibit different patterns of gazing and affect than infants in the NON condition during the manipulation period. Specifically, 4-month-old infants in the CON condition were hypothesized to show a varied amount of gazing towards their mothers' faces. This varied amount of gazing at their mothers' faces might be similar to the gazing patterns exhibited by 4-month-olds in the SF+T condition in Study 2, since the CON condition was identical to the SF+T condition in the first two studies, as described above. The variability in their gazing might be reflective of changes in the types or styles of maternal touching, as suggested in Study 2. The 7-month-olds in the CON condition were expected to show a linear decrease in the amount of gazing at the mothers' faces, again similar to infants in the SF+T condition in Study 1. As discussed in Study 1, this decrease in gazing at the mothers' faces would likely reflect a shift in attention to the mothers' active hands (Stack & LePage, 1996). In terms of gazing away from the experimental situation, infants in the CON condition for both age groups were expected to exhibit a low, stable amount of gazing away, as their attention was expected to be maintained within the experimental situation, similar to the infants in the SF+T condition in the first two studies.

Infants in the NON condition for both age groups were expected to display a linear decrease in gazing at their mothers' faces with a linear increase in gazing away, indicating their boredom, or dislike of the noncontingent stimulation they were receiving from their mothers. Given the results from Studies 1 and 2, this trend in gazing away might be more evident for the 7-month-old infants as the 4-month-olds may require more time within which to process information about the interaction with their mothers (e.g., Zelazo et al., 1995).

In terms of their affective displays, infants in the CON condition were hypothesized to exhibit varying levels of smiling throughout the manipulation period in response to their mothers' touching behaviours, again similar to the smiling exhibited by the 4-month-old infants in Study 2. Infants in the CON condition were also expected to show low, stable levels of fretting throughout the manipulation period. Infants in the NON condition were hypothesized to exhibit a linear decrease in their smiling throughout the manipulation period, with a linear increase in fretting during this period, possibly indicating their displeasure with the noncontingent interaction. Because there were no smiling or fretting differences between the conditions found for the 7-month-olds in Study 1, the hypothesized trends in affect during the manipulation period may be more evident for the 4-month-olds. Since in the present study the 7-month-olds were interacting with their mothers, however, and therefore stranger wariness was not an issue, the hypotheses for affect included the older infants. In summary, overall, infants at both ages were expected to show differential responding during the manipulation period based on whether they had received contingent or noncontingent social interactions from their mothers.

The second objective in the present study was to examine patterns in infants' gazing and affect during the reunion period, based on whether they had received a contingent or noncontingent interaction with their mothers during the manipulation period. During the reunion period, infants in the CON condition were expected to maintain higher and stable levels of gazing at their mothers' faces, and lower, stable levels of gazing away from the interaction, when compared to infants in the NON condition, due to the fact that their mothers were now using their faces and voices, as well as touch, to play with their infants. Infants in the NON condition, however, were expected to exhibit a slight linear increase in gazing at their mothers' faces, as they were slowly brought back into the interaction with the use of contingency, as well as facial and vocal expressions. In contrast, these infants were expected to show a linear decrease in their gazing away from the interaction during the reunion period. These results were hypothesized to occur in both age groups.

In terms of their affective responding during the reunion period it was anticipated that infants in the CON condition would exhibit stable levels of smiling and fretting throughout the period as they continued to participate in a contingent interaction with their mothers. Infants in the NON condition, however, were expected to show a linear increase from a low level of smiling and a linear decrease from a high level of fretting during the reunion period as they slowly became re-engaged in an interaction with their mothers.

The third objective in the present study, again similar to Studies 1 and 2, was to examine further the tactile channel of communication during social interactions. By using the SF with touch procedure, results from Studies 1 and 2 were extended to more naturalistic contexts. Further, results from previous studies examining mother-infant touch-alone interactions (e.g., Stack & LePage, 1996) were augmented by manipulating the contingency in these interactions, and examining infants' responses to these manipulations.

As a measure of reliability, the qualitative types (e.g., stroke, tickle) of touch mothers used with their infants were examined and compared to ensure that matched infants in the CON and NON conditions were receiving the same amount and type of stimulation during the manipulation period.

Thus, Study 3 extended the results from Studies 1 and 2 by examining infants' gazing and affective trends during contingent versus noncontingent touch-alone interactions with their mothers. Infants' responses during these more natural social interactions were anticipated to advance our understanding of the importance of contingency within social interactions.

Method

Participants

Participants were recruited as in the first two studies. The sample consisted of 59 healthy, full-term 4- and 7-month-old infants. Eleven infants were excluded from the analyses due to dislike of the chair (three 7-month-olds), fatigue (one 4-month-old), extreme gaze patterns (one 4-month-old), maternal difficulty with SF situation (one 7-month-old), maternal difficulty with imitation (one 7-month-old) and because some infants became engaged with the video monitor that was placed behind their heads (one 4-month-old; three 7-month-olds). The final sample consisted of 48 infants, half 4-month-olds (mean age = 4 months, 8.5 days, sd = 5.80 days) and half 7-month-olds (mean age = 7 months, 6.79 days, sd = 6.80 days). The majority of the participants were white (86%), and middle-class (94%; see Appendix K for detailed demographic information). There were equal numbers of boys and girls in the two experimental conditions and in the two age groups. The infants in the CON condition were randomly assigned. The sex and age of the infants in the NON condition were selected based on the sex and age of the infants in the CON condition. Ages of infants in the NON condition were matched to within 3 days before or 3 days after the ages of the infants in the CON condition. Power analyses conducted before the commencement of subject recruitment confirmed that sufficient power would be obtained with 33 subjects (Cohen, 1977).

Apparatus

The apparatus was similar to that used in Studies 1 and 2, except for a few minor changes outlined below. The video camera located to the right of the infant was no longer required as the mother was seated in front of her infant, instead of behind the black partition. Along with the one camera behind and to the right of the mother, which recorded the infant's face and body and the mother's hands, a Sony video camera was located above and to the left of the mother, and it recorded a top-down view of the mother's hands and the infant's body.

The audio-cassette recorder used in the first two studies was no longer required. The video recorder, which was located on the shelf of the VCR cart, was also removed. Instead, the video monitor located above and behind the infant seat was attached to a video recorder located behind the black partition. This video recorder was attached to a video monitor also behind the black partition. Therefore, playback of the video was displayed on both the monitor above and behind the infant seat and the monitor behind the black partition. The experimenter was located behind the black partition and used a hand-timer to measure the duration of the greeting and reunion periods for all infants and for the manipulation period for infants in the CON condition. For the manipulation period for infants in the NON condition the experimenter played back the recording of the appropriate contingent mother and her infant during their manipulation period. This image appeared both on the video monitor located above the infants' heads and the video monitor located behind the black partition. Thus, by viewing the video monitor behind the black partition, the experimenter used the time-line displayed on the recording from the contingent mother's interaction to indicate when the manipulation period for the noncontingent mother began and ended. The beginning and ending of each period was indicated to the mother by the experimenter who tapped lightly on the black partition.

As in Study 2, a pillow was placed on the seat for the 4-month-old infants so that the level of their heads was comparable to that of the 7-month-olds. This pillow facilitated the mothers' view of the video monitor while interacting with their infants.

Design

Each mother-infant pair participated in three interaction periods. The first and third periods were 1 min in duration, and the second period was 3 min. Inter-period intervals lasting 20 s occurred between each period. There were two experimental conditions within each of two infant ages (4 and 7 months). For all infants the first (greeting) and third (reunion) periods consisted of a normal interaction between the mothers and their infants, in which mothers were permitted to use facial expression, voice, and touch to play with their infants. The second period for all groups consisted of a modified SF period in which mothers were asked to remain silent and still faced throughout the period, and use only touch to interact with their infants (manipulation period).

In the first experimental condition (CON) mothers were asked to remain still-faced and silent and play with their infants using touch, an interaction that appears to contain a high level of contingency (LePage & Stack, 1998). In the second experimental condition (NON), mothers were asked to mimic or imitate the hand and touching movements of the mothers in the first condition (CON) when playing with their infants (see Appendix L for the detailed instructions to mothers). In this way, the only difference between the two conditions within each age was the level of contingency between the infant's and the mother's responses during the manipulation period. Table 4 illustrates the design for the study.

Procedure

The procedure for this study was similar to that of Studies 1 and 2. Once the mothers and infants were relaxed and comfortable, and after mothers had signed the informed consent form (Appendix M), they were escorted to the testing room. Infants were placed in the infant seat and mothers were seated in front of their infants, at eye level, on an adjustable stool. After the experimenter explained the instructions for the first period, she left the testing chamber and indicated the beginning of the period with a light tap on the black partition. The timer was set for 60 s, after which the experimenter

Table 4

Design Table for Study 3

Age	Condition	
	CON	NON
Period	G Man R	G Man R
4-month-olds	boys	boys
	n = 6	n = 6
	girls	girls
	n = 6	n = 6
7-month-olds	boys	boys
	n = 6	n = 6
	girls	girls
	n = 6	n = 6

Note. CON = contingent condition; NON = noncontingent condition; G = greeting period; Man = manipulation period; R = reunion period.

tapped on the black partition indicating the end of the period. The experimenter then re-entered the testing area and played with the infant for 20 s, consistent with previous studies using a similar paradigm (e.g., Stack & LePage, 1996). During this interval the instructions for the next period were given to the mother. Also during the inter-period interval, the video monitor located behind the infants' heads was turned on for the manipulation period. After the manipulation period, the monitor was turned off for the reunion period. Throughout the SF periods a reliability check was conducted on the participants to ensure that the mothers were maintaining a still face and that they were looking at the level of their infants' lower-foreheads, just above their eyes. If the mother was not following the experimental instructions adequately, testing was stopped, and then resumed once the instructions had been repeated ($\underline{n}$ = 3).

Before the testing session began, mothers in the NON condition had the opportunity to view the video recording of the contingent manipulation period between the CON mother-infant pair with which they had been matched, so they had an indication of how the CON mothers interacted with their infants during the SF with touch period. The contingent interaction was shown to the NON mothers on the video monitor located behind the black partitions. Once the testing sessions had begun, during the manipulation period the contingent interaction was displayed on the video monitor located above the infants' heads. Again, the video monitor was positioned such that the mothers were able to continue looking at the lower-foreheads of their infants (to maintain the semblance of eye-contact; see Control Study 1) while also seeing the image on the monitor. Mothers in both conditions were asked to direct their gaze at their infants' lower-foreheads so that they would be able to view the image on the video monitor while appearing to maintain gaze towards their infants. The video monitor was turned on (with no sound) during the manipulation period for both conditions to maintain consistency between the conditions. A local television station was played for the CON mothers, and the playback image of a CON mother interacting with her infant was played for the NON mothers.

As in Studies 1 and 2, at the end of the testing session the mother and infant were escorted back to the waiting room where the experimenter asked the mother a number of questions concerning the infant's history and family demographics (Appendix C). At this time, mothers in the CON condition were asked to sign a consent form (Appendix N) indicating their consent to have a mother from the NON condition view the video image of them playing with their infant. If they agreed, this image of the manipulation period was shown to the noncontingent mothers with the sound off and with no identifying information displayed. If they did not agree ($\underline{n} = 0$) they would have been replaced, however, this did not occur.

Dependent Measures and Coding

The behaviours examined from the videotapes were: (a) infant gaze at mothers' faces, (b) infant gaze away from experimental situation, (c) infant smiling, (d) infant fretting, and (e) type, (f) intensity, and (g) speed of maternal touch. The infant behaviours were coded as in the previous studies.

Type, intensity, and speed of maternal touch were assessed using the Caregiver-Infant Touch Scale (CITS; Stack et al., 1996), which measures both qualitative and quantitative dimensions of touching. This scale consists of 8 mutually exclusive categories of type of touch plus a no-touch category (see Table 5) and has been shown to have good reliability and validity when evaluated both within and between different labs (Stack, LePage, Hains, & Muir, 1998). It is coded using a second-by-second format whereby for each second of interaction the type of touch, plus various other measures such as the area of the infant's body, the context of the touch, and the intensity and speed of touch, are determined. For the present study, analyses were conducted on type of touch, and on the intensity and speed of the touch. Both intensity and speed are coded using 3-point scales representing low, moderate, and high levels of the measure (Table 5).

As in Studies 1 and 2, observers were trained on videotape examples prior to scoring the present data until they achieved high reliability ($r > .90$) with experienced coders. Coders were blind to the experimental condition in which the infant participated, and all coding was conducted with the sound off to diminish any external cues of the infants' responses. As a further control, reliability coders were also blind to the hypotheses of the study. Inter-rater reliability was assessed by a blind observer for 1/3 of the records upon completion of coding. Intraclass correlation coefficients, conducted on the maternal touching variables that were analyzed through ANOVA's (see below), were all high, ranging from $r = .89$ to $r = .98$ (type of touch = .98; intensity of touch = .91; speed of touch = .89). Cohen's kappa coefficients conducted on the infant variables that were analyzed through trend analyses (see below) were also high, ranging from $r_k = .80$ to $r_k = .89$ (gaze at face = .89; gaze away = .83; smile = .80; fret = .88).

Data Reduction and Preparation

To assess the reliability of touching behaviours between the CON-NON mother

Table 5

Categories of the Caregiver-Infant Touch Scale (CITS)

Type of Touch	Intensity	Speed
0. No-Touch	1. Low	1. Low
1. Static Touch (Hold, Rest)	2. Moderate	2. Moderate
2. Stroke/Caress/Rub/Massage	3. High	3. High
3. Pat/Tap		
4. Squeeze/Pinch/Grasp		
5. Tickle/Finger Walk/Prod/Poke/Push		
6. Shake/Wiggle		
7. Pull/Lift/Flexion/Extension/Clap		
8. Other (e.g., kiss, wipe, adjust posture)		

pairs during the manipulation period, the type of touch coded for the CON-NON mother pair was compared for each second during the manipulation period and a Kappa reliability coefficient was obtained for each pair. Any CON-NON mother pair who did not obtain a Kappa coefficient of at least $r_k = .60$, which is considered a moderate amount of reliability (Cohen, 1968), was replaced ($n = 1$).

After obtaining the desired number of CON-NON mother pairs who achieved kappa scores of $r_k = .60$ or higher, it was deemed useful to conduct an examination of the amount of time each CON-NON mother pair spent using each type of touch to maintain further that the mothers in the NON condition were adequately imitating their CON partners. This examination was extended to the greeting and reunion periods as any differences between the conditions in maternal touching behaviours in these periods might be reflected in differences in subsequent infant responses as well. Further, an examination of the durations of the intensity and speed of maternal touch used by each CON-NON mother pair was included. This comparison on not only the quality, or type, of touch, but also the intensity and speed of the touch was conducted between the paired CON-NON mothers to ensure that the infants were indeed receiving similar tactile stimulation from their mothers throughout the study.

The frequencies and durations of type, intensity, and speed of touch were tallied for each subject, and percent durations of these measures for each period were obtained. For the type of touch, the percent duration was based on the length of the period (i.e., 60 s for the greeting and reunion periods, and 180 s for the manipulation period). For intensity and speed of touch, however, the percent durations were based on the amount of time the mothers spent in tactile contact with their infants (e.g., when type of touch was coded as no-touch, neither intensity nor speed was coded). A comparison of these percent durations between the CON and NON mothers during the three periods was then conducted.

Once it was established that the imitation of mothers in the NON condition during the manipulation period was successful, the data for the infant behaviours (gaze at face, gaze away, smiling, and fretting) were reduced into time units so that a trend analysis on the changes in these behaviours throughout the manipulation period could be conducted. The data for the greeting and reunion periods were split into 3 20-s time units, and the data for the manipulation period were split into 6 30-s time units, as in Studies 1 and 2. The percent duration of each infant behaviour during those time units was then obtained for analysis.

Results

For ease of comprehension, the results for the present study are separated into two sections. The first section focuses on the reliability for the type, intensity, and speed of maternal touching, as assessed by the CITS, to establish that mothers in the NON condition were successfully imitating the touching behaviours of mothers in the CON condition during the manipulation period. This section also includes a comparison of the touching behaviours between the two conditions during the greeting and the reunion periods.

Once it was established that mothers in the NON condition successfully imitated mothers in the CON condition during the manipulation period, the second section of results focuses on the infants' reactions to their mother's behaviours throughout the study. Thus, an examination of infant gazing and affective trends across the three interaction periods is discussed.

Reliability in Maternal Touching Behaviours

Three orthogonal dependent variables were included in these analyses: percent durations of time spent using each (a) type, (b) intensity, and (c) speed of maternal touch. Each dependent variable will be discussed separately.

The data were first assessed for any non-normality or outliers. If transformations were required, these are mentioned at the relevant point in the text. For ease of comprehension, raw means are presented in the text and tables. Following the screening analyses, split-plot ANOVAs were conducted for each period with condition (CON, NON) and the relevant maternal variable (type: no touch, static, stroke, pat/tap, squeeze/grasp, tickle, shake, lift, kiss/blow; intensity: low, moderate, high; speed: low, moderate, high) as the within-subjects variables. As in Studies 1 and 2, since infants in the two conditions were matched by age and sex, condition was treated statistically as a repeated-measures variable (Stevens, 1996). The ANOVA summary tables for these analyses are found in Appendix O.

The specific hypothesis for the analyses in the present section was that mothers in the CON and NON conditions would spend similar amounts of time using a specific type of touch, or a specific level of intensity or speed of touch, during any of the three interaction periods. Although significant type, intensity, and speed main effects were found in the data (see Appendix O), these results were not central to the focus of the present study, and thus are not discussed in the following section.

Type of Maternal Touch

The data for all three periods were positively skewed, necessitating a square-root transformation for the greeting and reunion periods. Because the data for the manipulation period were substantially positively skewed, a log transformation was necessary for this period. The subsequent split-plot ANOVAs revealed no differences in the types of touch mothers in the two conditions were using during the greeting, manipulation, or reunion periods (Tables O1, O2, O3). The fact that no condition effects were found for any of the three interaction periods indicated that the infants in the two conditions were receiving the same type of stimulation from their mothers. Thus, mothers used similar types of touch with their infants throughout the study, and mothers in the NON condition were able to imitate the types of touch used by mothers in the CON condition during the manipulation period.

Intensity of Maternal Touch

Due to positive skewness, a square-root transformation was conducted on the data during the manipulation period. No differences between the conditions were found during any of the three interaction periods (Tables O4, O5, O6). These results suggested that mothers used similar intensities of touch throughout the study, and that mothers in the NON condition were able to imitate adequately the intensity of the touching behaviours of mothers in the CON condition.

Speed of Maternal Touch

A square-root transformation was necessary to control for positive skewness in the data from the greeting and manipulation periods only. No differences in the speed of maternal touching were found between the conditions for any of the interaction periods (Tables O7, O8, O9). Once again, it appeared that mothers touched their infants at similar speeds throughout the study, and that mothers in the NON condition were successful in their imitation of the touching behaviours of mothers in the CON condition during the manipulation period.

In summary, the only difference in the conditions during the manipulation period was the level of contingency between the mothers and infants; mothers in the CON condition were naturally contingent with their infants, whereas mothers in the NON condition were not contingently responding to their infants during the manipulation period.

Infant Variables

Four orthogonal dependent variables were analyzed to assess infants' reactions to their mothers' behaviours: (a) infant gaze at mother's face, (b) infant gaze away from the experimental situation, (c) infant smiling, and (d) infant fretting. Each variable will be discussed separately, in order, beginning with gaze at face.

After screening the data for nonnormality, any infant sex effects were first assessed by including sex in the trend analyses for the infant variables (i.e., gaze at face, gaze away, smiling, fretting). Relevant transformations or sex effects are mentioned at the appropriate place in the text. As in Studies 1 and 2, if transformations were used the raw means are presented in the text and figures for ease of comprehension (see Appendix P for the means of main effects and the transformed means). If there were no sex effects the data were collapsed across this variable, and the subsequent trend analyses consisted of one between-subjects variable (age; 4 months, 7 months) and two within-subjects variables; condition (CON, NON), and unit of time (3 levels for the greeting and reunion periods, 6 levels for the manipulation periods), as in Studies 1 and 2. Any significant interactions were further explored through contrast analyses, followed by simple effects analyses where relevant, as for the affect measures in Studies 1 and 2. See Appendix Q for the trend analysis summary tables for infant gaze at face, gaze away, smiling, and fretting.

The first hypothesis for both the infant gaze and affect measures was that there would be no differences between the conditions in the patterns of gaze or affect during the greeting period. The general hypotheses for the infant gaze measures during the manipulation period were: (1) 4-month-old infants in the CON condition would exhibit variable patterns of gaze at their mothers' faces, as in Study 2, (2) 7-month-old infants in the CON condition would exhibit a linear decrease in gaze at face, (3) infants in the NON condition at both ages would show a linear decrease in gaze at face, (4) infants of both ages in the CON condition would show a low, stable pattern of gaze away, (5) infants at both ages in the NON condition would show a linear increase in gaze away, although this might be more evident for the 7-month-olds.

The general hypotheses for the infant gaze measures during the reunion period were: (1) infants in the CON condition at both ages would show a stable, high amount of gaze at their mothers' faces and a stable, but lower, amount of gaze away when compared with gaze at face, (2) infants in the NON condition would show a linear increase in gaze at their mothers' faces, and a linear decrease in gaze away from the situation.

The general hypotheses for the infant affect measures during the manipulation period were: (1) infants in the CON condition would show variable levels of smiling throughout the period, similar to Study 2, (2) infants in the CON condition would show stable, low levels of fretting, (3) infants in the NON condition would show a linear decrease in smiling, and (4) infants in the NON condition would show a linear increase in their fretting. These hypotheses were relevant for both ages.

The general hypotheses for the infant affect measures during the reunion period were: (1) infants in the CON condition would show stable but high levels of smiling, and stable but low levels of fretting, (2) infants in the NON conditions would show a linear increase in smiling and a linear decrease in fretting. Again, these hypotheses were generated for infants at both 4 and 7 months of age.

As in the previous studies, a critical alpha level of .05 was chosen as the criterion for statistical significance, and the pooled results for unit and the condition by unit interaction are not discussed in the Results section, although they are available in Appendix Q. Unlike Studies 1 and 2, trend analysis results are not appropriate for the condition variable, as it has only two levels. Therefore, any condition effects not associated with the unit trend analyses are mentioned in the following text.

Infant Gaze at Face

Greeting period. No differences in the amount of infant gaze at face were found between the two conditions for the greeting period. A linear trend was found overall, $F(1, 22) = 4.49$, $p < .05$ (Table Q1), whereby infant gaze at face increased over the greeting period for all infants (Table P1).

Manipulation period. A square-root transformation was conducted on the data of infant gaze at face for the manipulation period to correct for non-normality. A significant quadratic trend by sex interaction was found during the manipulation period, $F(1, 20) = 6.01$, $p < .05$ (Table Q2). Subsequent simple effects analyses revealed that only boys exhibited a quadratic trend in their gaze at face, $F(1, 11) = 7.80$, $p < .05$, in that their gazing decreased slightly towards the middle of the period and then increased slightly to become stable by the end of the period (Figure 12, Table P2).

A significant condition-linear trend by unit-linear trend interaction was found, $F(1, 20) = 4.96$, $p < .05$, and subsequent simple effects analysis revealed that only infants in the CON condition exhibited a linear decrease in their gazing at their mothers' faces, $F(1, 23) = 5.93$, $p < .02$ (Figure 13, Table P3). A significant condition-linear trend by unit-cubic trend by age interaction was found, $F(1, 20) = 7.54$, $p < .05$, however subsequent simple effects analyses did not reveal any significance.

Reunion period. Analyses on gaze at face during the reunion period revealed a significant quadratic trend by sex interaction, $F(1, 20) = 8.31$, $p < .01$ (Table Q3). Simple effects analyses indicated that girls exhibited a quadratic trend when gazing at their mothers' faces during the reunion period in that they decreased gazing at the face in the middle of the period, but then increased gazing at the face by the end of that period, $F(1, 11) = 5.65$, $p < .05$ (Figure 14). A condition-linear trend by unit-linear trend by age interaction was also found, $F(1, 20) = 5.74$, $p < .05$, and subsequent simple effects analyses revealed that 7-month-old infants had opposite patterns of gazing at their

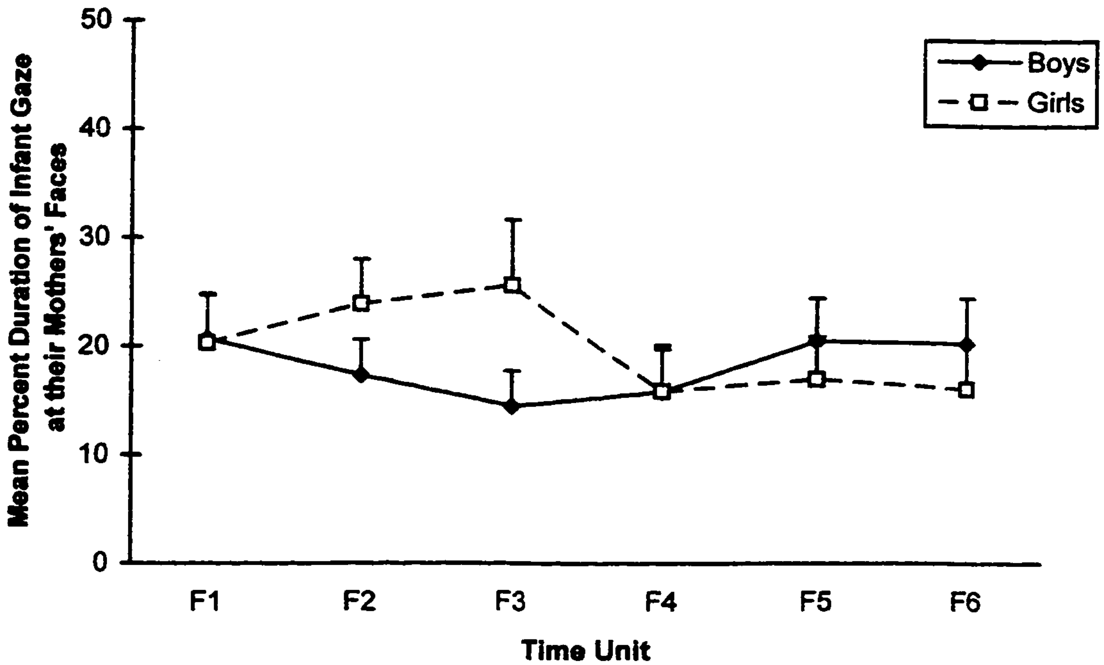

Figure 12. Mean percentage of time infants spent gazing at their mothers' faces during the manipulation period as a function of 30-s time unit (F1, F2, F3, F4, F5, F6) and infant sex (boy, girl). Standard errors are shown by vertical bars.

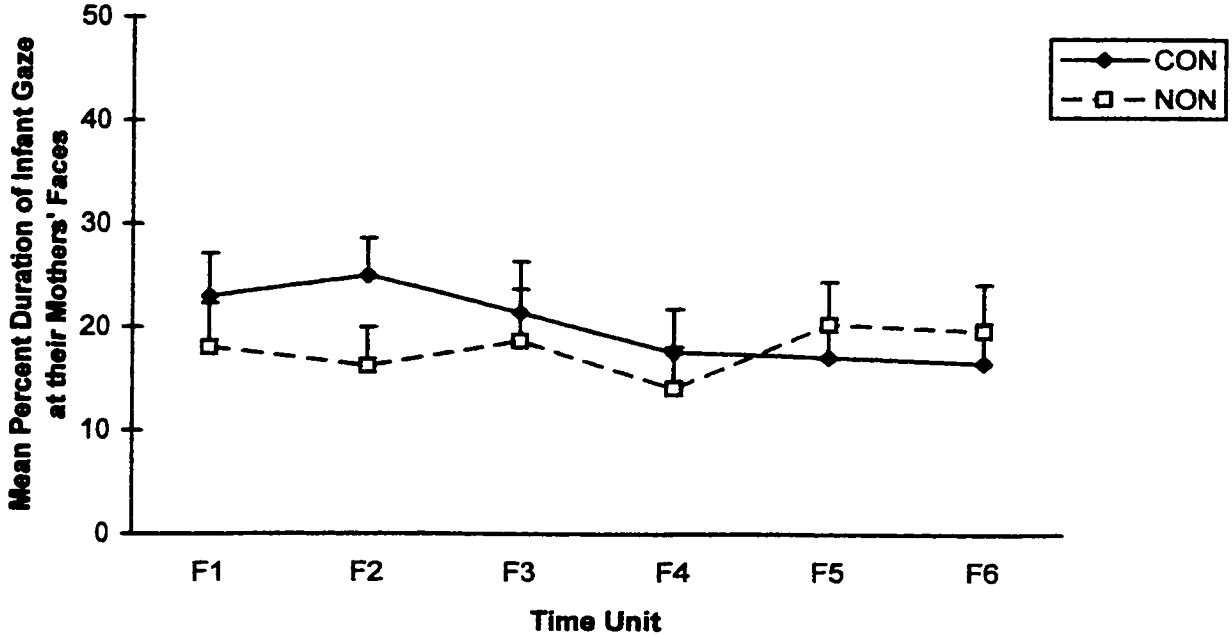

Figure 13. Mean percentage of time infants spent gazing at their mothers' faces during the manipulation period as a function of 30-s time unit (F1, F2, F3, F4, F5, F6) and condition (CON, NON). Standard errors are shown by vertical bars.

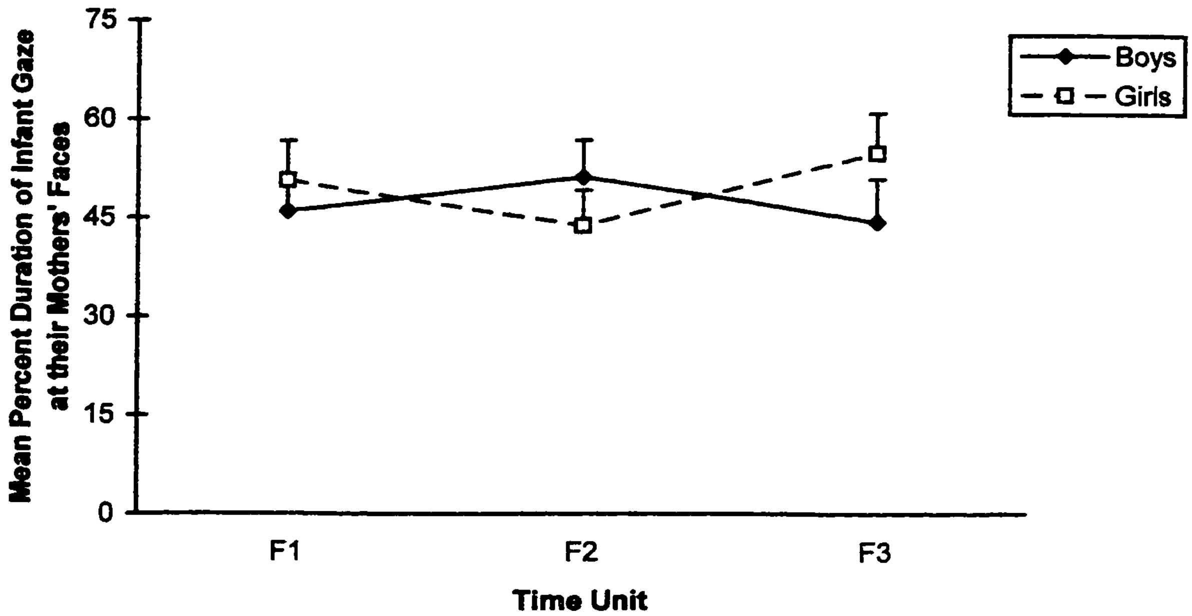

Figure 14. Mean percentage of time infants spent gazing at their mothers' faces during the reunion period as a function of 20-s time unit (F1, F2, F3) and infant sex (boy, girl).
Standard errors are shown by vertical bars.

mothers' faces depending on the condition in which they participated, $F(1, 11) = 26.08$, $p < .001$. As Figure 15 illustrates, 7-month-old infants in the CON condition showed a significant linear trend when gazing at their mothers' faces, $F(1, 11) = 9.53$, $p < .05$, in that their gazing decreased throughout the period. Conversely, 7-month-olds in the NON condition showed a significant linear trend, $F(1, 11) = 11.05$, $p < .01$, in that their gazing at their mothers' faces increased throughout the reunion period.

Infant Gaze Away

Greeting period. Due to moderate positive skewness a log transformation was conducted on the data for infant gaze away for the greeting period. A significant sex main effect was found for this variable, $F(1, 20) = 4.55$, $p < .05$ (Table Q4), revealing that boys ($M = 14.51\%$) gazed away from the experimental situation more than girls ($M = 4.91\%$) during the greeting period (see Table P4 for transformed means). A significant age main effect was also revealed, $F(1, 20) = 10.68$, $p < .01$. Seven-month-old infants ($M = 14.03\%$) gazed away more than 4-month-old infants ($M = 5.39\%$) during the greeting period (see Table P5 for transformed means). A significant condition by sex by age interaction was found, $F(1, 20) = 5.13$, $p < .05$, however subsequent simple effects analyses did not reveal any significant effects.

Manipulation period. A log transformation was used on the data for infant gaze away to correct for positive skewness. An age main effect was revealed, $F(1, 22) = 7.50$, $p < .05$ (Table Q5), whereby, as in the greeting period, 7-month-old infants ($M = 15.37\%$) gazed away from the experimental situation more than 4-month-old infants ($M = 10.31\%$; see Table P6 for transformed means). A condition main effect was also found, $F(1, 22) =$

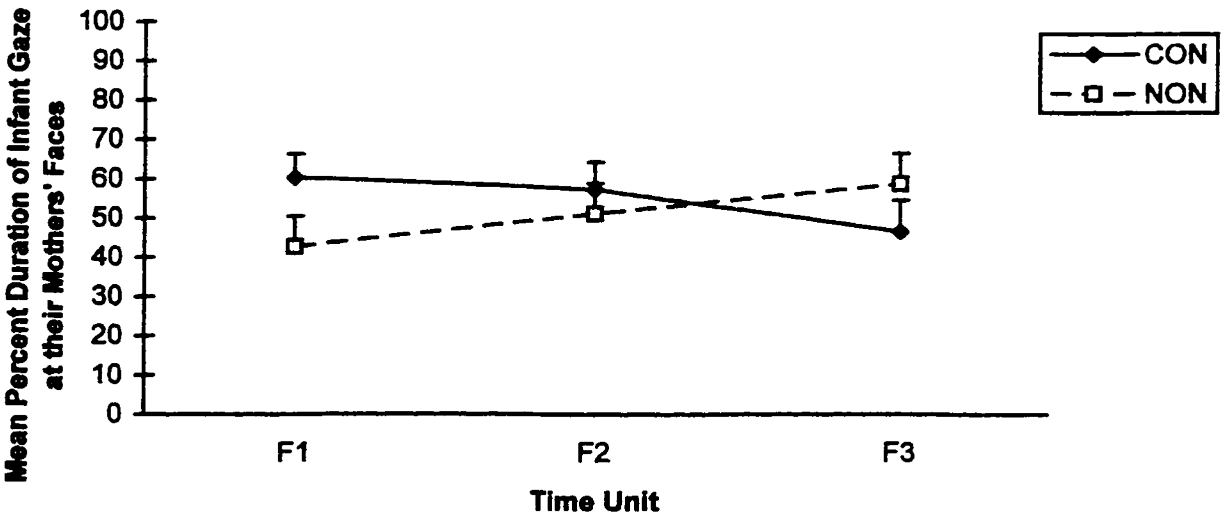

Figure 15. Mean percentage of time 7-month-old infants spent gazing at their mothers' faces during the reunion period as a function of 20-second time unit (F1, F2, F3) and condition (CON, NON).
Standard errors are shown by vertical bars.

4.71, $p < .05$, revealing that infants in the NON condition ($M = 17.19\%$) gazed away from the experimental situation more than infants in the CON condition ($M = 8.48\%$; Figure 16, Table P7), consistent with results found in Study 1.

Significant linear, $F(1, 22) = 5.20$, $p < .05$, and quadratic, $F(1, 22) = 4.37$, $p < .05$, Trends were found in gaze away overall, in that gazing away decreased towards the middle of the period and increased to the end (Table P8). A significant condition-linear trend by unit-cubic trend interaction was found, $F(1, 22) = 5.15$, $p < .05$, and subsequent simple effects analysis revealed that only infants in the NON condition showed a cubic trend in their patterns of gaze away, $F(1, 23) = 7.73$, $p < .05$ (Figure 17, Table P9).

Reunion period. A log transformation was conducted on the gaze away data to correct for substantial positive skewness. A significant quadratic trend by sex interaction was found, $F(1, 20) = 7.21$, $p < .05$ (Table Q6), and subsequent simple effects analyses revealed that only boys exhibited a quadratic trend in their gazing away during the reunion period, $F(1, 11) = 6.15$, $p < .05$ (Figure 18, Table P10).

Infant Smiling

Greeting period. Analyses on infant smiling for the greeting period did not reveal any differences between the conditions. A significant age main effect was found, $F(1, 22) = 5.14$, $p < .05$ (Table Q7). Seven-month-olds (52.01%) smiled more during the greeting period than 4-month-olds (39.94%). A significant linear trend was found across conditions, $F(1, 22) = 5.73$, $p < .05$, in that infant smiling gradually increased throughout this period for all infants (Table P11).

Manipulation period. A square-root transformation was conducted to correct for

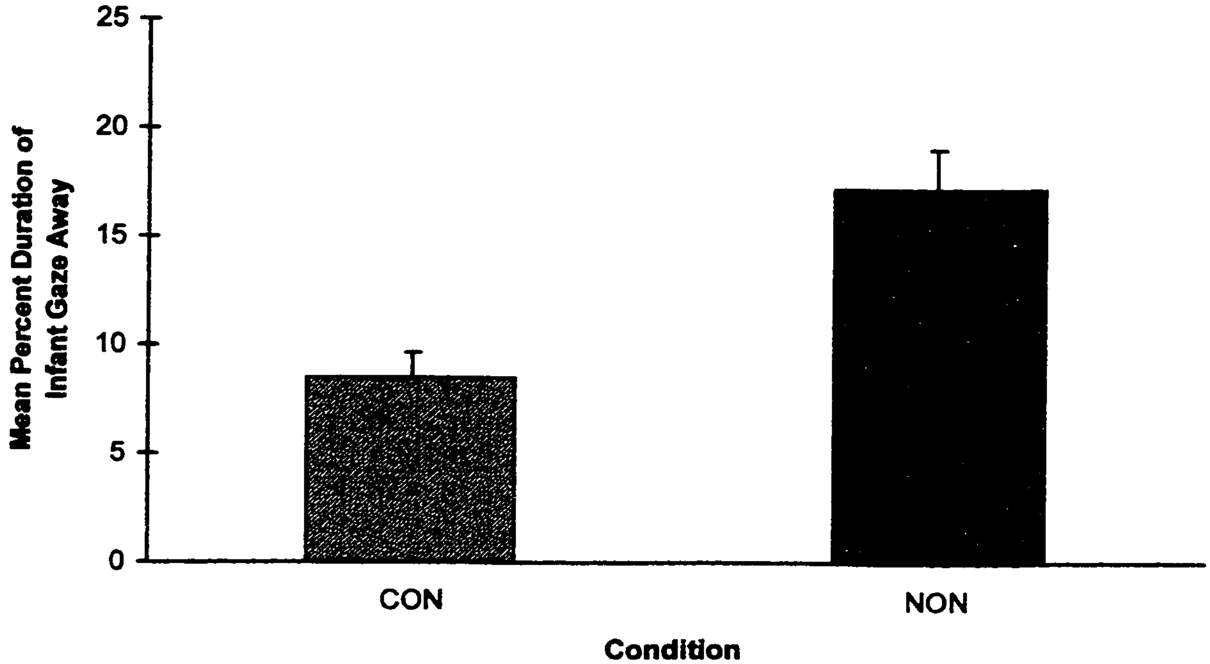

Figure 16. Mean percentage of time infants spent gazing away from experimental situation during the manipulation period as a function of condition (CON, NON).
Standard errors are shown by vertical bars.

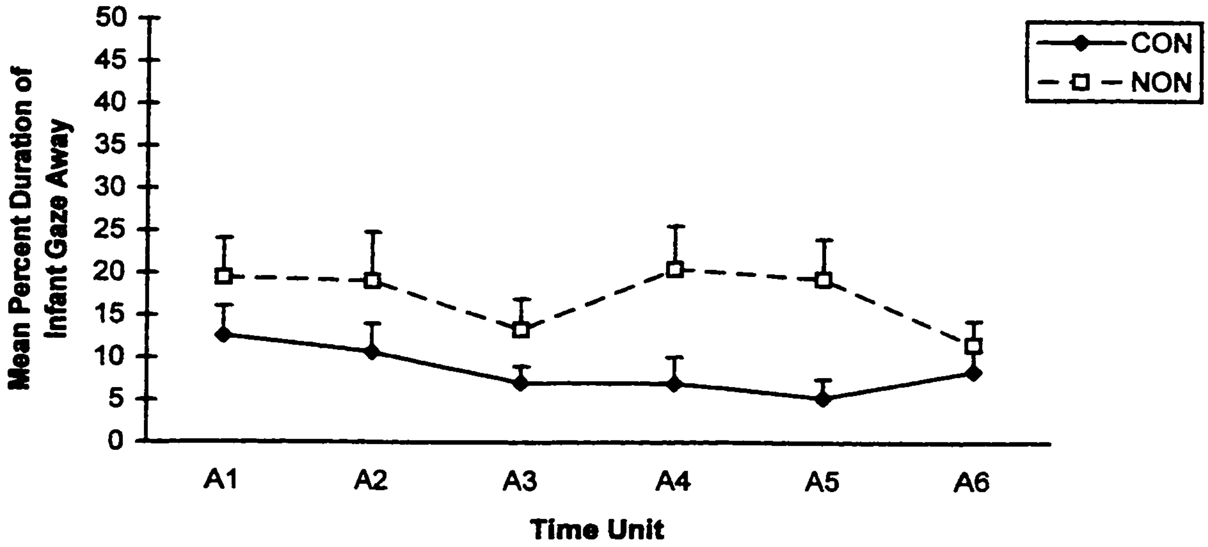

Figure 17. Mean percentage of time infants spent gazing away from experimental situation during the manipulation period as a function of 30-s time unit (A1, A2, A3, A4, A5, A6) and condition (CON, NON).
Standard errors are shown by vertical bars.

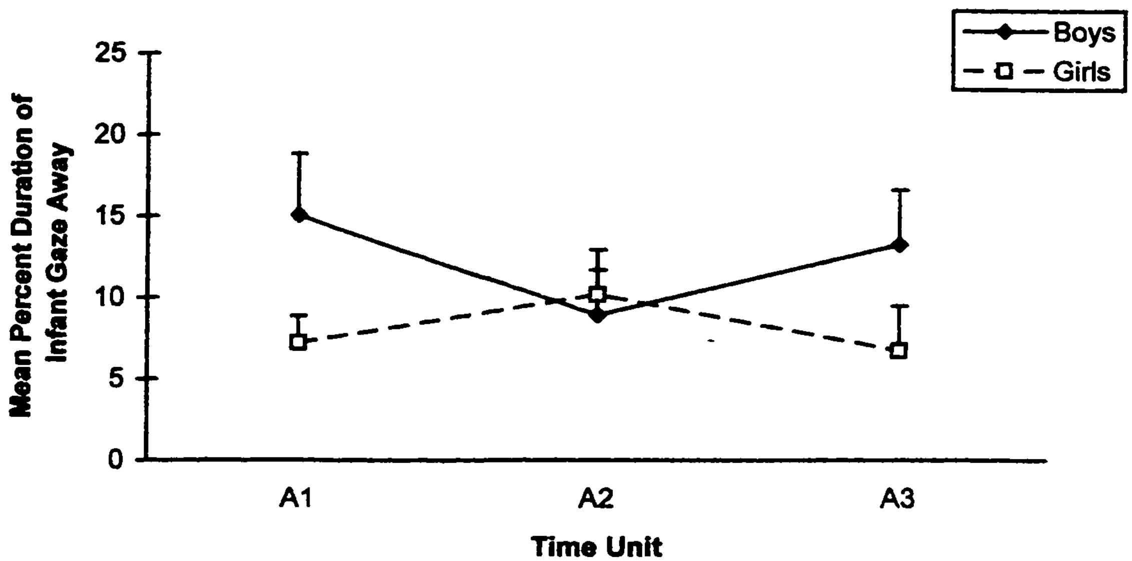

Figure 18. Mean percentage of time infants spent gazing away from the experimental situation during the reunion period as a function of 20-s time unit (A1, A2, A3) and infant sex (boy, girl).
Standard errors are shown by vertical bars.

positive skewness. A linear trend was found $F(1, 20) = 5.39$, $p < .05$ (Table Q8), in that smiling decreased throughout the period for all infants (see Table P12). Significant quadratic trend by sex by age, $(1, 20) = 5.46$, $p < .05$, condition-linear trend by unit-linear trend by sex by age, $F(1, 20) = 6.67$, $p < .05$, and condition-linear trend by unit-quartic trend by sex by age, $F(1, 20) = 5.49$, $p < .05$, interactions were found. Subsequent simple effects analyses revealed differences between conditions for 7-month-old girls only, $F(1, 5) = 7.20$, $p < .05$. Seven-month-old girls in the NON condition exhibited a linear decrease in their smiling during the manipulation period, $F(1, 5) = 16.75$, $p < .01$ (Figure 19, Table P13).

Reunion period. An age main effect in infant smiling was found during the reunion period, $F(1, 20) = 5.71$, $p < .05$ (Table Q9). Seven-month-old infants (M = 52.84%) smiled more during the reunion period than did 4-month-old infants (M = 36.20%). A linear trend by sex by age interaction was found, $F(1, 20) = 7.78$, $p < .05$. Subsequent simple effects analyses revealed that 7-month-old boys exhibited a linear increase in their smiling during the reunion period, $F(1, 5) = 15.25$, $p < .05$ (Table P14).

Infant Fretting

Greeting period. There was no infant fretting during the greeting period for either age across conditions.

Manipulation period. Due to substantial positive skewness a log transformation was conducted on infant fretting for the manipulation period. Subsequent analyses revealed both a significant linear, $F(1, 20) = 5.43$, $p < .05$, and a significant quintic, $F(1, 20) = 10.92$, $p < .01$, trend (Table Q10). Infant fretting initially increased, then became

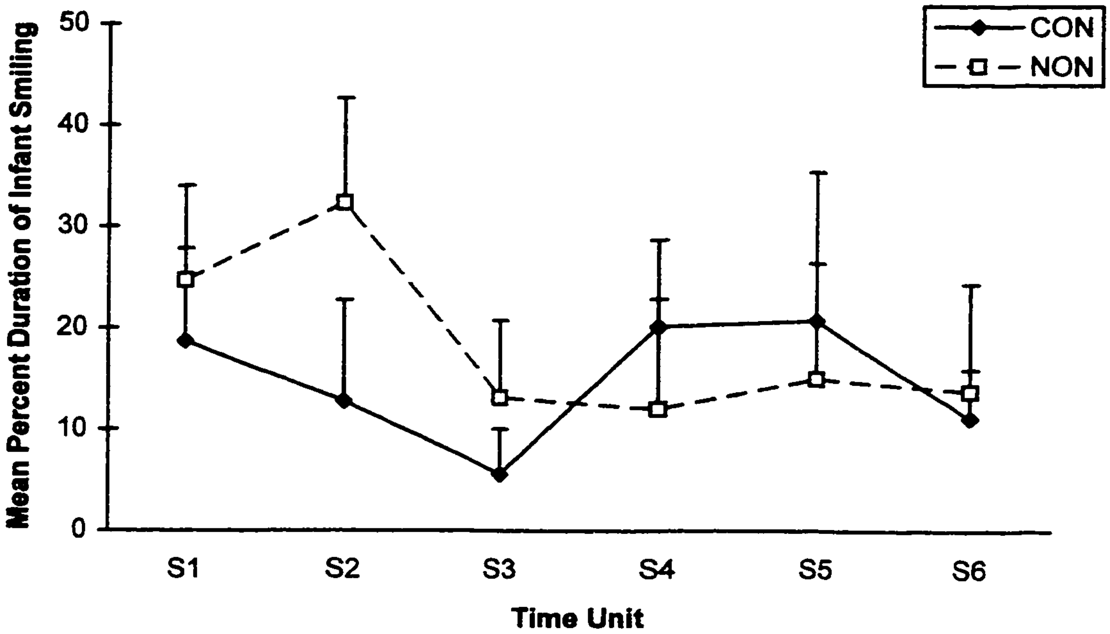

Figure 19. Mean percentage of time 7-month-old girls spent smiling during the manipulation period as a function of 30-s time unit (S1, S2, S3, S4, S5, S6) and condition (CON, NON). Standard errors are shown by vertical bars.

stable, then finally increased toward the end of the manipulation period (Table P15). Simple effects analyses conducted to examine the significant quadratic trend by age, $F(1, 20) = 5.48$, $p < .05$, cubic trend by age, $F(1, 20) = 4.78$, $p < .05$, and quartic trend by age, $F(1, 20) = 5.23$, $p < .05$, interactions revealed that 4-month-old infants exhibited a quartic trend in their fretting throughout the manipulation period, $F(1, 11) = 7.45$, $p < .05$ (Figure 20, Table P16).

A significant condition-linear trend by unit-linear trend by sex interaction was found, $F(1, 20) = 9.72$, $p < .01$, and subsequent simple effects analyses revealed that girls in the NON condition exhibited a linear increase in their fretting throughout the manipulation period, $F(1, 11) = 6.35$, $p < .05$ (Figure 21, Table P17).

A significant condition-linear trend by unit-linear trend interaction was found, $F(1, 20) = 7.36$, $p < .05$, and subsequent simple effects analyses revealed that a linear trend existed only for the NON condition, $F(1, 23) = 8.42$, $p < .01$. As illustrated in Figure 22, infant fretting increased throughout the manipulation period for the NON infants only, while fretting for the CON infants remained relatively stable and low (Table P18).

Reunion period. A log transformation was conducted on the data to correct for positive skewness. A significant condition main effect was found, $F(1, 22) = 20.14$, $p < .001$ (Table Q11), revealing more fretting for infants in the NON condition (22.20%) than infants in the CON condition (4.09%; Table P19). Both linear, $F(1, 22) = 14.55$, $p < .001$, and quadratic, $F(1, 22) = 20.51$, $p < .001$, trends were found in the data overall. fretting was initially high at the beginning of the period, and decreased in the middle only

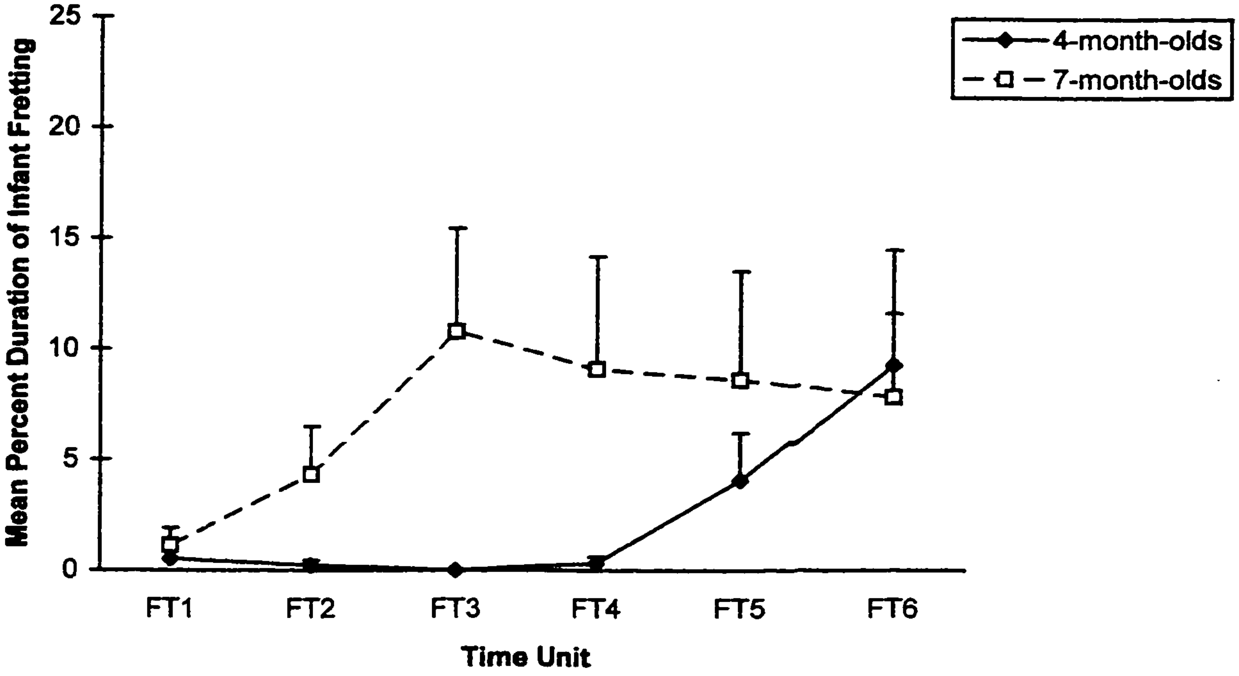

Figure 20. Mean percentage of time infants spent fretting during the manipulation period as a function of 30-s time unit (FT1, FT2, FT3, FT4, FT5, FT6) and infant age (4, 7 months).
Standard errors are shown by vertical bars.

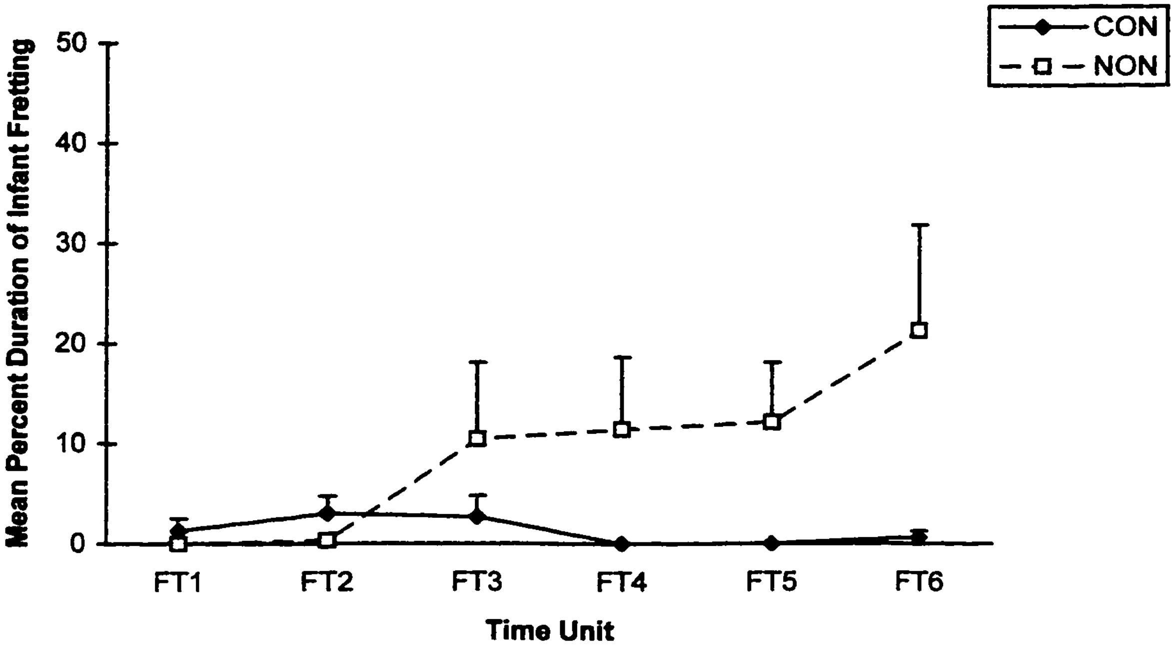

Figure 21. Mean percentage of time girls spent fretting during the manipulation period as a function of 30-s time unit (FT1, FT2, FT3, FT4, FT5, FT6) and condition (CON, NON).
Standard errors are shown by vertical bars.

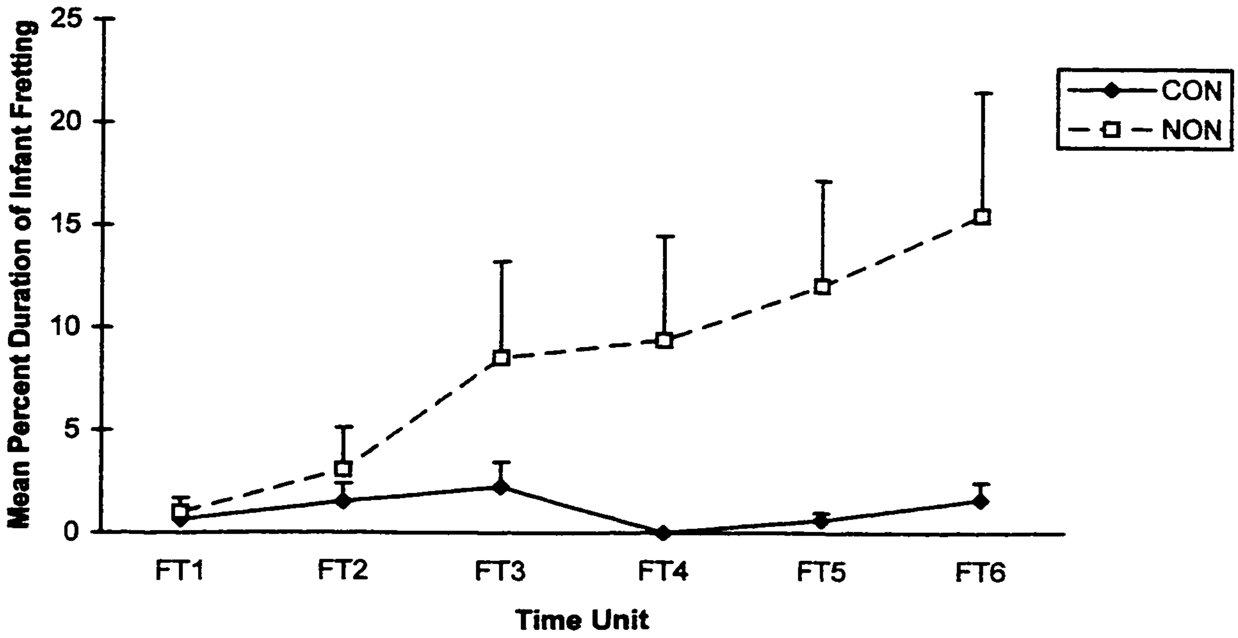

Figure 22. Mean percentage of time infants spent fretting during the manipulation period as a function of 30-s time unit (FT1, FT2, FT3, FT4, FT5, FT6) and condition (CON, NON).
Standard errors are shown by vertical bars.

to increase slightly at the end of the period (Table P20). Further, condition-linear trend by unit-linear trend, $F(1, 22) = 20.57$, $p < .001$ and condition-linear trend by unit-quadratic trend, $F(1, 22) = 29.74$, $p < .001$, interactions were found. Subsequent simple effects analyses revealed that only infants in the NON condition exhibited linear, $F(1, 23) = 21.74$, $p < .001$ and quadratic, $F(1, 23) = 27.53$, $p < .001$, trends in their fretting during the reunion period (Figure 23, Table P21).

Discussion

The results from the present study support the primary hypothesis and indicate that infants at both 4 and 7 months of age are sensitive to contingencies, or a lack thereof, during social interactions with their mothers. Although not all of the specific hypotheses were supported, strong evidence exists that the infants were responding differently during the manipulation period depending on whether the interaction was contingent or noncontingent. Further, there were differences in infant responding during the reunion period depending on whether they had previously received a contingent or noncontingent interaction. The fact that infants were sensitive to the differences in the levels of contingency in their mothers' touching provides further evidence for the ability of mothers to use touch as a means of maintaining communication with their infants.

The initial hypotheses that the durations of type, intensity, and speed of maternal touching behaviours would be similar between the CON and NON conditions during either the greeting or the manipulation periods were supported. Thus, mothers in both conditions touched their infants similarly at the onset of the study. Further, based both on the reliability analyses conducted in the present study and on the analysis of the flow of

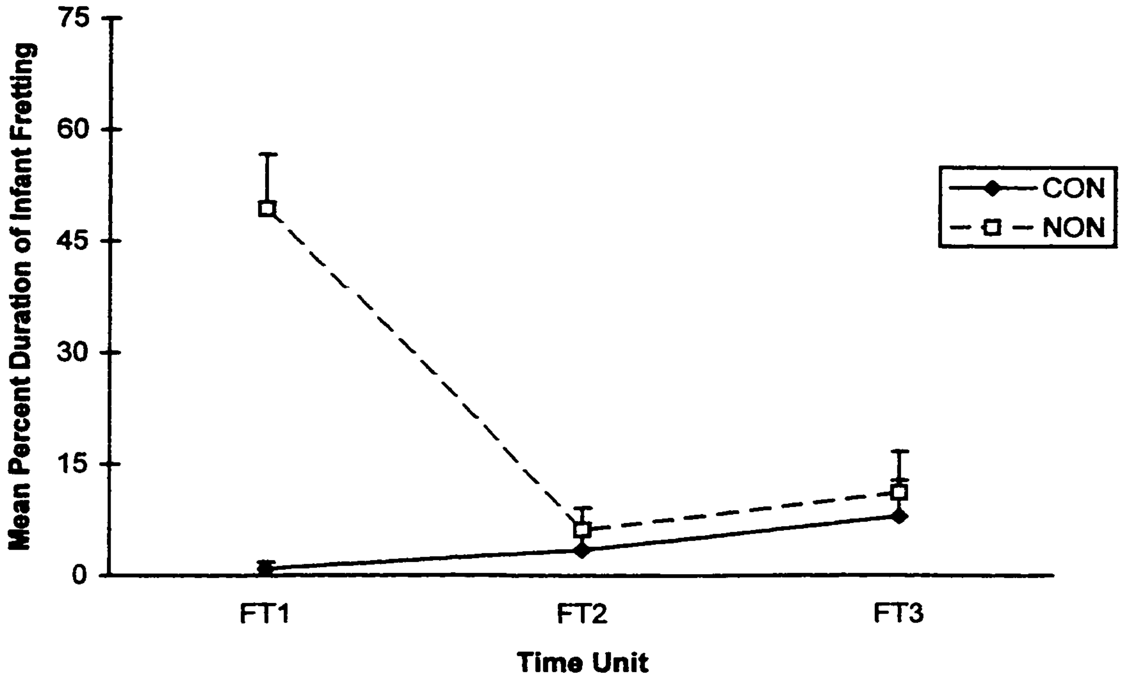

Figure 23. Mean percentage of time infants spent fretting during the reunion period as a function of 20-s time unit (FT1, FT2, FT3) and condition (CON, NON).
Standard errors are shown by vertical bars.

these interactions, conducted in Control Study 2 (to follow), mothers in the NON condition were able to imitate successfully the touching behaviours of mothers in the CON condition while maintaining a natural flow in their behaviours. In light of these results, and the fact that infants were responding similarly to their mothers during the greeting period, the infant responses during the manipulation period can be interpreted in terms of the presence or lack of contingency between their behaviours and those of their mothers.

Infants in the present study responded differently during the manipulation period depending on whether they received a contingent or a noncontingent interaction with their mothers. As hypothesized, during the manipulation period infants in the CON condition exhibited a linear decrease in the amount of gazing at their mothers' faces. This decrease in gazing at mothers' faces is similar to that exhibited by the 7-month-old infants in the SF+T condition in Study 1. The interpretation for this decrease in gaze, as discussed in Chapter 2, is based on previous research where infants were found to show lower amounts of gazing at the faces of the adults during standard SF with touch interactions. In this past research, the direction of infant gaze has generally switched from the adults' faces during a normal interaction to their hands during a SF with touch interaction (e.g., Stack & LePage, 1996; Stack & Muir, 1990, 1992). Although durations and trends of infant gazing at hands were not examined in the present studies, based on past research it was expected that the infants' gaze would gradually move away from the mothers' still faces during the SF with touch interactions.

The fact that infants in the NON condition did not show this decrease in gazing at their mothers' faces during the manipulation period is interesting, however. An examination of infant gazing at face reveals that the trend exhibited by infants in the NON condition was relatively stable throughout the period, fluctuating only slightly from the mean point (M = 17.84%). It is possible that infants in the NON condition maintained a level of gaze at their mothers' still faces due to the fact that their mothers were not being contingent with them. Perhaps these infants were attempting to regain a sense of communication with their mothers by gazing at their mothers' faces.

As hypothesized, however, this stable level of gazing at the mothers' faces exhibited by infants in the NON condition was offset by an increase in their gazing away from the experimental situation. Overall, infants in the NON condition spent more time gazing away from the situation than infants in the CON condition. This result is similar to that found with the 7-month-olds in Study 1, and indicates that these infants were perhaps bored with the stimulation they were receiving from their mothers, and were thus gazing elsewhere in the room. Further, infants in the NON condition exhibited a cubic trend in their gazing away, such that their gazing away remained fairly high with a decline and increase in the middle of the period, and then another decrease during the last 30 s of the period (see Figure 17). This pattern further suggests that infants in the NON condition lost interest or became bored with their mothers' tactile stimulation once they perceived it as not being contingent with their responses, and thus began to focus their gaze elsewhere in the room. In contrast, infants in the CON condition displayed lower and more stable levels of gazing away, indicating that they were maintaining their attention within the experimental situation, possibly at their mothers' hands, as discussed above. It is clear, therefore, that the infants in the two conditions were responding differently, in terms of their gazing patterns, strongly suggesting that they were sensitive to the contingency, or lack thereof, which was being communicated to them through their mothers' touching behaviours. Thus, through the examination of infants' gazing patterns and durations of gazing it appears as though infants at both 4 and 7 months of age are sensitive to the difference between a contingent and a noncontingent interaction. A similar conclusion can be drawn when examining the trends in infants' affect throughout the manipulation period.

Although many of the hypotheses for infant affect were not supported in the present study, there was a significant difference in the patterns of smiling exhibited between the conditions for girls who were 7 months of age. Specifically, 7-month-old girls in the NON condition displayed a linear decrease in the amount of smiling throughout the manipulation period while 7-month-old girls in the CON condition did not display this decrease in smiling. These results were not exhibited by the 4-month-olds nor the boys, however they suggest that the 7-month-old girls participating in a noncontingent condition were reducing their positive affect as the interaction continued, while the 7-month-old girls participating in a contingent interaction appeared to fluctuate in their smiling throughout the interaction (Figure 19). That 7-month-olds exhibited this difference in trends between the conditions, whereas 4-month-olds did not, is perhaps indicative of the more developed affective displays of the older infants (Lamb, 1988).

That only girls exhibited this difference between the conditions is intriguing, yet difficult to explain. Previous studies examining infants' responses to contingencies have often failed to find differences between boys and girls (e.g., Alessandri et al., 1990; Bigelow, 1998; Bigelow et al., 1996; Watson, 1979), or they have not appeared to systematically examine differences in infant sex (e.g., Dunham & Dunham, 1990; Dunham et al., 1989; Millar, 1988). However, this result could be interpreted based on past research examining mother-infant interactions that has found that mothers tend to use more facial and vocal expressions and less touching with their daughters than with their sons (Moss, 1967). Given these past results, although maternal facial and vocal expressions were not examined in the present study, it could be speculated that the girls were more attentive to the touching behaviours of their mothers, and therefore more sensitive to the way in which that touch was delivered than the boys. Since this difference between the sexes appears to be unusual, given past research, it could be spurious or due to chance. Thus, the above interpretations are both cautious, and subject to modification, pending adequate replication and consistency in sex-difference findings.

Girls were also found to exhibit differential patterns of fretting depending on whether they had participated in a contingent or noncontingent tactile interaction with their mothers. Regardless of their age, girls in the NON condition exhibited a linear increase in their fretting throughout the manipulation period, whereas girls in the CON condition exhibited low and stable amounts of fretting. The increase in fretting exhibited by girls in the NON condition, taken with the decrease in smiling exhibited by the 7-month-old girls in the NON condition, indicates that these infants were not enjoying the noncontingent interaction they were participating in with their mothers.

Further differences in the fretting patterns exhibited by infants in the CON and

NON conditions, regardless of their age or sex, were also demonstrated. Specifically, infants in the NON condition exhibited a linear increase in their fretting throughout the manipulation period while infants in the CON condition displayed relatively lower and more stable amounts of fretting throughout that period. These results support the evidence from the infant gazing patterns suggesting that infants in the NON condition were responding differently from infants in the CON condition during the manipulation period. Infants in the NON condition displayed greater and more variable amounts of gazing away from the experimental situation, and they increased their fretting throughout the period during which they were receiving noncontingent tactile stimulation from their mothers. Seven-month-old girls in the NON condition also showed a decrease in their smiling throughout that period. Infants in the CON condition, however, who were receiving the same type of stimulation, showed less gazing away from the interaction, a linear decrease in gaze at face, possibly towards the hands, and low, stable levels of fretting throughout the manipulation period, with no decrease in smiling. Thus, it does not appear to be only the *type* of stimulation that is necessary to maintain an infants' interest in an interaction, but also the fact that the stimulation is *contingent* with their behaviours (e.g., Papousek et al., 1986). By including contingency in the interactions infants' gaze towards the situation and positive affect are maintained, and their negative affect is retained at a minimum. Conversely, by not including contingency, even if the overall type of stimulation is the same, infants appear to disengage from the interaction and respond with decreasing amounts of positive affect and increasing amounts of negative affect. In this case, if it is necessary for infants to interact and be engaged in contingent social interactions in order to learn and develop socially and emotionally (e.g., Fogel, 1992), it would follow that a lack of contingency in interactions could be deleterious to this development.

As some researchers have suggested, a lack of contingency could also have detrimental effects on infants' motivations to engage in future interactions (e.g., Dunham et al., 1989; Glenn et al., 1994). Therefore, an examination of infants' responses during the reunion period was included in the present study.

The initial hypothesis that mothers in the two conditions would touch their infants similarly during the reunion period was supported, although only one of the hypotheses for infants' gazing responses during the reunion period was supported. Seven-month-old infants displayed different trends in gazing at their mothers' faces depending on the condition in which they participated. Infants in the CON condition, who were 7 months of age, gradually decreased their gazing at their mothers' faces, whereas 7-month-olds in the NON condition, who were initially exhibiting lower gazing at their mothers' faces, increased this gazing throughout the reunion period. In light of the hypotheses of the present study, and based on past research, it appears as though having had a previous noncontingent interaction with their mothers the 7-month-old infants were less readily re-engaged in a subsequent contingent interaction (Bigelow et al., 1996; Dunham et al., 1989; Glenn et al., 1994; Hains & Muir, 1996a).

That the hypothesized difference in responding between the conditions for 7-month-olds during the reunion period was not found for the 4-month-old infants could be explained in terms of the reduced expectations of the 4-month-old infants. As discussed in Chapter 2, it is possible that the 4-month-old infants in the NON condition would be more influenced by the interaction preceding the reunion period, and thus be slower to re-engage with their mothers, whereas the 7-month-olds, having had more social experiences, would not be as likely to exhibit this trend. An examination of the 4-month-olds' trends in gazing at their mothers' faces during the reunion period suggests that these younger infants were indeed slower to re-engage with their mothers if they were in the NON condition (Figure 24). Statistically, the 4-month-old infants exhibited a stable amount of gazing at their mothers' faces throughout the reunion period. A descriptive examination of the trend, however, reveals that the 4-month-olds in the NON condition actually decreased the amount of gazing at their mothers' faces towards the middle of the reunion period, before exhibiting an increase by the end of that period. This suggests that, while 7-month-olds in the NON condition were slow to re-engage with their mothers, the 4-month-olds in the NON condition may also have displayed a reluctance to re-engage with their mothers during this period. Thus, the infants displayed differential patterns in their gazing during the reunion period, depending on whether they had previously participated in a contingent or a noncontingent interaction with their mothers.

The hypotheses for infant fretting during the reunion period were also supported in the present study, further revealing that the infants were responding differently depending on whether they had previously received a contingent or noncontingent interaction with their mothers. Infants in the NON condition displayed a higher amount of fretting overall during the reunion period than infants in the CON condition. Furthermore, in terms of their trends of fretting, infants in the CON condition displayed

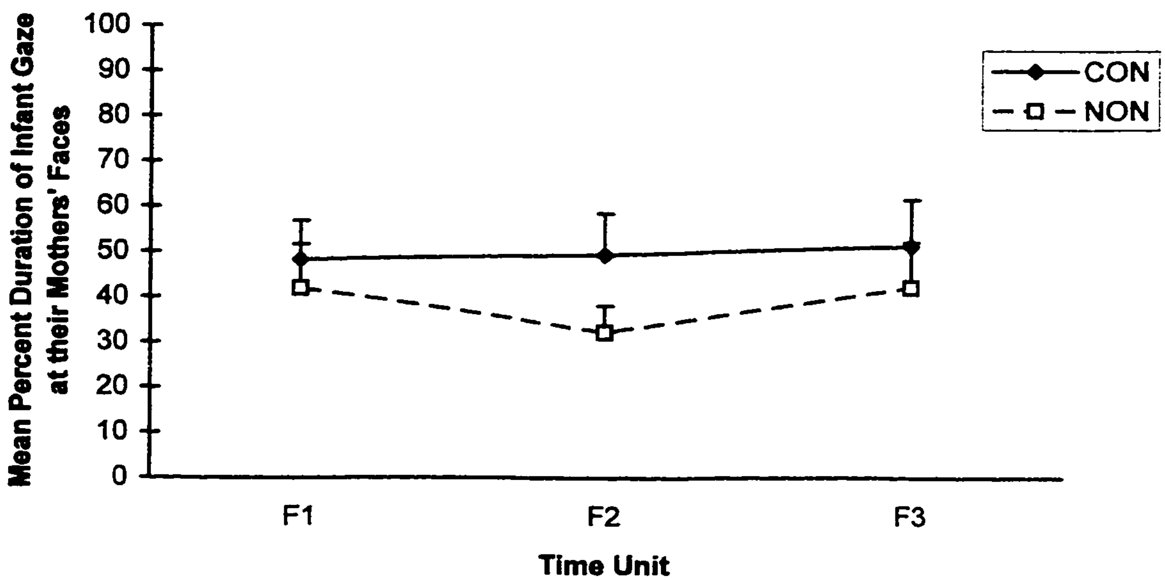

Figure 24. Mean percentage of time 4-month-old infants spent gazing at their mothers' faces during the reunion period as a function of 20-s time unit (F1, F2, F3) and condition (CON, NON). Standard errors are shown by error bars.

low, stable amounts of fretting throughout the reunion period. In contrast, infants in the NON condition displayed a trend in their fretting such that it decreased from the beginning of the reunion period to become stable at the end of that period (Figure 23). This indicates that infants in the NON condition may have been initially reluctant to participate in the reunion interaction with their mothers, whereas infants in the CON condition remained at a positive or neutral level of engagement with their mothers. Thus, after having participated in a noncontingent interaction, infants in the NON condition appeared to be slower to re-engage with their mothers during the reunion period as they initially exhibited less gazing at their mothers' faces and more fretting, which changed by the end of that period to more gazing at the mothers' faces and less fretting. Thus, the inclusion of contingency in social interactions appears to be important in infants' motivation to engage in subsequent social interactions, in terms of their gazing and affect.

The above results, taken together, provide strong evidence that infants at both 4 and 7 months of age are sensitive, and respond differently, to interactions that include or lack a contingent relationship between their behaviours and those of their mothers. The results from the present study support research indicating that it is not merely the type of stimulation that is important for an infants' continued attention and positive affect, but it is the relationship of this stimulation to the infants' behaviours that is necessary (Papousek et al., 1986). For example, Papousek and Papousek (1979) suggested that the 4-month-old infants in their study were less interested in the reinforcing stimulus than in the fact that the stimulus would appear when they expected it to occur. The infants would perform the required behaviour to elicit the stimulus, but would not spend time attending to it. If the stimulus did not appear, however, the infants would become upset and begin to search for the stimulus. These authors thus proposed that it was the contingency that was considered more important, or interesting, to the infants, rather than the stimulus per se (Papousek & Papousek, 1979). In the present study, infants in the CON and NON conditions were receiving the same stimulation, however the relationship of that stimulation to their behaviour was not the same. When contingency was lacking, infants disengaged from the interaction and exhibited a decrease in their positive affect and an increase in their negative affect, indicating their sensitivity to the noncontingent interaction.

Thus, as revealed in the present study, contingent social interactions maintain infants' gaze towards the interactive situation and their positive affect, and decrease the amount of negative affect displayed by the infants, regardless of the fact that the stimulation is the same. In this way, the inclusion of contingency in these interactions provides a more optimal environment in which the infant can develop and learn (Fogel, 1992). Further, by participating in a face-to-face interaction that includes contingency, infants appear more willing to be re-engaged in subsequent contingent social interactions (as reflected in the differences in gazing at face and fretting behaviours between the CON and NON conditions during the reunion period). Therefore, contingency appears important for infants' increased motivations to continue participating in social interactions, and thus for their further development as social and emotional beings.

The results from the present study further indicate the abilities of mothers to use the tactile modality to maintain communication with their infants. Mothers were using only touch during the social interaction in which contingency was manipulated. Infants responded differently depending on whether they were receiving contingent or noncontingent tactile stimulation from their mothers. Although the tactile stimulation the infants were receiving was the same, the more natural (i.e., contingent) communication was not evident for the infants receiving the noncontingent stimulation. This result suggests, not only the importance of contingency, but the sensitivity of infants to the touching behaviours of their mothers. These results further suggest that infants' negative reactions to the standard SF period (e.g., Tronick et al., 1978) may be due to the lack of contingency during this period, as stimulation alone (with no regard to contingency) does not appear to be enough to maintain their interest and positive affect. Thus, touch, if delivered contingently, appears able to influence infants' reactions to a standard SF period, and to be an aid in maintaining communication between a mother and her young infant, at least for brief periods of time.

Overall, evidence that infants at both 4 and 7 months of age were able to perceive the difference between an interaction that includes contingency, and one that does not, was obtained. The infants in the present study responded differently depending on whether they were participating in a contingent or a noncontingent tactile interaction with their mothers, reflected in both their gazing and affective displays. Thus, infants are sensitive to contingency even if it is provided through the tactile modality alone, and, if they perceive that contingency is present, they are more likely to maintain communication with their mothers.

CHAPTER 4: CONTROL STUDIES

In Study 3 various manipulations were conducted on the mothers' behaviours, which have not been attempted in previous studies. The primary, and most obvious, of these manipulations was the instruction for mothers in the NON condition to imitate the behaviours of mothers in the CON condition. To facilitate their imitation, mothers in the NON condition were asked to maintain their gaze at their infants' lower foreheads, just above their eyes, rather than directly at their eyes. In this way, the mothers were able to remain face-to-face with their infants while also being able to view the hand movements of the CON mothers on the video monitor located just above and behind their infants' heads. Mothers in the CON condition were also asked to look at their infants' lower foreheads to maintain consistency between the conditions.

This subtle manipulation of mothers' gazing during these types of interactions has not been conducted in the past, although some studies have examined the effects of more obvious changes in adult eye gaze on infants' responses (e.g., Lasky & Klein, 1979; Hains & Muir, 1996b). These studies have found that infants react to changes in the adults' gaze direction with decreased gaze and less positive affect (Hains & Muir, 1996b). However, the changes in gaze direction in these studies were quite dramatic (e.g., above the infants' heads; Lasky & Klein, 1979) in comparison with the subtle manipulation used in the present study (e.g., lower forehead, just above the infants' eyes). The manipulation conducted in Study 3 was not expected to have any impact on the infants' behaviours, given the slight change in their mothers' eye direction. Further, since mothers in both conditions were gazing at their infants' lower foreheads (as confirmed by reliability checks), any differences in infant behaviours would not have influenced the results found between the conditions in Study 3. Potential differences in infant behaviour may have implications for the generalizability of the results to other face-to-face adult-infant interactions, however. Therefore, Control Study 1 was conducted to systematically determine whether the subtle change in gaze direction of the mothers had any effect on infants' responding during a SF with touch period.

A second manipulation check was undertaken to empirically evaluate the nature of the interactions during the manipulation period between the mothers and their infants in the NON condition. Mothers in the NON condition were asked to imitate the hand and touching behaviours of mothers in the CON condition. Although the mothers in the NON condition were shown to have accurately imitated the touching behaviours, it was possible that the fluidity, or natural flow, of their behaviours may have been disrupted due to the uncertainty of what behaviour would need to be imitated next. Therefore, Control Study 2 was conducted to evaluate this flow in the mother's interactions by asking adult females (blind to the hypotheses of the study and the condition) to judge whether they were viewing a mother playing with her infant or a mother imitating the touching behaviours of another mother. If the participants in this control study were unable to differentiate between the two types of interaction, based on the mothers' behaviours, it could then be assumed that mothers in the NON condition were able to maintain a natural flow when interacting with their infants.

Control Study 1

Control Study 1 was conducted to determine if the manipulation in gaze used in Study 3 might have inadvertently caused infants to react differently to their mothers than they would have in previous studies using typical SF with touch procedures. During Study 3 mothers were asked to maintain their gaze towards their infants' lower foreheads, just above their eyes. This manipulation was implemented so that the mothers in the NON condition would be able to continue gazing towards their infants while maintaining a view of the video monitor located above and behind their infants' heads. Since previous studies using the SF procedure have asked mothers to maintain gaze towards their infants' eyes a control study was conducted to establish whether 4- and/or 7-month-olds could detect the slight difference in the direction of their mothers' gaze during Study 3. If infants could detect the slight change in where their mothers were looking they might react differently overall, making it more difficult to generalize the results of Study 3 to other face-to-face adult-infant interactions. Thus, Control Study 1 examined infants' responses to their mothers when they were asked to participate in four periods; a normal interaction, two SF with touch interactions, and a final normal interaction. During one of the SF with touch interactions, mothers were asked to gaze at their infants' eyes. During the second SF with touch interaction they were asked to gaze at their infants' lower foreheads, just above their eyes. The two SF with touch periods were counterbalanced. This examination provided a direct assessment of whether infants detected the subtle change in the direction of their mothers' eyes and whether they reacted differently. Should infants have detected this change in the focus of their mothers' eyes, it would be more difficult to generalize the results from Study 3 to other face-to-face interactions. However, if there were no differences in infants' responses depending on where their mothers were focusing their gaze, it would suggest that the infants were not aware of the subtle difference in their mothers' eye directions, and the results from Study 3 could be generalized with more confidence. As infants at 4 and 7 months of age were included in Study 3, infants at both of these ages were included in the present control study.

Method

Participants

Participants were recruited using the same procedures as for the previous studies. The sample consisted of 14 full-term, healthy infants of 4 and 7 months of age. Two infants were excluded from the analyses. One infant did not want to remain seated in the infant seat, and another infant's mother had difficulty following the instructions. The final sample consisted of 12 infants, half 4-month-olds (mean age = 4 months, 6 days, sd = 6.93 days; 3 boys) and half 7-month-olds (mean age = 7 months, 6.5 days, sd = 3.73 days; 2 boys). The majority of the participants were white (92%), and middle-class (92%; see Appendix R for more detailed demographic information). Since this was a control study, the number of subjects included in the study was based on the number of subjects in each condition, within each age, in Study 3.

Apparatus

The apparatus was identical to that used in Study 3. As in Studies 2 and 3, 4-month-old infants were seated on a pillow placed on the infant seat so that their heads were at such a height that their mothers could still see the video monitor while looking at their infants.

A stopwatch was used to time the interactive sessions, and the onset and offset of all the interactive periods was indicated to the mothers by the experimenter lightly tapping on the black partition.

Design

Each infant and mother participated in four 90-s interaction periods separated by 20-s inter-period intervals. There were two orders of presentation. For all infants the first (greeting) and fourth (reunion) periods consisted of a normal interaction between the mothers and infants, where mothers could use facial expression, voice, and touch to play with their infants. The second and third periods for both orders consisted of a modified SF period in which the mothers were asked to remain silent and still faced throughout the period and interact with their infants using only touch. For the second period, mothers in Order 1 were asked to play with their infants using only touch while looking at their infants' eyes (EYES). For the third period, mothers in Order 1 were asked to play with their infants using only touch while looking at their infants' lower foreheads, just above their eyes (FORE). These two SF periods were reversed in Order 2, such that mothers were asked to look at their infants' lower foreheads during the second period, while they were asked to look at their infants' eyes during the third period. Table 6 illustrates the design of the study.

Procedure

The procedure for this study was similar to that for Study 3 (see Appendix S for the informed consent form). After the mother and infant were seated in the testing

Table 6

Design Table for Control Study 1

Age	Order							
	1				2			
Period	Greeting	EYES	FORE	Reunion	Greeting	FORE	EYES	Reunion
4-month-olds	boys n = 1 girls n = 2				boys n = 2 girls n = 1			
7-month-olds	boys n = 1 girls n = 2				boys n = 1 girls n = 2			

Note. EYES = SF with touch period during which mothers looked at their infants' eyes; FORE = SF with touch period during which mothers looked at their infants' lower foreheads.

chamber, the experimenter went behind the black partition and signalled the beginning of the period with a light tap. The timer was set for 90 s, after which the experimenter tapped on the black partition indicating the end of the period. During the inter-period interval, the video monitor located behind the infants' heads was turned on. This manipulation enabled a similar set-up to that in Study 3, where the monitor was turned on for the SF with touch period. In the present study, the monitor was left on for the third period, and then turned off for the reunion period. A reliability check was conducted on the participants, which ensured that the mothers were maintaining a still face throughout the SF periods and that they were looking at either their infants' eyes or lower foreheads, depending on the instructions for that period. If the mother was not following the experimental instructions adequately, testing was stopped, and then resumed once the instructions had been repeated ($n = 3$).

At the end of the testing session, the mother and infant were escorted back to the waiting room where the experimenter asked the mother a number of questions concerning the infant's history and family demographics (Appendix C), as in the previous studies.

If an infant was distressed during any of the periods, and cried for more than 20 consecutive seconds ($n = 1$), the session was interrupted.

Data Reduction

As in the previous studies, the video records were examined frame-by-frame using an adjustable speed remote control with shuttle function so that both the frequency and the duration of each of the infants' behaviours could be assessed. The behaviours examined from the videotapes were: (a) infant gaze at the mother's face, (b) infant gaze away from the experimental situation, (c) infant smiling, and (d) infant fretting. The operational definitions for coding were identical to those used in Studies 1, 2, and 3.

Observers were trained on videotape examples prior to scoring the present data until they achieved high intra-class reliability ($r > .90$) with experienced coders. Coders were blind to the experimental order in which the infant participated, and all coding was conducted with the sound off to diminish any external cues as to the infants' responses. Further, reliability coders were blind to the hypotheses of the study. Inter-rater reliability was assessed by blind observers for 1/3 of the records upon completion of coding. Intraclass correlation coefficients were all high, ranging from $r = .99$ to $r = 1.00$ (gaze at face = .99; gaze away = .99; smiling = .99; fretting = 1.00).

Results

Four orthogonal dependent variables were analyzed: percent durations of (a) infant gaze at mother's face, (b) infant gaze away from experimental situation, (c) infant smiling, and (d) infant fretting. Each dependent variable is discussed separately, beginning with the infant gaze variables and ending with the infant affect variables.

Analyses conducted to assess normality of the data revealed no significant skewness or outliers, thus none of the data were transformed. An examination of sex or order effects was then conducted for each variable, as for the gaze measures in Studies 1 and 2. Split-plot ANOVAs with sex (boys, girls), order (1, 2) and age (4 and 7 months) as the between-subject variables, and period (greeting, EYES, FORE, reunion) as the within-subject variable were conducted. If no main effects or interactions were found for either sex or order they were collapsed for the subsequent analyses. No order effects were found for any of the dependent variables, and thus the data were collapsed across this variable for all analyses. Any sex effects that were found are mentioned at the relevant place in the text.

Assuming no sex or order effects were found, the final set of analyses consisted of a split-plot ANOVA with age (4 and 7 months) as the between-subjects variable and period (greeting, EYES, FORE, reunion) as the within-subjects variable to assess any differences between the interaction periods. If an interaction was significant, simple effects analyses, followed by Tukey comparisons where relevant, were conducted to isolate the source of effects contributing to the interaction (Keppel, 1982; Linton & Gallo, 1975; Tabachnick & Fidell, 1989; Winer, 1971). The ANOVA summary tables are located in Appendix T.

As in the previous studies, a critical alpha level of .05 was chosen as the criterion for statistical significance, and the more conservative Greenhouse-Geisser Adjusted F-score was used to assess significance.

<u>Infant Gaze at Face</u>

Analyses of infant gaze at their mothers' faces revealed an age main effect, $\underline{F}(1, 10) = 5.27$, $\underline{p} < .05$ (Table T1). Four-month-old infants ($\underline{M} = 43.13\%$) spent more time gazing at their mothers' faces throughout the study than 7-month-old infants ($\underline{M} = 28.85\%$). The ANOVA also revealed a significant period main effect, $\underline{F}(2.35, 23.52) = 11.07$, $\underline{p} < .001$, and subsequent Tukey's analyses revealed that infants spent more time gazing at their mothers' faces during both the greeting ($\underline{M} = 48.99\%$) and the reunion ($\underline{M} = 52.89\%$) periods than during the EYES ($\underline{M} = 21.65\%$) or the FORE ($\underline{M} = 20.42\%$)

periods ($p < .05$, Figure 25). However, infants did not react differently to their mothers depending on where the mothers were looking (eyes or lower forehead) during the SF with touch periods.

Infant Gaze Away

Analyses of infant gaze away from the experimental situation revealed a sex main effect, $F(1, 8) = 7.45$, $p < .05$ (Table T2), in that girls ($M = 26.15\%$) spent more time gazing away throughout the study than did boys ($M = 10.32\%$).

A significant age main effect was also revealed, $F(1, 8) = 14.55$, $p < .01$, in that 7-month-old infants ($M = 29.17\%$) spent more time gazing away throughout the study than did 4-month-olds ($M = 9.94\%$). There was no period effect, however, indicating, as in the gaze at face measure, that the infants did not gaze away differently during the SF with touch periods depending on where their mothers were looking (eyes or lower forehead).

Infant Smiling

Analyses conducted on infant smiling revealed a significant period main effect, $F(1.85, 18.47) = 22.52$, $p < .001$ (Table T3). Subsequent Tukey's analysis showed that infants smiled more during the greeting ($M = 56.34\%$) and reunion ($M = 39.86\%$) periods than they did in either the EYES ($M = 15.19\%$) or the FORE ($M = 10.64\%$) periods ($p < .05$, Figure 26). There was no difference, however, in the duration of infant smiling during the EYES and FORE periods.

Infant Fretting

Analyses conducted on infant fretting revealed no significant main effects or interactions (Table T4). Infants exhibited low levels of fretting throughout the study.

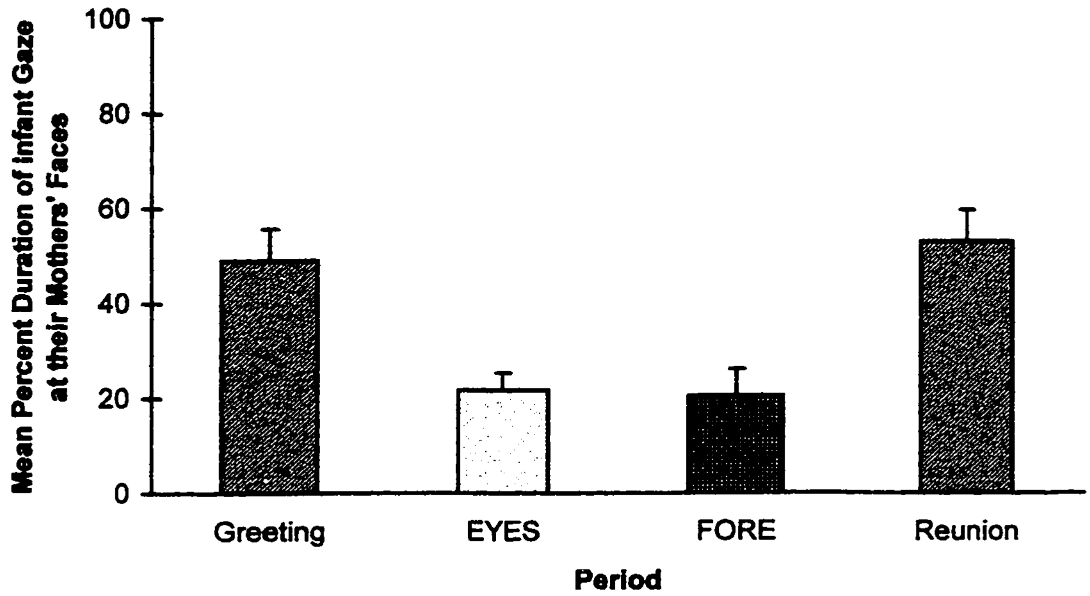

Figure 25. Mean percentage of time infants spent gazing at their mothers' faces as a function of period (Greeting, EYES, FORE, Reunion).
Standard errors are shown by vertical bars.

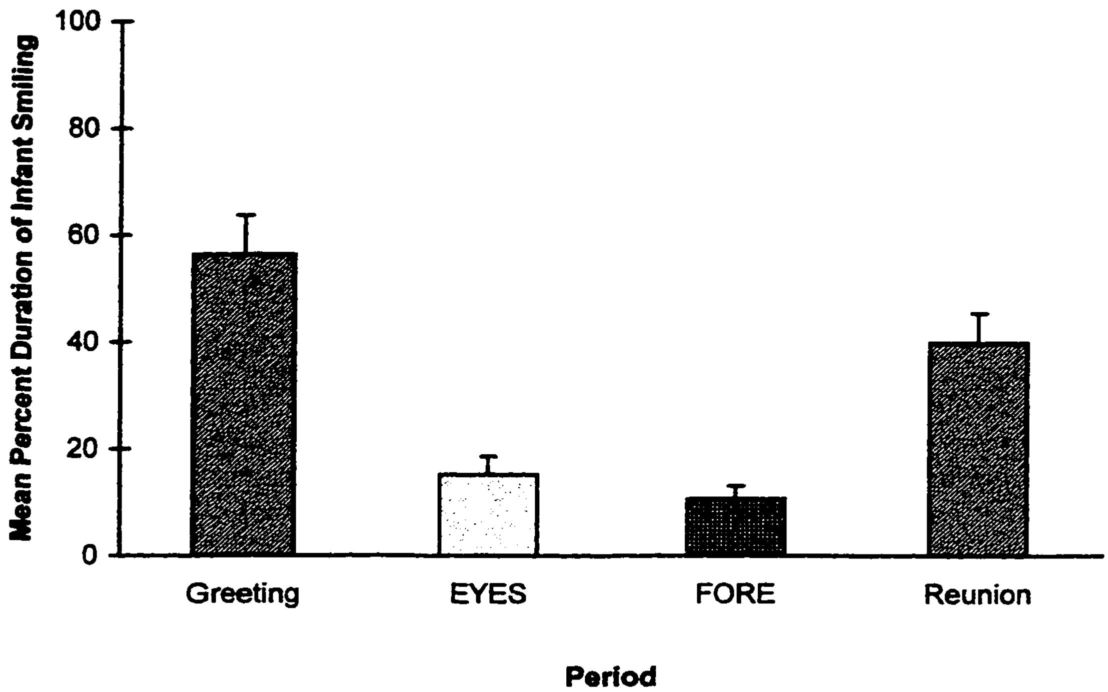

Figure 26. Mean percentage of time infants spent smiling as a function of period (Greeting, EYES, FORE, Reunion). Standard errors are shown by vertical bars.

Discussion

Four-and 7-month-old infants in Control Study 1 did not react differently depending on whether their mothers were gazing at their eyes or at their lower foreheads during the SF with touch interaction periods. That is, infants spent a similar amount of time gazing at their mothers' faces during the EYES and the FORE periods, which was consistently less than the amount of time they spent gazing at their mothers' faces during either the greeting or reunion periods. Infants gazed away a similar amount of time throughout the study, and their fretting was also consistently low throughout the study. Infants smiled more during the normal periods, but they did not exhibit a difference in the amount of smiling between the EYES and FORE periods.

Although the number of subjects used in this control study was small, strong differences were found in infant responding between the normal and SF with touch periods. Since differences were found in infant responding between the normal and SF with touch periods, chances are that any differences that existed in infant responding between the two SF with touch periods would also have been revealed. Therefore, these findings strongly suggest that the infants were unable to distinguish whether their mothers were looking directly at their eyes or at their lower foreheads during the SF with touch periods. The results imply that the subtle shift in gaze had no effect on them, thus indicating that the results from Study 3 could be generalized to other face-to-face social adult-infant interactions.

The fact that the 4-month-old infants spent more time looking at their mothers' faces and less time looking away from the experimental situation than the 7-month-old infants is consistent with previous studies suggesting that face-to-face interaction peaks within the fourth month of life and declines thereafter, when object play becomes more frequent (e.g., Field, 1977; Kaye & Fogel, 1980; Lamb et al., 1987). The fact that girls spent more time gazing away from the experimental situation than boys may be explained in part by some previous studies in which mothers were found to vocalize more with their girls than with their boys (e.g., Wasserman & Lewis, 1985). Possibly, since mothers were asked to remain silent when interacting with their infants, the lack of vocal stimulation was more evident to the girls than to the boys, and thus the girls became bored with the situation and averted their gaze more often. It is interesting to note that no sex differences had been found in previous research that was similar in design to the present study (e.g., Stack & LePage, 1996; Stack & Muir, 1990, 1992). These past studies did not include Gaze Away in their analyses, however, which could account for discrepant results.

In conclusion, the results from Control Study 1 suggest that infants at 4 and at 7 months of age do not respond differently to their mothers during a SF with touch interaction as a result of whether their mothers are looking at their eyes or at their lower foreheads. Therefore, the differences in infant responding shown in Study 3 were not due to the direction of the mothers' eyes (at the infants' lower foreheads) but were more likely due to the contingency, or lack thereof, of the mothers' behaviours with their infants. The results found in Study 3 can, therefore, be generalized to similar contexts including interactions where mothers are asked to play with their infants using touch.

Control Study 2

Although, it can be concluded, based on reliability and statistical analyses, that mothers in the NON condition in Study 3 accurately imitated the touching behaviours of the mothers in the CON condition, it is possible that the noncontingent interactions may have flowed less smoothly than the contingent interactions. For example, in an effort to accurately imitate the other mother, a mother in the NON condition may have made more quick, abrupt (e.g., jerky) changes in her touching behaviours than the mother in the CON condition. Thus, the infants may have been reacting not only to the lower level of contingency between their behaviours and those of their mothers, but also to the lack of natural fluidity typically present in their interactions.

Thus, Control Study 2 was designed to assess whether both the contingent and noncontingent interactions between mothers and their infants appeared to be fluid, or to flow naturally. Adult females were asked to judge whether the video clips they were viewing were of mothers playing with their infants (contingently) or mothers imitating other mothers playing with their infants (noncontingently). If the judges were making their choices at chance level, as hypothesized, then it could be assumed that both types of interaction (i.e., play and imitate) appeared to be fluid and natural, and thus any differences in infant responding between the two conditions were based on the level of contingency between their own and their mothers' behaviours.

Method

Participants

Participants were 10 adult females (age range = 23 to 42 years), none of whom were mothers, and all of whom were blind to the hypotheses of both Control Study 2 and Study 3.

Apparatus

The apparatus consisted of a Sony VHS video player connected to a video monitor on which images of the mother-infant interactions were played back for participants to watch while seated comfortably on an easy chair.

Design and Procedure

After each subject signed a consent form (Appendix U), they were asked to read the instructions for the study (Appendix V) while the experimenter read the same instructions out loud. After answering any questions the subject might have had about the study, the experimenter started the video and left the participants to watch the videotape. Each subject watched the same twelve 30-s randomly selected clips of mothers from Study 3 interacting with their infants (6 CON, 6 NON). The clips were selected through the use of a random-numbers table. Before each 30-s video clip a number was displayed as a reference for the participants to know which clip was following. After each clip there was a 6-s pause during which the participants were asked to make their choices between whether they judged that the clip was of a mother playing with her infant, or of a mother imitating another mother playing with her infant. Participants were asked to circle their choice on the forms given to them (Appendix V). At the end of the testing sessions participants were asked open-ended questions about the task and any difficulties they had in making their judgements.

Data Reduction

Prior to data reduction participants' responses to two of the video-clips were removed from consideration due to overwhelming cues in the clips indicating to which condition (i.e., CON or NON) the mother-infant pair belonged. These cues were mentioned by the participants as evidence they used in making their decisions. For one of the clips the infant was sucking on the mother's finger and moving the mother's hand around with no restriction from the mother. For another of the clips the mother removed a visible piece of lint from her infant's chest. Since these cues bore no relation to the fluidity of the interaction between the mother and infant but provided direct leads for judgements as to the condition in which the mother-infant pair were participating, they were removed from consideration before data reduction. For each subject the number of correct and incorrect responses were then tallied for the remaining 10 clips.

Results

A binomial test of significance, corrected for continuity, was conducted on the data to determine if there was any difference between the total number of correct and incorrect answers (Siegel & Castellan, 1988). This binomial test was nonsignificant, $z = .70$, ns, indicating that participants were unable to distinguish between a contingent and a noncontingent mother-infant interaction. As illustrated in Figure 27, participants were just as likely to be correct ($n = 54$) as incorrect ($n = 46$) in their decisions about whether the mother they were viewing was playing contingently with her infant or whether she was imitating another mother playing with her infant. This finding indicates that both types of interactions were fluid, again supporting the argument that the only difference

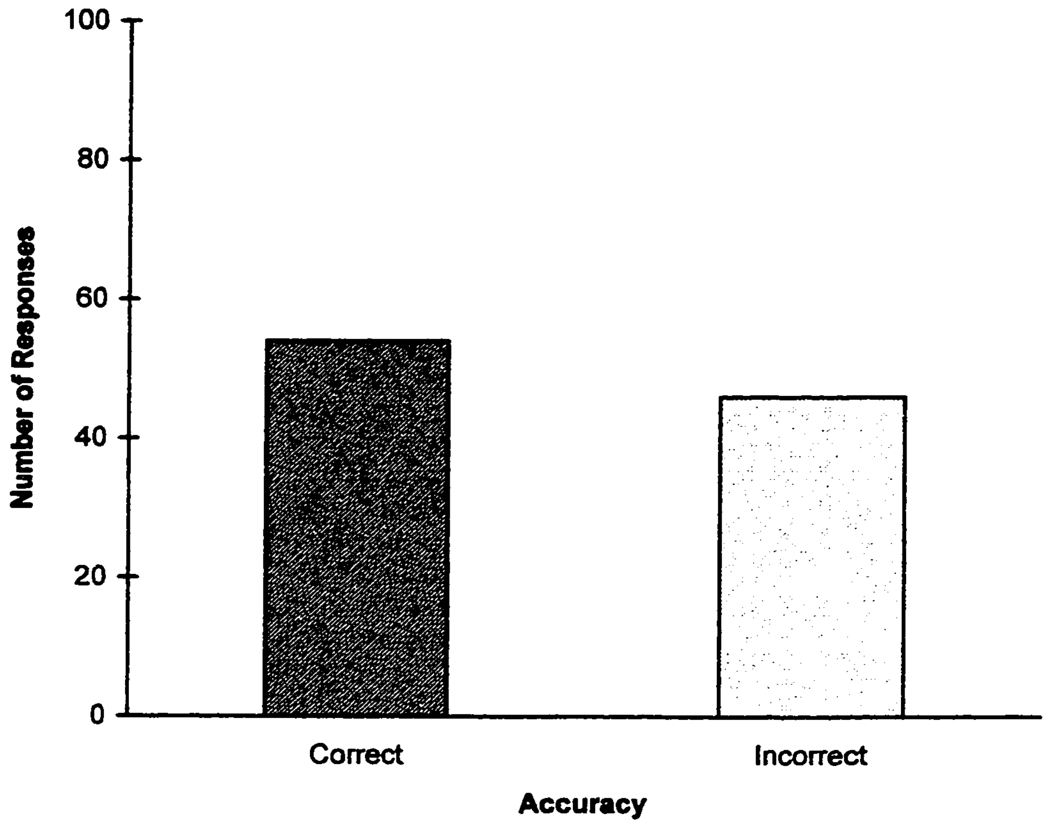

Figure 27. Number of responses from adult subjects as a function of accuracy (Correct, Incorrect).

between the two conditions was the level of contingency between the mothers and their infants.

Discussion

The results from Control Study 2 revealed that the adult subjects were not able to discriminate, beyond a chance level, a SF with touch interaction in which the mother was playing contingently with her infant from a SF with touch interaction in which the mother was imitating another mother playing with her infant. This result indicates that the mothers in the NON condition were not only accurately imitating their CON partners, but that they were doing so in a relatively fluid fashion. Therefore, it appears as though the only difference between the stimulation that infants in the CON and NON conditions were receiving was the level of the contingency between their own behaviours and those of their mothers. The results from Study 3 can thus be interpreted in terms of the presence or lack of contingency during the touch-alone interactions.

General Discussion

Control Studies 1 and 2 both indicated that the manipulations of mothers' behaviours in Study 3 did not appear to significantly affect the responses of the infants to the primary manipulation; the level of contingency between the mothers and their infants. In Control Study 1, infants were not affected by where their mothers were looking (at their infants' eyes or lower foreheads) when they were interacting with their infants using touch alone. Thus, infants in Study 3 were not responding to the fact that their mothers were not gazing at their eyes. The generalizability of this study to other studies examining mother-infant touch-only interactions is therefore warranted.

Furthermore, Control Study 2 indicated that mothers in the NON condition were able to maintain the natural flow of the interaction when imitating the mothers in the CON condition, at least according to adult female judges. This suggests that infants in the NON condition were not reacting to a disruption in the flow of their mothers' touching behaviours. Thus, the different responses found in Study 3 between infants in the CON and NON conditions can be interpreted as being due to the different amounts or levels of contingency between the mothers' and infants' behaviours.

CHAPTER 5: GENERAL DISCUSSION

The results from the present series of three studies, combined with the two control studies, indicate that both 4- and 7-month-old infants are sensitive to the presence and relative absence of contingency during social interactions. Furthermore, the importance of contingency in maintaining infants' gaze within a social interaction, in maintaining their positive affect, and in decreasing their negative affect, was also demonstrated. Some evidence that the absence of contingency in social interactions has a negative impact on infants' motivations to engage in future social interactions was also found. All of this was accomplished through the adults' use of the tactile modality, alone, when interacting with the infants, and thus our understanding of the communicative abilities of touch was further extended.

Previous studies examining infants' abilities to perceive and learn a contingency between their behaviour and a specific event have primarily made use of the operant-learning paradigm within perceptual-cognitive frameworks (e.g., Greco et al., 1986; Rovee-Collier et al., 1985, Watson, 1984, 1985). The present series of studies extends the knowledge obtained from past research into a social context. While still using the operant-learning paradigm, Studies 1 and 2 examined 7- and 4-month-old infants' abilities to perceive and learn a specific contingent relationship between their gazing and the tactile behaviour of a still-faced and silent experimenter. Once infants' abilities to learn a contingency within a social context (using an operant-learning paradigm) were established, Study 3 extended these results further by examining infants' reactions to the presence or lack of contingency during more natural social interactions with their own mothers.

The results from the present series of studies provide evidence that: (a) 4- and 7-month-old infants are able to learn a specific tactile contingency within a social context, (b) 4- and 7-month-olds are sensitive to and are able to perceive the presence or lack of contingency during a more natural social interaction in which their mothers are using only touch, and (c) the inclusion of contingency within social interactions is important for infants' active and positive participation in present and future social interactions.

Contingency Learning within a Social Context

The results from Studies 1 and 2 provide clear and direct evidence of infants' abilities to learn a contingent relationship within a social context. Infants who were receiving contingent tactile reinforcement when they gazed at the experimenter's still face exhibited more gazing at her face than infants receiving yoked-control tactile stimulation. Thus, infants are able to learn contingent relationships within a social context, as assessed through the use of an operant-learning paradigm.

That the 7-month-old infants were able to learn this contingency was not surprising, given past research (e.g., Rovee-Collier, 1984; Lewis et al., 1990). However, Millar (1988) suggested that infants at this age were not yet capable of understanding the causal means/ends implications between their behaviours and that of the reinforcing stimuli. It was suggested earlier (in Chapter 1), that the reason infants did not learn the contingency presented to them by Millar was due to the fact that the required behaviour, touching a manipulandum, was nonsocial in nature, whereas the reinforcing stimulus, their mothers' faces, was social (Collis, 1981; Reeve et al., 1993). In Study 1 of the present series, both the required response from the infant and the reinforcing stimulus from the experimenter were considered social in nature, as the movement of the infants' legs was delivered within a social context. In this social context the 7-month-olds readily learned the contingency presented to them. The present results, as well as results from past studies (e.g., Reeve et al., 1993) suggest that the discrepant results in Millar's study may have been due to the combination of social and nonsocial required response and reinforcing stimuli.

By using the same paradigm as in Study 1, in Study 2 it was established that infants at 4 months of age were also capable of learning the contingent relationship presented to them. Past research has found that infants as young as 4 months were able to learn contingencies within perceptual-cognitive frameworks (e.g., Lewis et al., 1990; Sullivan & Lewis, 1989). The present study extends this past research by demonstrating the abilities of these younger infants to learn a contingent relationship within a social context. Therefore, contingency learning in a social context occurs at a relatively young age (4 months), when infants are beginning to develop both an understanding of the world and its relationships, and the expectations that accompany this understanding (Lamb, 1981). Thus, the learning capabilities of infants can be generalized to a social context, and appear to be emerging at least by 4 months of age.

Once it was confirmed that 4- and 7-month-old infants were able to learn a specific contingent relationship within a social context, the next step was to remove the artificial aspect of the operant-learning paradigm and examine infants' responses within more natural contingent versus noncontingent social interactions.

Infants' Sensitivities to Contingency within a Social Context

In Study 3, 4- and 7-month-old infants' abilities to perceive, or detect, the lack of contingency within a more natural social interaction were examined. It was important to extend the results from Studies 1 and 2 to a more natural social context as infants are rarely, if ever, presented with such clear contingent relationships as those included in an operant-learning paradigm. Therefore, a more ecologically valid examination of infants' responses to their contingent or noncontingent mothers was attempted in Study 3, and, as confirmed by reliability analyses and through Control Study 2, it was established that infants in the CON and NON condition were receiving similar tactile stimulation from their mothers, except for the level of contingency.

Infants who had participated in a noncontingent interaction with their mothers exhibited more gazing away from the interaction and a more variable pattern in gazing away than infants participating in a contingent interaction. Furthermore, if their mothers did not behave contingently with them, infants exhibited a linear decrease in their smiling and a linear increase in fretting throughout the period, whereas if contingency was included, infants did not display the decrease in smiling, and they exhibited low, stable amounts of fretting. These results suggest that infants in the NON condition were less interested in, and became increasingly upset during, the social interaction with their mothers. In contrast, infants in the CON condition remained engaged with their mothers and they exhibited a more stable, positive state of affect throughout the interaction period. Therefore, it appears that when given the same type of stimulation, if contingency is lacking infants respond with negative affect and they may disengage from the interaction.

Infants at both ages exhibited similar responses to the contingent and noncontingent social tactile interactions. Thus, infants as young as 4 months of age were sensitive to the subtle lack of contingency in their mothers' touching behaviours during social interactions. The perceptual and learning abilities of young infants during social interactions were thus further determined.

The Importance of Contingency

While the sensitivities of young infants to the presence or lack of contingency during both operant-learning and more natural social contexts has been established, the importance of contingency to infants during interactions also warrants attention. The present series of studies examined not only infants' abilities to perceive contingencies, but also their responses to those contingencies within social contexts. In Study 1, evidence was provided that 7-month-old infants decrease their gaze towards the social partner during an interaction in which contingency is absent. The 7-month-old infants who were receiving noncontingent tactile stimulation from the experimenter spent more time gazing away from the experimental situation than those infants receiving contingent tactile stimulation. Furthermore, in Study 2, the 4-month-old infants decreased their gaze during the reunion period following a noncontingent interaction with the experimenter. Thus, contingency appeared to be important in maintaining infants' gaze within the interaction, and during the following social interaction.

In Study 3, as discussed above, infants in the NON condition exhibited more gazing away, a linear decrease in their smiling, and a linear increase in their fretting throughout the manipulation period, whereas infants in the CON condition maintained their gazing within the interaction and did not show either a decrease in positive affect or an increase in negative affect. Furthermore, during the normal reunion period following the manipulation period, infants in the NON condition in Study 3 exhibited greater amounts of fretting than infants in the CON condition. Infants who had previously participated in a noncontingent interaction also exhibited a trend in their fretting during the reunion period such that it started high, and gradually decreased to be similar to the fretting displayed by infants who had previously participated in a contingent interaction with their mothers. Finally, there was evidence in Study 3 that 7-month-old infants behaved differently during the normal reunion period depending on whether they had previously participated in a contingent or a noncontingent social interaction. Seven-month-olds in the NON condition displayed a linear increase in their gazing at their mothers' faces, whereas 7-month-olds in the CON condition exhibited a linear decrease in gazing at their mothers' faces.

Therefore, through their affective and gazing patterns, it appears that infants who had participated in a noncontingent interaction were less readily re-engaged with their mothers during the subsequent contingent reunion period. Taken together, these results indicate that the inclusion of contingency during social interactions is important in maintaining infants' positive affect as well as their interest in current and subsequent interactions.

That contingency appears important in maintaining infants' interest and positive affect in social interactions has been suggested by other researchers (e.g., Bigelow, 1998; Bigelow et al., 1996; Glenn et al., 1994; Hains & Muir, 1996a; Papousek & Papousek, 1979). As discussed previously, Hains and Muir found that infants exposed to a noncontingent stranger were quicker to gaze away from the situation, and spent more time doing so, than when the stranger was contingent. Furthermore, the infants displayed less positive affect when interacting with a noncontingent stranger. Bigelow (1996) also found that infants indicated a preference for a stranger with whom they had previously had a contingent interaction over a stranger with whom they had had a noncontingent interaction. Further, as discussed in Chapter 3, it appears that contingency may be more important in maintaining infants' interest and positive affect than the reinforcing stimulation per se (e.g., Gunnar, 1980; Gunnar, Leighton, & Peleaux, 1984; Papousek & Papousek, 1979), although infants do appear to respond differently to a contingent social partner and a contingent object such as a doll (Ellsworth, Muir, & Hains, 1993; Legerstee, Pomerleau, Malcuit, & Feider, 1987). Thus, infants appear to have a preference for stimuli, or people, who are contingent with them and they will remain engaged in interactions that include contingencies.

The negative affect exhibited by infants during the noncontingent manipulation period in Study 3 could also be indicative of the significance of contingency for these infants. For example, according to Campos' (1994) theory of emotional functionalism, only events that are significant to the person will elicit affect. Campos asserts that events are considered significant through various means such as the social signals given by other people, or the relation of the event to hedonic or positive stimulation. For example, infants in the NON condition in Study 3 may have been fretting because their mothers were not responding contingently to their behaviours, and so the social signals provided to the infants may have been unclear, or perhaps perceived by the infants as negative. Thus, the lack of contingency in the mothers' behaviours could have been important or significant to the infants, and as such they responded by increasing their negative affect and disengaging from the interaction.

This negative affect could also be interpreted as a signal from infants in the NON condition that they disliked their mother's behaviours and wanted them to change. Infants are considered competent at communicating their desires and dislikes to adults through their gazing, affective, and movement behaviours (Field, 1977; Symons & Moran, 1987; Toda & Fogel, 1993; Tronick & Cohn, 1989). Typically, adults react to infants' gazing away and fretting behaviours with various actions that create proximity, or re-engagement (Lamb, 1988; Tronick et al., 1978). Thus, infants' negative affect and their disengagement from situations appear to be effective in changing or eliciting specific behaviours from adults. The disengagement and fretting behaviours of infants in the NON condition in Study 3 could then be interpreted as attempts to change their mothers' behaviours. As mothers in the NON condition were behaving the same way as mothers in the CON condition, where infants remained engaged and positive during the interaction, it appears as though it was specifically the lack of contingency that infants in the NON condition may have been attempting to change. Perhaps infants in the NON condition were using the social and communicative skills available to them in an attempt to influence their mothers' behaviours. This interpretation further underscores that the presence of contingencies during social interactions is important for infants, and that they will respond to a contingent interaction with interest through their gazing and positive or neutral affective patterns.

The results and ensuing interpretations of the infants' behaviours in the present series of studies suggest that infants are cognitively and socially sophisticated, and that their participation in interactions is far from passive. That contingency appears important in maintaining infants' interest and positive affect during social interactions is also significant in terms of the opportunities for infants' social and emotional development. Fogel (1992) and others (e.g., Gergely & Watson, in press; Papousek & Papousek, 1979; Suomi, 1981) contend that social interactions provide infants with many opportunities to learn and develop as social beings. For example, Fogel's theory of social dynamics suggests that infants learn many of their social as well as nonsocial behaviours (e.g., walking) during interactions within a social or relational context. Although he suggests that infants can learn under adverse circumstances, he argues that it is important that infants' attention remain directed towards these social interactions (Fogel, 1992). From the results of the present series of studies, it appears as though the inclusion of contingency is important for maintaining infants' gaze within a social interaction. Further, infants appear to decrease their positive affect and, more importantly, increase their negative affect when there is a lack of contingency in a social interaction. Therefore, if infants' gaze and positive or neutral affect are important for their learning within social interactions (Fogel, 1992), it follows that the inclusion of contingency within these interactions is instrumental.

There is an abundance of evidence that the inclusion of contingency in a learning paradigm or learning interaction helps in fostering future learning (e.g., Bloom et al., 1987; Finkelstein & Ramey, 1977; Rovee-Collier, 1984; Stevenson & Lamb, 1981). For example, Rovee-Collier (1984), as discussed in Chapter 1, found that by including a contingent relationship between infants' behaviours and an event, infants are better able to learn and remember that event for up to 1 week. Furthermore, researchers have found that maternal responsiveness or contingent responding to their infants appears to precipitate greater cognitive competence (e.g., Clarke-Stewart, 1973; Lewis & Coates, 1980; Lewis & Goldberg, 1969; Yarrow, Rubenstein, & Pedersen, 1975). Lewis and Coates (1980), for example, found that the cognitive performance of 3-month-old infants was positively related to the probability of their mothers' contingent responses. Thus, the inclusion of contingency appears to facilitate the cognitive, as well as the social-emotional, development of infants.

Furthermore, researchers examining the levels of attachment between infants and their mothers have suggested that maternal sensitivity to their infants' demands is important for developing secure relationships (e.g., Ainsworth, Blehar, Waters, & Wall, 1978; Cohn et al., 1991). This type of maternal sensitivity has been used as a synonym for contingency (Bloom et al., 1987; Dunham & Dunham, 1990; Tarabulsy, Tessier, & Kappas, 1996), and it provides a context within which infants' expectations about their mothers' behaviours can be developed. The predictability of maternal behaviour allows infants to be secure in their relationship with her, and this security is manifested in their greater exploratory behaviours, which engender further learning (e.g., Ainsworth et al., 1978). Therefore, inclusion of contingency in interactions between a caregiver and infant facilitates secure attachments, as well as a sense of self-efficacy in the infant, which lead to greater exploration and learning (e.g., Bigelow, in press). While contingency within a social interaction will help infants in their social and emotional development, it will also aid in the subsequent experiences and learning opportunities by allowing infants to feel secure in their explorations outside the relationship with that caregiver. The knowledge that infants as young as 4 months of age are sensitive to the lack of contingency in a social interaction, and their subsequent negative responses during noncontingent interactions, provides support for the contention that contingency is necessary in these early social interactions for infants' future learning and development.

Infants' responses during the reunion periods in the present series of studies suggest that infants respond differently to an adult during a normal contingent social interaction depending on whether they have previously participated in a contingent or a noncontingent interaction with that adult. A number of researchers have indicated the importance of the inclusion of contingency in maintaining infants' motivation to participate in future interactions, as well as their perception of contingency in these future interactions (Bigelow, 1996; Dunham & Dunham, 1990; Dunham et al., 1989; Glenn et al., 1994; Millar & Weir, 1992, 1994; Papousek et al., 1986; Suomi, 1981). Infants who have been exposed to a previous noncontingent interaction do not appear to be motivated to seek out and perceive future interactions, even if they include contingency. This response has been interpreted in terms of the learned helplessness theory developed by Seligman (1975). Some researchers suggest that perceived lack of control over a situation may lead infants to display the apathetic reactions, in terms of not seeking out or perceiving future contingent relationships, that were evident in Seligman's study (e.g., Lewis et al., 1992). With these data in mind, then, the importance of the inclusion of contingency becomes even more critical. Perhaps a perceived pervasive lack of control, or contingency, in infants' early interactions could have deleterious effects on their future interactions, into childhood. Although systematic studies examining infants' exposure to noncontingent relationships early in life and their future behaviours would be challenging and cannot be conducted for ethical reasons, it is nonetheless possible, according to various researchers, that the inclusion of contingency is necessary for infants to develop into active, motivated social beings (e.g., Bigelow, in press; Millar & Weir, 1992, 1994; Suomi, 1981; Tarabulsy et al., 1996).

Contingency appears to be an important component in social interactions, and the present series of studies indicate that infants as young as 4 months of age are sensitive and respond differentially to the inclusion or lack of contingency within social interactions. The fact that these contingent or noncontingent social interactions were delivered within the tactile modality alone provides further evidence for the versatility of touch in communicating with young infants. Thus, the present series of studies advanced past research examining tactile stimulation during social interactions to include the communication of contingency.

The overall results from the present series of studies have invoked some intriguing hypotheses about infants' sensitivities and responses to the presence or lack of contingencies during social interactions. Promising results were obtained and future research concentrating on the hypotheses generated will aid in further clarifying the intricacies of mother-infant interactions. Although the present studies had a few limitations, which may restrict some interpretations and generalizations, many of these can be dealt with in future research projects. For example, examining the responses of infants younger than 4 months during social interactions in which contingency is absent is warranted. The present findings suggest that infants were able to learn the contingencies by 4 months of age. It remains to be determined whether infants younger than 4 months of age would be able to learn contingencies within social paradigms. Consistent with this suggestion, prospective longitudinal studies would help to document infants' responses to the presence or lack of contingency during social interactions throughout their first year, and would better establish the importance of contingency to infants at different stages in their lives. Further, as Stevenson and Lamb (1981) discuss, the significance of individual differences in infants' temperaments on their abilities to learn and react to contingencies could be better delineated through longitudinal research. Although evidence suggests that individual differences in infant temperament do not impinge on their abilities to learn contingencies (e.g., Alessandri et al., 1990; Tarabulsy et al., 1996), a longitudinal procedure would best delineate the effects of these individual differences. A longitudinal study might also further reveal possible effects of early contingencies on later cognitive competency. That early contingent relationships appear to be associated with infant cognitive competence is intriguing (e.g., Lewis & Coates, 1980), however the impact of early contingent relationships on future competencies has yet to be adequately established.

An examination of infants' reactions to contingencies presented in other modalities, for example facial or vocal expressions, would further extend the present findings. Combining the various communicative modalities (i.e., face, voice, touch, gesture) to establish the importance of contingency and the importance of the modalities in maintaining contingency and communication between adults and infants would be an important step in increasing our understanding of early social interactions. In this regard, an examination of other infant responses as well as their gazing and affect, such as postural and hand movements or manipulations, would serve to enhance the present knowledge of infants' communicative abilities during contingent or noncontingent interactions.

Although beyond the scope of this thesis, an analysis of the sequencing of mother-infant behaviours during social interactions in which contingency is manipulated would also add information as to how infants coordinate their responses when their mothers are not contingent or sensitive to their behaviours. This type of analysis would help to establish whether patterns that normally exist during contingent interactions are changed during noncontingent interactions and how these changes are reflected. A sequential analysis would thus help to delineate further the effects of the removal of contingency on mother-infant interactions, and the potential importance of contingency in these interactions.

The limitations notwithstanding, the present series of studies demonstrated strong support for the importance of contingency and provided clear evidence that infants are sensitive to and understand contingencies presented within a social context. Taken together, the results from the present series of studies indicate that infants as young as 4 months of age are able to recognize, and respond differently to, social interactions in which contingency is present or lacking. Infants who are presented with a social interaction in which contingency is lacking disengage from the interaction, decrease their positive affect, and increase their negative affect. In contrast, infants who are participating in a contingent social interaction maintain their gaze towards that interaction and display either neutral or positive affect, and little negative affect. Further, infants appear to be less readily engaged in contingent, social interactions that follow noncontingent social interactions, as reflected in their gazing and affective patterns. Infants who had participated in contingent social interactions, however, appeared to be more readily engaged in subsequent interactions, suggesting the importance of contingency in maintaining infants' interest and positive affect, and in decreasing their negative affect, both during current, and for subsequent social interactions. The importance of the inclusion of contingency in adult-infant social interactions in enhancing infants' attachment to caregivers, in increasing their self-efficacy and cognitive development, and in promoting their motivation to seek out and engage in future contingent social interactions has been demonstrated in varying degrees by several researchers (e.g., Ainsworth et al., 1978; Bigelow, in press; Bloom et al., 1987; Dunham et al., 1989; Fogel, 1992; Gergely & Watson, in press;). Through increased gaze and positive affect, and reduced negative affect, these contingent interactions may thus enable a more optimal environment within which infants can learn and develop as social and emotional human beings.

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Appendix A

Demographics for Study 1

The majority of the families who participated in Study 1 were White (92%), two-parent, intact (97%) and middle-class (94%). Specifically, the sample included Non-Hispanic White (92%) and Asian/Pacific Islander (8%). In terms of educational attainment, families were classified as 6% with high-school but without college education, 26% had some college education, and 69% had degrees from programs requiring 4 years of college or more. In terms of occupational status, the families were classified in the domains of Executive, Administrators, Managerial (24%), Professional Specialty (15%), Technical and Related Support (15%), Sales (18%), Administration, Support, Clerical (6%), Precision Production, Craft & Repair (3%), Handlers, Equipment Cleaners, Helpers and Labourers (3%), and Service Workers not in private households (6%; categories based on US Bureau of the Census, 1996). In addition, there were some Students (3%) and those that were unemployed (3%).

Appendix B

<u>Consent Form for Studies 1 and 2</u>

CONSENT FORM

This study is designed to look at infants' responses to touch under different interactive conditions. I understand that my baby will participate in one session lasting about 30 minutes. The study itself will last for a total of 6 minutes, and will consist of three brief interaction periods during which different tactile games will be presented on my baby's body. My baby will be seated in an infant seat directly facing a female experimenter who will interact naturally during some periods, and be neutral and unresponsive in facial expression and silent during other periods. During one period when the female experimenter is neutral in facial expression and silent, she may play tactile games with my baby, while during another period she may respond to my baby with touch, only when my baby makes eye-contact with her. There will be brief breaks separating the interaction periods. No manipulation will be harmful to my baby. The entire session will be videotaped so that at a later point my baby's responses can be scored. However, the recordings are kept in the strictest of confidence and are not shown to others without my permission. In any case, all recordings will be destroyed once coding is completed.

I understand that my participation in this study, and that of my baby, is totally voluntary. I know that I may withdraw at any time and for any reason. I also understand that I may request that the videotape recording be erased. In the event that the results of the study are published, my name and the name of my baby will be kept confidential.

In the event that I have any unanswered concerns or complaints about this study, I may express these to Dr. Dale Stack (848-7565) or Diane LePage (848-7547) of the Psychology Department's Centre for Research in Human Development at Concordia University. In addition, the patient representative at the Jewish General Hospital is Roslyn Davidson (340-8222).

Thank you for your cooperation.

I ______________________ do hereby give my consent for my baby ____________________ to participate in a study conducted by Dr. Dale Stack and Diane LePage at Concordia University, and with the cooperation of the Jewish General Hospital. A copy of the consent form has been given to me.

Signature: ______________________ Date: ___________

Witness: _______________________ Date: ___________

Appendix C

Demographic Questionnaire

Demographic Information

Group:___ Study #:_______

Infant #:___ Test Date:______

Infant's Name:________________

D.O.B.:______ E.D.O.B.:_____ Age:_____

Mother's Name:________________ Age:_____

Lang.'s Spoken:_______________________

Father's Name:________________ Age:_____

Lang.'s Spoken:_______________________

Phone #:_________

Address:____

Sex:___ Birth Weight:_____ Length of Labour:______

Preg. Complications and Delivery Status:____
____

Medical History:____

Breast fed:____ Bottle fed:____

Siblings: Age Sex

_____ _____

_____ _____

_____ _____

Father's Occupation:__________ Education:_____

Mother's Occupation:__________ Education:_____

Mother's Recent Work History (full/part-time/home):_____

Father's Recent Work History (full/part-time/home):_____

Hours spent with infant all day:
Mother: all day 3/4 1/2 1/4 < 1/4
Father: all day 3/4 1/2 1/4 < 1/4

Caretaking History (# of caretakers, day/homecare, hours):_______________________________________
____

Comments:____

Interested in Participating in Other Studies at CRDH:____________

Appendix D

Planned Comparison Summary Tables for

Experimenter Touch, Infant Gaze at Face, and Gaze Away,

Study 1

Table D1

Planned Comparisons for Experimenter Touch, Study 1

Source	df	F
	Within subjects	
GC_GN	1	1.18
GC_GN x S within-group error	11	(60.12)
GC_GT	1	0.29
GC_GT x S within-group error	11	(67.17)
GN_GT	1	0.30
GN_GT x S within-group error	11	(53.29)
CON_NON	1	1.41
CON_NON x S within-group error	11	(40.77)
CON_SF+T	1	40.18*
CON_SF+T x S within-group error	11	(139.19)
NON_SF+T	1	38.37*
NON_SF+T x S within-group error	11	(176.79)
RC_RN	1	0.12
RC_RN x S within-group error	11	(270.73)
RN_RT	1	0.16
RN_RT x S within-group error	11	(156.63)
Period (P)	3.42	14.29*
P x S within-group error	37.65	(138.61)

Note. Values enclosed in parentheses represent mean square errors. GC = greeting period for CON condition; GN = greeting period for NON condition; GT = greeting period for SF+T condition; CON = manipulation period for CON condition; NON = manipulation period for NON condition; SF+T = manipulation period for SF+T condition; RC = reunion period for CON condition; RN = reunion period for NON condition; RT = reunion period for SF+T condition; S = subjects.

*$p < .001$.

Table D2

Planned Comparisons for Infant Gaze at Face, Study 1

Source	df	F
	Within subjects	
GC_GN	1	2.32
GC_GN x S within-group error	11	(172.44)
GC_GT	1	0.26
GC_GT x S within-group error	11	(240.64)
GN_GT	1	0.66
GN_GT x S within-group error	11	(220.00)
CON_NON	1	18.97**
CON_NON x S within-group error	11	(209.82)
CON_SF+T	1	9.40*
CON_SF+T x S within-group error	11	(399.01)
NON_SF+T	1	0.01
NON_SF+T x S within-group error	11	(415.50)
RC_RN	1	0.92
RC_RN x S within-group error	11	(235.47)
RN_RT	1	2.61
RN_RT x S within-group error	11	(193.69)
Period (P)	4.54	41.81**
P x S within-group error	49.91	(266.71)

Note. Values enclosed in parentheses represent mean square errors. GC = greeting period for CON condition; GN = greeting period for NON condition; GT = greeting period for SF+T condition; CON = manipulation period for CON condition; NON = manipulation period for NON condition; SF+T = manipulation period for SF+T condition; RC = reunion period for CON condition; RN = reunion period for NON condition; RT = reunion period for SF+T condition; S = subjects.

*$p < .05$. **$p = .001$.

Table D3

Planned Comparisons for Infant Gaze Away, Study 1

Source	df	F
	Within subjects	
GC_GN	1	1.06
GC_GN x S within-group error	11	(38.42)
GC_GT	1	0.83
GC_GT x S within-group error	11	(33.99)
GN_GT	1	0.02
GN_GT x S within-group error	11	(48.50)
CON_NON	1	6.53*
CON_NON x S within-group error	11	(363.95)
CON_SF+T	1	0.92
CON_SF+T x S within-group error	11	(203.64)
NON_SF+T	1	6.75*
NON_SF+T x S within-group error	11	(577.85)
RC_RN	1	0.12
RC_RN x S within-group error	11	(88.61)
RN_RT	1	0.08
RN_RT x S within-group error	11	(117.82)
Period (P)	2.27	11.08**
P x S within-group error	24.93	(163.84)

Note. Values enclosed in parentheses represent mean square errors. GC = greeting period for CON condition; GN = greeting period for NON condition; GT = greeting period for SF+T condition; CON = manipulation period for CON condition; NON = manipulation period for NON condition; SF+T = manipulation period for SF+T condition; RC = reunion period for CON condition; RN = reunion period for NON condition; RT = reunion period for SF+T condition; S = subjects.

*$p < .05$. **$p = .001$.

Appendix E

Transformed Means and Main Effects

for Infant Smiling and Fretting,

Study 1

Table E1

Means for the Percent Duration of 20-s Time Units of Infant Smiling during the Greeting Period, Study 1

Time Unit	M	SE
S1	43.29	6.41
S2	49.84	6.36
S3	43.04	5.90

Note. S = 20-s time unit.

Table E2

Transformed Means for the Percent Duration of Infant Smiling during the Manipulation Period, by Condition, Study 1: Square Root Transformation

Condition	M	SE
CON	1.68	0.26
NON	1.38	0.26
SF+T	4.44	0.34

Note. CON = contingent condition; NON = noncontingent condition; SF+T = SF with touch condition.

Table E3

Transformed Means for the Percent Duration of 30-s Time Units of Infant Smiling during the Manipulation Period, Study 1: Square Root Transformation

Time Unit	M	SE
S1	3.97	0.49
S2	3.22	0.54
S3	2.79	0.47
S4	2.34	0.42
S5	1.44	0.35
S6	1.23	0.38

Note. S = 30-s time unit.

Table E4

Transformed Means for the Percent Duration of 30-s Time Units of Infant Fretting during the Manipulation Period, Study 1: Log Transformation

Time Unit	M	SE
FT1	0.04	0.40
FT1	0.03	0.03
FT3	0.13	0.06
FT4	0.30	0.10
FT5	0.31	0.10
FT6	0.40	0.12

Note. FT = 30-s time unit.

Appendix F

Trend Analysis Summary Tables

for Infant Smiling and Fretting,

Study 1

Table F1

Trend Analysis for Infant Smiling during the Greeting Period, Study 1

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	2.66
C1 x S within-group error	11	(2660.37)
Condition Quadratic Trend (C2)	1	0.05
C2 x S within-group error	11	(3536.28)
Condition (C)	1.85	1.17
C x S within-group error	20.39	(3098.32)
Unit Linear Trend (U1)	1	0.00
U1 x S within-group error	11	(325.55)
Unit Quadratic Trend (U2)	1	7.32*
U2 x S within-group error	11	(146.14)
Unit (U)	1.75	2.27
U x S within-group error	19.21	(235.85)
C1 x U1	1	2.15
(C1 x U1) x S within-group error	11	(560.97)
C1 x U2	1	0.20
(C1 x U2) x S within-group error	11	(389.93)
C2 x U1	1	0.20
(C2 x U1) x S within-group error	11	(484.97)
C2 x U2	1	0.03
(C2 x U2) x S within-group error	11	(344.51)
C x U	3.29	0.78
(C x U) x S within-group error	36.16	(445.10)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$.

Table F2

Trend Analysis for Infant Smiling during the Manipulation Period, Study 1

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	14.42*
C1 x S within-group error	11	(19.00)
Condition Quadratic Trend (C2)	1	15.66*
C2 x S within-group error	11	(8.62)
Condition (C)	1.75	14.80**
C x S within-group error	19.27	(13.81)
Unit Linear Trend (U1)	1	18.79*
U1 x S within-group error	11	(10.37)
Unit Quadratic Trend (U2)	1	0.08
U2 x S within-group error	11	(3.53)
Unit Cubic Trend (U3)	1	0.02
U3 x S within-group error	11	(2.48)
Unit Quadratic Trend (U4)	1	1.53
U4 x S within-group error	11	(1.83)
Unit Quintic Trend (U5)	1	0.22
U5 x S within-group error	11	(1.94)
Unit (U)	2.54	9.84**
U x S within-group error	27.96	(4.03)
C1 x U1	1	1.30
(C1 x U1) x S within-group error	11	(5.01)
C1 x U2	1	0.33
(C1 x U2) x S within-group error	11	(4.82)
C1 x U3	1	1.17
(C1 x U3) x S within-group error	11	(2.09)
C1 x U4	1	0.05
(C1 x U4) x S within-group error	11	(5.14)
C1 x U5	1	0.20
(C1 x U5) x S within-group error	11	(4.02)

Table F2, continued

Source	df	F
C2 x U1	1	0.03
(C2 x U1) x S within-group error	11	(5.97)
C2 x U2	1	0.66
(C2 x U2) x S within-group error	11	(0.86)
C2 x U3	1	0.06
(C2 x U3) x S within-group error	11	(0.97)
C2 x U4	1	0.81
(C2 x U4) x S within-group error	11	(1.20)
C2 x U5	1	0.29
(C2 x U5) x S within-group error	11	(2.34)
C x U	4.53	0.43
(C x U) x S within-group error	49.85	(3.24)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

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

Table F3

Trend Analysis for Infant Smiling during the Reunion Period, Study 1

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	2.38
C1 x S within-group error	11	(2932.88)
Condition Quadratic Trend (C2)	1	1.13
C2 x S within-group error	11	(1696.08)
Condition (C)	1.87	1.93
C x S within-group error	20.53	(2314.48)
Unit Linear Trend (U1)	1	0.05
U1 x S within-group error	11	(835.71)
Unit Quadratic Trend (U2)	1	2.62
U2 x S within-group error	11	(927.55)
Unit (U)	1.94	1.40
U x S within-group error	21.34	(881.63)
C1 x U1	1	1.90
(C1 x U1) x S within-group error	11	(832.85)
C1 x U2	1	0.22
(C1 x U2) x S within-group error	11	(458.94)
C2 x U1	1	1.18
(C2 x U1) x S within-group error	11	(842.54)
C2 x U2	1	1.96
(C2 x U2) x S within-group error	11	(244.98)
C x U	2.76	1.32
(C x U) x S within-group error	30.41	(594.83)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

Table F4

Trend Analysis for Infant Fretting during the Manipulation Period, Study 1

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	0.17
C1 x S within-group error	11	(0.64)
Condition Quadratic Trend (C2)	1	0.17
C2 x S within-group error	11	(1.52)
Condition (C)	1.69	0.17
C x S within-group error	18.57	(1.08)
Unit Linear Trend (U1)	1	12.12*
U1 x S within-group error	11	(0.34)
Unit Quadratic Trend (U2)	1	0.08
U2 x S within-group error	11	(0.13)
Unit Cubic Trend (U3)	1	2.56
U3 x S within-group error	11	(0.05)
Unit Quadratic Trend (U4)	1	2.62
U4 x S within-group error	11	(0.04)
Unit Quintic Trend (U5)	1	1.92
U5 x S within-group error	11	(0.02)
Unit (U)	2.01	7.58*
U x S within-group error	22.11	(0.12)
C1 x U1	1	0.14
(C1 x U1) x S within-group error	11	(0.33)
C1 x U2	1	0.46
(C1 x U2) x S within-group error	11	(0.04)
C1 x U3	1	2.20
(C1 x U3) x S within-group error	11	(0.08)
C1 x U4	1	1.43
(C1 x U4) x S within-group error	11	(0.06)
C1 x U5	1	3.56
(C1 x U5) x S within-group error	11	(0.02)

Table F4, continued

Source	df	F
C2 x U1	1	0.23
(C2 x U1) x S within-group error	11	(0.48)
C2 x U2	1	0.54
(C2 x U2) x S within-group error	11	(0.16)
C2 x U3	1	0.69
(C2 x U3) x S within-group error	11	(0.08)
C2 x U4	1	0.05
(C2 x U4) x S within-group error	11	(0.03)
C2 x U5	1	0.16
(C2 x U5) x S within-group error	11	(0.03)
C x U	3.20	0.51
(C x U) x S within-group error	35.23	(0.13)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .01$.

Table F5

Trend Analysis for Infant Fretting during the Reunion Period, Study 1

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	1.86
C1 x S within-group error	11	(0.64)
Condition Quadratic Trend (C2)	1	0.25
C2 x S within-group error	11	(1.14)
Condition (C)	1.51	0.83
C x S within-group error	16.61	(0.89)
Unit Linear Trend (U1)	1	1.68
U1 x S within-group error	11	(0.16)
Unit Quadratic Trend (U2)	1	0.23
U2 x S within-group error	11	(0.16)
Unit (U)	1.81	0.97
U x S within-group error	19.90	(0.16)
C1 x U1	1	0.53
(C1 x U1) x S within-group error	11	(0.21)
C1 x U2	1	1.22
(C1 x U2) x S within-group error	11	(0.08)
C2 x U1	1	0.13
(C2 x U1) x S within-group error	11	(0.22)
C2 x U2	1	0.29
(C2 x U2) x S within-group error	11	(0.10)
C x U	2.84	0.44
(C x U) x S within-group error	31.29	(0.15)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

Appendix G

Demographics for Study 2

The majority of the families who participated in Study 2 were White (86%), two-parent, intact (97%) and middle-class (92%). Specifically, the sample included Non-Hispanic White (86%), African-American (6%), and Asian/Pacific Islander (8%). In terms of educational attainment, families were classified as 8% with high-school but without college education, 14% had some college education, and 78% had degrees from programs requiring 4 years of college or more. In terms of occupational status, the families were classified in the domains of Executive, Administrators, Managerial (17%), Professional Specialty (22%), Technical and Related Support (6%), Sales (8%), Administration, Support, Clerical (22%), Machine Operators, Assemblers, and Inspectors (3%), Handlers, Equipment Cleaners, Helpers and Labourers (6%), and Service Workers not in private households (17%; categories based on US Bureau of the Census, 1996).

Appendix H

Planned Comparison Summary Tables for

Experimenter Touch, Infant Gaze at Face and Gaze Away,

Study 2

Table H1

Planned Comparisons for Experimenter Touch, Study 2

Source	df	F
	Within subjects	
GC_GN	1	1.20
GC_GN x S within-group error	11	(90.12)
GC_GT	1	0.00
GC_GT x S within-group error	11	(120.93)
GN_GT	1	1.57
GN_GT x S within-group error	11	(74.94)
CON_NON	1	4.29
CON_NON x S within-group error	11	(15.33)
CON_SF+T	1	16.32**
CON_SF+T x S within-group error	11	(276.46)
NON_SF+T	1	12.97**
NON_SF+T x S within-group error	11	(268.95)
RC_RN	1	1.15
RC_RN x S within-group error	11	(246.91)
RN_RT	1	0.73
RN_RT x S within-group error	11	(108.05)
Period (P)	2.58	4.84*
P x S within-group error	28.41	(241.05)

Note. Values enclosed in parentheses represent mean square errors. GC = greeting period for CON condition; GN = greeting period for NON condition; GT = greeting period for SF+T condition; CON = manipulation period for CON condition; NON = manipulation period for NON condition; SF+T = manipulation period for SF+T condition; RC = reunion period for CON condition; RN = reunion period for NON condition; RT = reunion period for SF+T condition; S = subjects.

*p .05. **$p < .001$.

Table H2

Planned Comparisons for Infant Gaze at Face, Study 2

Source	df	F
	Within subjects	
GC_GN	1	1.33
GC_GN x S within-group error	11	(230.51)
GC_GT	1	0.28
GC_GT x S within-group error	11	(400.21)
GN_GT	1	4.36
GN_GT x S within-group error	11	(180.97)
CON_NON	1	5.28*
CON_NON x S within-group error	11	(665.15)
CON_SF+T	1	4.53
CON_SF+T x S within-group error	11	(593.85)
NON_SF+T	1	0.10
NON_SF+T x S within-group error	11	(518.41)
RC_RN	1	0.02
RC_RN x S within-group error	11	(548.41)
RN_RT	1	1.02
RN_RT x S within-group error	11	(468.85)
Period (P)	4.82	29.47**
P x S within-group error	53.04	(417.23)

Note. Values enclosed in parentheses represent mean square errors. GC = greeting period for CON condition; GN = greeting period for NON condition; GT = greeting period for SF+T condition; CON = manipulation period for CON condition; NON = manipulation period for NON condition; SF+T = manipulation period for SF+T condition; RC = reunion period for CON condition; RN = reunion period for NON condition; RT = reunion period for SF+T condition; S = subjects.

*p .05. **p < .001.

Table H3

Planned Comparisons for Infant Gaze Away, Study 2

Source	df	F
	Within subjects	
GC_GN	1	3.40
GC_GN x S within-group error	11	(62.20)
GC_GT	1	0.22
GC_GT x S within-group error	11	(115.58)
GN_GT	1	2.44
GN_GT x S within-group error	11	(36.66)
CON_NON	1	0.22
CON_NON x S within-group error	11	(117.65)
CON_SF+T	1	1.78
CON_SF+T x S within-group error	11	(409.78)
NON_SF+T	1	1.72
NON_SF+T x S within-group error	11	(279.36)
RC_RN	1	4.95*
RC_RN x S within-group error	11	(88.14)
RN_RT	1	3.03
RN_RT x S within-group error	11	(76.76)
Period (P)	2.78	5.13**
P x S within-group error	30.60	(135.84)

Note. Values enclosed in parentheses represent mean square errors. GC = greeting period for CON condition; GN = greeting period for NON condition; GT = greeting period for SF+T condition; CON = manipulation period for CON condition; NON = manipulation period for NON condition; SF+T = manipulation period for SF+T condition; RC = reunion period for CON condition; RN = reunion period for NON condition; RT = reunion period for SF+T condition; S = subjects.

*p .05. **$p < .01$.

Appendix I

Transformed Means and Main Effects

for Infant Smiling and Fretting,

Study 2

Table I1

Means for the Percent Duration of 20-s Time Units of Infant Smiling during the Greeting Period, Study 2

Time Unit	M	SE
S1	52.55	4.80
S2	68.47	6.34
S3	49.32	6.65

Note. S = 20-s time unit.

Table I2

<u>Transformed Means for the Percent Duration of 30-s Time Units of Infant Smiling during the Manipulation Period, Study 2: Square Root Transformation</u>

Time Unit	M	SE
S1	2.54	0.50
S2	2.19	0.52
S3	2.75	0.52
S4	2.08	0.49
S5	2.29	0.51
S6	2.15	0.45

Note. S = 30-s time unit.

Table I3

Transformed Means for the Percent Duration of 30-s Time Units of Infant Fretting during the Manipulation Period, Study 2: Log Transformation

Time Unit	M	SE
FT1	0.04	0.04
FT2	0.08	0.05
FT3	0.13	0.06
FT4	0.29	0.10
FT5	0.28	0.10
FT6	0.34	0.11

Note. FT = 30-s time unit.

Table I4

Transformed Means for the Percent Duration of 30-s Time Units for Infant Fretting during the Manipulation Period, by Condition, Study 2: Log Transformation

Time Unit	Condition		
	CON	NON	SF+T
FT1	0.00 (0.00)	0.11 (0.11)	0.00 (0.00)
FT2	0.00 (0.00)	0.25 (0.14)	0.00 (0.00)
FT3	0.09 (0.09)	0.30 (0.16)	0.00 (0.00)
FT4	0.30 (0.17)	0.37 (0.20)	0.21 (0.14)
FT5	0.54 (0.25)	0.16 (0.11)	0.14 (0.14)
FT6	0.86 (0.26)	0.00 (0.00)	0.15 (0.10)

Note. FT = 30-s time unit; Standard errors are shown in parentheses.

Appendix J

Trend Analysis Summary Tables

for Infant Smiling and Fretting,

Study 2

Table J1

Trend Analysis for Infant Smiling during the Greeting Period, Study 2

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	0.60
C1 x S within-group error	11	(2589.71)
Condition Quadratic Trend (C2)	1	0.96
C2 x S within-group error	11	(2296.56)
Condition (C)	1.99	0.77
C x S within-group error	21.89	(2443.13)
Unit Linear Trend (U1)	1	0.32
U1 x S within-group error	11	(591.16)
Unit Quadratic Trend (U2)	1	15.37*
U2 x S within-group error	11	(479.71)
Unit (U)	1.98	7.06*
U x S within-group error	21.75	(535.44)
C1 x U1	1	0.28
(C1 x U1) x S within-group error	11	(1030.77)
C1 x U2	1	0.05
(C1 x U2) x S within-group error	11	(450.13)
C2 x U1	1	0.01
(C2 x U1) x S within-group error	11	(1303.63)
C2 x U2	1	0.32
(C2 x U2) x S within-group error	11	(228.16)
C x U	2.59	0.13
(C x U) x S within-group error	28.50	(753.17)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .01$.

Table J2

Trend Analysis for Infant Smiling during the Manipulation Period, Study 2

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	0.22
C1 x S within-group error	11	(32.99)
Condition Quadratic Trend (C2)	1	0.66
C2 x S within-group error	11	(38.15)
Condition (C)	1.71	0.45
C x S within-group error	18.85	(35.57)
Unit Linear Trend (U1)	1	1.44
U1 x S within-group error	11	(1.89)
Unit Quadratic Trend (U2)	1	0.01
U2 x S within-group error	11	(3.70)
Unit Cubic Trend (U3)	1	0.00
U3 x S within-group error	11	(1.78)
Unit Quadratic Trend (U4)	1	1.08
U4 x S within-group error	11	(0.96)
Unit Quintic Trend (U5)	1	7.03*
U5 x S within-group error	11	(1.19)
Unit (U)	3.56	1.28
U x S within-group error	39.13	(1.90)
C1 x U1	1	0.07
(C1 x U1) x S within-group error	11	(8.85)
C1 x U2	1	1.69
(C1 x U2) x S within-group error	11	(10.66)
C1 x U3	1	0.00
(C1 x U3) x S within-group error	11	(4.44)
C1 x U4	1	6.12*
(C1 x U4) x S within-group error	11	(3.50)
C1 x U5	1	9.34*
(C1 x U5) x S within-group error	11	(0.53)

Table J2, continued

Source	df	F
C2 x U1	1	0.16
(C2 x U1) x S within-group error	11	(6.02)
C2 x U2	1	0.00
(C2 x U2) x S within-group error	11	(5.64)
C2 x U3	1	0.17
(C2 x U3) x S within-group error	11	(2.91)
C2 x U4	1	0.08
(C2 x U4) x S within-group error	11	(4.24)
C2 x U5	1	0.59
(C2 x U5) x S within-group error	11	(1.72)
C x U	4.76	0.99
(C x U) x S within-group error	52.32	(4.85)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$.

Table J3

Trend Analysis for Infant Smiling during the Reunion Period, Study 2

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	0.25
C1 x S within-group error	11	(2406.92)
Condition Quadratic Trend (C2)	1	0.02
C2 x S within-group error	11	(3766.71)
Condition (C)	1.84	0.11
C x S within-group error	20.23	(3086.81)
Unit Linear Trend (U1)	1	1.88
U1 x S within-group error	11	(300.72)
Unit Quadratic Trend (U2)	1	2.90
U2 x S within-group error	11	(257.11)
Unit (U)	1.99	2.35
U x S within-group error	21.87	(278.91)
C1 x U1	1	0.17
(C1 x U1) x S within-group error	11	(488.53)
C1 x U2	1	0.03
(C1 x U2) x S within-group error	11	(218.96)
C2 x U1	1	0.35
(C2 x U1) x S within-group error	11	(269.01)
C2 x U2	1	0.02
(C2 x U2) x S within-group error	11	(325.10)
C x U	3.48	0.15
(C x U) x S within-group error	38.32	(325.40)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

Table J4

Trend Analysis for Infant Fretting during the Greeting Period, Study 2

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	0.41
C1 x S within-group error	11	(623.24)
Condition Quadratic Trend (C2)	1	1.26
C2 x S within-group error	11	(287.55)
Condition (C)	1.63	0.68
C x S within-group error	17.88	(455.39)
Unit Linear Trend (U1)	1	1.16
U1 x S within-group error	11	(250.24)
Unit Quadratic Trend (U2)	1	2.48
U2 x S within-group error	11	(61.52)
Unit (U)	1.43	1.42
U x S within-group error	15.75	(155.88)
C1 x U1	1	0.02
(C1 x U1) x S within-group error	11	(329.02)
C1 x U2	1	1.13
(C1 x U2) x S within-group error	11	(230.19)
C2 x U1	1	2.72
(C2 x U1) x S within-group error	11	(80.78)
C2 x U2	1	0.03
(C2 x U2) x S within-group error	11	(34.81)
C x U	2.35	0.73
(C x U) x S within-group error	25.85	(169.20)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

Table J5

Trend Analysis for Infant Fretting during the Manipulation Period, Study 2

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	4.74
C1 x S within-group error	11	(0.35)
Condition Quadratic Trend (C2)	1	0.00
C2 x S within-group error	11	(0.66)
Condition (C)	1.79	1.64
C x S within-group error	19.67	(0.50)
Unit Linear Trend (U1)	1	5.77*
U1 x S within-group error	11	(0.45)
Unit Quadratic Trend (U2)	1	0.13
U2 x S within-group error	11	(0.12)
Unit Cubic Trend (U3)	1	0.34
U3 x S within-group error	11	(0.15)
Unit Quadratic Trend (U4)	1	0.88
U4 x S within-group error	11	(0.03)
Unit Quintic Trend (U5)	1	1.43
U5 x S within-group error	11	(0.08)
Unit (U)	2.07	3.39*
U x S within-group error	22.78	(0.17)
C1 x U1	1	6.17*
(C1 x U1) x S within-group error	11	(0.31)
C1 x U2	1	6.54*
(C1 x U2) x S within-group error	11	(0.06)
C1 x U3	1	0.19
(C1 x U3) x S within-group error	11	(0.11)
C1 x U4	1	0.12
(C1 x U4) x S within-group error	11	(0.02)
C1 x U5	1	0.53
(C1 x U5) x S within-group error	11	(0.08)

Table J5, continued

Source	df	F
C2 x U1	1	7.19*
(C2 x U1) x S within-group error	11	(0.32)
C2 x U2	1	4.92*
(C2 x U2) x S within-group error	11	(0.24)
C2 x U3	1	0.19
(C2 x U3) x S within-group error	11	(0.06)
C2 x U4	1	0.08
(C2 x U4) x S within-group error	11	(0.08)
C2 x U5	1	0.01
(C2 x U5) x S within-group error	11	(0.10)
C x U	3.57	4.27**
(C x U) x S within-group error	39.31	(0.14)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$. *$p < .01$.

Table J6

Trend Analysis for Infant Fretting during the Reunion Period, Study 2

Source	df	F
	Within subjects	
Condition Linear Trend (C1)	1	0.18
C1 x S within-group error	11	(0.71)
Condition Quadratic Trend (C2)	1	0.36
C2 x S within-group error	11	(0.52)
Condition (C)	1.56	0.26
C x S within-group error	17.19	(0.61)
Unit Linear Trend (U1)	1	0.29
U1 x S within-group error	11	(0.32)
Unit Quadratic Trend (U2)	1	1.09
U2 x S within-group error	11	(0.11)
Unit (U)	1.39	0.50
U x S within-group error	15.33	(0.22)
C1 x U1	1	0.00
(C1 x U1) x S within-group error	11	(0.26)
C1 x U2	1	2.03
(C1 x U2) x S within-group error	11	(0.38)
C2 x U1	1	0.95
(C2 x U1) x S within-group error	11	(0.09)
C2 x U2	1	0.02
(C2 x U2) x S within-group error	11	(0.11)
C x U	2.41	1.02
(C x U) x S within-group error	26.54	(0.21)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

Appendix K

Demographics for Study 3

The majority of the families who participated in Study 3 were White (86%), two-parent, intact (94%) and middle-class (94%). Specifically, the sample included Non-Hispanic White (86%), African-American (11%), and Asian/Pacific Islander (3%). In terms of educational attainment, families were classified as 6% with high-school but without college education, 6% had some college education, and 88% had degrees from programs requiring 4 years of college or more. In terms of occupational status, the families were classified in the domains of Executive, Administrators, Managerial (23%), Professional Specialty (19%), Technical and Related Support (6%), Sales (10%), Administration, Support, Clerical (10%), and Service Workers not in private households (17%; categories based on US Bureau of the Census, 1996). In addition, there were some Students (10%) and those that were unemployed (4%).

Appendix L

Detailed Instructions to Mothers.

Study 3

Instructions to Mothers in the Contingent Condition

1. For this period I would like you to play with your baby as you normally would at home.
2. For this period I would like you to be silent and have a still face, but play with your baby using touch.
3. For this period I would like you to play with your baby as you normally would at home.

Instructions to Mothers in the Noncontingent Condition

1. For this period I would like you to play with your baby as you normally would at home.
2. For this period I would like you to be silent and have a still face, but imitate the touch and hand movements that you see on the t.v.
3. For this period I would like you to play with your baby as you normally would at home.

Appendix M

<u>Consent Form A, Study 3</u>

CENTRE FOR RESEARCH IN HUMAN DEVELOPMENT
CENTRE DE RECHERCHE EN DÉVELOPPEMENT HUMAIN
Tel: (514)848-2240
Fax: (514)848-2815

Concordia University
Department of Psychology

FACE-TO-FACE MOTHER-INFANT INTERACTIONS
AND EARLY INFANT SOCIAL DEVELOPMENT

PARENT CONSENT FORM

A - Participation Consent

This study is designed to look at infants' responses to touch and to study the different types of touching used by caregivers. I understand that my baby will participate in one session lasting about 30 minutes. My baby will be seated in an infant seat directly facing me. The procedure will last about 6 minutes, and will consist of three brief periods where I will play with my baby. I will be asked to be neutral and unresponsive in facial expression and silent in one of the periods, while using different touch games to interact with my baby. During this same period I may be asked to imitate another mother's touch and hand movements during her interaction with her infant. There will be brief breaks separating the interaction periods. No manipulation will be harmful to my baby. The entire session will be videotaped so that at a later point my baby's responses can be scored. These recordings will be kept in the strictest of confidence and will not be shown to others without my permission. In any case, all recordings will be destroyed once coding is completed.

I understand that my participation in this study is totally voluntary. I know that I may withdraw at any time and for any reason. I also understand that I may request that the videotape recording be erased. In the event that the results of the study are published, my name and the name of my baby will be kept confidential.

In the event that I have any unanswered concerns or complaints about this study, I may express these to Dr. Dale Stack (848-7565) or Diane LePage (848-7547) of the Psychology Department's Centre for Research in Human Development at Concordia University. In addition, the patient representative at the Jewish General Hospital is Roslyn Davidson (340-8222).

Thank you for your cooperation.

I ____________________________ do hereby give my consent for my

baby ______________________ to participate in a study conducted by Dr. Dale Stack and Diane LePage at Concordia University, and with the cooperation of the Jewish General Hospital. A copy of the consent form has been given to me.

Signature: ____________________________ Date: _______________

Witness: ____________________________ Date: _______________

Appendix N

<u>Consent Form B, Study 3</u>

CENTRE FOR RESEARCH IN HUMAN DEVELOPMENT
CENTRE DE RECHERCHE EN DÉVELOPPEMENT HUMAIN
Tel: (514)848-2240
Fax: (514)848-2815

Concordia University
Department of Psychology

FACE-TO-FACE MOTHER-INFANT INTERACTIONS
AND EARLY INFANT SOCIAL DEVELOPMENT

PARENT CONSENT FORM

B - Permission to Show Videotape

I understand that the videorecording of my interaction with my baby during Part A of the present research may be shown to other mothers as a component of the study in which I have just participated. These mothers will be asked to imitate my touch and hand movements while I was interacting with my baby, during their interactions with their own babies. I understand that only the second interaction period, when I was still-faced and silent and playing with my baby using touch, will be shown. Further, I understand that the videorecording will be of my baby and my touch and hand movements and the sound will be turned off. No other identifying information will be revealed. Outside the context of the research the recordings will be kept in the strictest of confidence and will not be shown to others without my permission.

I understand that my consent to show the videorecording of my baby is totally voluntary. I know that I may withdraw my consent to show this videorecording at any time and for any reason. I also understand that I may request that the videotape recording be erased. In the event that the results of the study are published, my name and the name of my baby will be kept confidential.

In the event that I have any unanswered concerns or complaints about this study, I may express these to Dr. Dale Stack (848-7565) or Diane LePage (848-7547) of the Psychology Department's Centre for Research in Human Development at Concordia University. In addition, the patient representative at the Jewish General Hospital is Roslyn Davidson (340-8222).

NAME OF INFANT:____________________

I ____________________ give permission for the videotape of my interactions with my infant to be shown to other mothers in the context of the present study conducted by Dr. Dale Stack and Diane LePage at Concordia University, and with the cooperation of the Jewish General Hospital.

Signature: ________________________ Date: ____________

Witness: ________________________ Date: ____________

Appendix O

ANOVA Summary Tables for

Maternal Touching Behaviours,

Study 3

Table O1

Analysis of Variance for Type of Maternal Touch during the Greeting Period, Study 3

Source	*df*	*F*
	Within subjects	
Condition (C)	1	2.61
C x *S* within-group error	23	(1.22)
Type (T)	3.76	30.84*
T x *S* within-group error	86.49	(3.18)
C x T	5.12	1.33
(C x T) x *S* within-group error	117.86	(3.16)

Note. Values enclosed in parentheses represent mean square errors. *S* = subjects.

*$p < .001$.

Table O2

Analysis of Variance for Type of Maternal Touch during the Manipulation Period, Study 3

Source	df	F
	Within subjects	
Condition (C)	1	0.21
C x S within-group error	23	(0.04)
Type (T)	5.01	36.14*
T x S within-group error	115.26	(0.26)
C x T	5.31	1.33
(C x T) x S within-group error	122.17	(0.04)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Table O3

Analysis of Variance for Type of Maternal Touch during the Reunion Period, Study 3

Source	df	F
	Within subjects	
Condition (C)	1	2.70
C x S within-group error	23	(0.78)
Type (T)	4.74	31.23*
T x S within-group error	109.09	(3.54)
C x T	4.16	1.17
(C x T) x S within-group error	95.66	(2.20)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Table O4

Analysis of Variance for Intensity of Maternal Touch during the Greeting Period, Study 3

Source	df	F
	Within subjects	
Condition (C)	1	1.02
C x S within-group error	23	(3.67)
Intensity (I)	1.09	65.22*
I x S within-group error	25.13	(572.16)
C x I	1.12	0.49
(C x I) x S within-group error	25.72	(289.20)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Table O5

Analysis of Variance for Intensity of Maternal Touch during the Manipulation Period,

Study 3

Source	df	F
	Within subjects	
Condition (C)	1	3.04
C x S within-group error	23	(0.20)
Intensity (I)	1.49	142.15*
I x S within-group error	34.22	(4.00)
C x I	1.48	0.46
(C x I) x S within-group error	34.13	(1.64)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Table O6

Analysis of Variance for Intensity of Maternal Touch during the Reunion Period, Study 3

Source	df	F
	Within subjects	
Condition (C)	1	0.10
C x S within-group error	23	(0.19)
Intensity (I)	1.32	276.77*
I x S within-group error	30.32	(2.55)
C x I	1.35	0.69
(C x I) x S within-group error	31.01	(2.78)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Table O7

Analysis of Variance for Speed of Maternal Touch during the Greeting Period, Study 3

Source	df	F
	Within subjects	
Condition (C)	1	0.44
C x S within-group error	23	(0.28)
Speed (Sp)	1.39	353.05*
Sp x S within-group error	31.86	(2.11)
C x Sp	1.37	0.65
(C x Sp) x S within-group error	31.44	(2.80)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Table O8

Analysis of Variance for Speed of Maternal Touch during the Manipulation Period, Study 3

Source	df	F
	Within subjects	
Condition (C)	1	0.22
C x S within-group error	23	(0.37)
Speed (Sp)	1.38	161.89*
Sp x S within-group error	31.79	(3.86)
C x Sp	1.56	1.20
(C x Sp) x S within-group error	35.82	(1.85)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Table O9

Analysis of Variance for Speed of Maternal Touch during the Reunion Period, Study 3

Source	df	F
	Within subjects	
Condition (C)	1	0.96
C x S within-group error	23	(3.13)
Speed (Sp)	1.06	107.37*
Sp x S within-group error	24.34	(464.65)
C x Sp	1.07	0.43
(C x Sp) x S within-group error	24.72	(383.75)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Appendix P

Transformed Means and Main Effects for

Infant Gaze at Face, Gaze Away,

Smiling, and Fretting, Study 2

Table P1

Means for the Percent Duration of 20-s Time Units of Infant Gaze at Face during the Greeting Period, Study 3

Time Unit	M	SE
F1	40.93	3.93
F2	43.42	4.38
F3	50.88	4.55

Note. F = 20-s time unit.

Table P2

Transformed Means for the Percent Duration of 30-s Time Units for Infant Gaze at Face during the Manipulation Period, by Sex, Study3: Square Root Transformation

Time Unit	Sex	
	Boys	Girls
F1	3.91 (0.49)	3.70 (0.54)
F2	3.61 (0.43)	4.20 (0.52)
F3	3.16 (0.44)	4.03 (0.64)
F4	3.08 (0.52)	3.24 (0.48)
F5	3.85 (0.49)	3.42 (0.48)
F6	3.86 (0.48)	3.23 (0.49)

Note. F = 30-s time unit; Standard errors are shown in parentheses.

Table P3

Transformed Means for the Percent Duration of 30-s Time Units for Infant Gaze at Face during the Manipulation Period, by Condition, Study3: Square Root Transformation

Time Unit	Condition	
	CON	NON
F1	4.09 (0.52)	3.52 (0.50)
F2	4.55 (0.43)	3.26 (0.49)
F3	3.74 (0.57)	3.45 (0.54)
F4	3.46 (0.49)	2.86 (0.51)
F5	3.47 (0.47)	3.81 (0.50)
F6	3.35 (0.48)	3.74 (0.50)

Note. F = 30-s time unit; CON = contingent condition; NON = noncontingent condition; Standard errors are shown in parentheses.

Table P4

Transformed Means for the Percent Duration of Infant Gaze Away during the Gretting Period, by Sex, Study 3: Log Transformation

Sex	M	SE
Boys	0.68	0.09
Girls	0.41	0.06

Table P5

Transformed Means for the Percent Duration of Infant Gaze Away by Infant Age during the Gretting Period, Study 3: Log Transformation

Age	M	SE
4-month-olds	0.34	0.07
7-month-olds	0.76	0.08

Table P6

Transformed Means for the Percent Duration of Infant Gaze Away by Infant Age during the Manipulation Period, Study 3: Log Transformation

Age	M	SE
4-month-olds	0.54	0.05
7-month-olds	0.85	0.05

Table P7

Transformed Means for the Percent Duration of Infant Gaze Away by Condition during the Manipulation Period, Study 3: Log Transformation

Condition	M	SE
CON	0.55	0.05
NON	0.84	0.06

Note. CON = contingent condition; NON = noncontingent condition.

Table P8

Transformed Means for the Percent Duration of 30-s Time Units for Infant Gaze Away during the Manipulation Period, Study3: Log Transformation

Time Unit	M	SE
A1	0.89	0.09
A2	0.69	0.10
A3	0.64	0.09
A4	0.62	0.10
A5	0.67	0.10
A6	0.66	0.09

Note. A = 30-s time unit; Standard errors are shown in parentheses.

Table P9

Transformed Means for the Percent Duration of 30-s Time Units for Infant Gaze Away during the Manipulation Period, by Condition, Study3: Log Transformation

Time Unit	Condition	
	CON	NON
A1	0.78 (0.12)	1.01 (0.12)
A2	0.63 (0.13)	0.74 (0.16)
A3	0.56 (0.12)	0.72 (0.14)
A4	0.38 (0.12)	0.86 (0.15)
A5	0.37 (0.12)	0.97 (0.13)
A6	0.55 (0.13)	0.77 (0.13)

Note. A = 30-s time unit; CON = contingent condition; NON = noncontingent condition; Standard errors are shown in parentheses.

Table P10

Transformed Means for the Percent Duration of 20-s Time Units for Infant Gaze Away during the Reunion Period, by Sex, Study3: Log Transformation

Time Unit	Sex	
	Girls	Boys
A1	0.63 (0.11)	0.80 (0.14)
A2	0.61 (0.14)	0.55 (0.13)
A3	0.39 (0.12)	0.77 (0.14)

Note. A = 20-s time unit; Standard errors are shown in parentheses.

Table P11

Means for the Percent Duration of 20-s Time Units of Infant Smiling during the Greeting Period, Study 3

Time Unit	M	SE
S1	40.46	4.38
S2	47.23	4.78
S3	50.24	4.62

Note. S = 20-s time unit.

Table P12

Transformed Means for the Percent Duration of 30-s Time Units of Infant Smiling during the Manipulation Period, Study 3: Square Root Transformation

Time Unit	M	SE
S1	3.19	0.37
S2	3.14	0.36
S3	2.40	0.39
S4	2.38	0.42
S5	2.35	0.40
S6	2.12	0.38

Note. S = 30-s time unit.

Table P13

Transformed Means for the Percent Duration of 30-s Time Units for 7-month-old Girls' Smiling during the Manipulation Period, by Condition, Study3: Square Root Transformation

Time Unit	Condition	
	CON	NON
S1	3.35 (1.23)	4.47 (0.97)
S2	2.52 (1.13)	5.29 (0.93)
S3	1.42 (0.84)	2.40 (1.21)
S4	3.52 (1.24)	1.76 (1.34)
S5	2.92 (1.56)	2.43 (1.35)
S6	2.63 (0.92)	2.05 (1.39)

Note. S = 30-s time unit; CON = contingent condition; NON = noncontingent condition; Standard errors are shown in parentheses.

Table P14

Means for the Percent Duration of 20-s Time Units of 7-month-old Boys' Smiling during the Reunion Period, Study 3

Time Unit	M	SE
S1	41.34	5.71
S2	53.21	7.71
S3	55.08	9.94

Note. S = 20-s time unit.

Table P15

Transformed Means for the Percent Duration of 30-s Time Units of Infant Fretting during the Manipulation Period, Study 3: Log Transformation

Time Unit	M	SE
FT1	0.08	0.04
FT2	0.15	0.06
FT3	0.23	0.08
FT4	0.14	0.07
FT5	0.27	0.08
FT6	0.33	0.09

Note. FT = 30-s time unit.

Table P16

Transformed Means for the Percent Duration of 30-s Time Units for Infant Fretting during the Manipulation Period, by Age Study3: Log Transformation

Time Unit	Age	
	4-month-olds	7-month-olds
FT1	0.55 (0.05)	0.10 (0.07)
FT2	0.34 (0.34)	0.26 (0.11)
FT3	0.00 (0.00)	0.45 (0.14)
FT4	0.04 (0.04)	0.23 (0.13)
FT5	0.28 (0.11)	0.25 (0.13)
FT6	0.30 (0.13)	0.37 (0.13)

Note. FT = 30-s time unit; Standard errors are shown in parentheses.

Table P17

Transformed Means for the Percent Duration of 30-s Time Units for Girls' Fretting during the Manipulation Period, by Condition, Study3: Log Transformation

Time Unit	Condition	
	CON	NON
FT1	0.12 (0.10)	0.00 (0.00)
FT2	0.27 (0.14)	0.06 (0.06)
FT3	0.19 (0.13)	0.29 (0.20)
FT4	0.00 (0.00)	0.38 (0.21)
FT5	0.00 (0.00)	0.57 (0.21)
FT6	0.08 (0.08)	0.57 (0.25)

Note. FT = 30-s time unit; CON = contingent condition; NON = noncontingent condition; Standard errors are shown in parentheses.

Table P18

Transformed Means for the Percent Duration of 30-s Time Units for Infant Fretting during the Manipulation Period, by Condition, Study3: Log Transformation

Time Unit	Condition	
	CON	NON
FT1	0.06 (0.05)	0.09 (0.06)
FT2	0.13 (0.08)	0.16 (0.09)
FT3	0.19 (0.09)	0.27 (0.13)
FT4	0.00 (0.00)	0.27 (0.13)
FT5	0.10 (0.05)	0.44 (0.15)
FT6	0.17 (0.08)	0.50 (0.16)

Note. FT = 30-s time unit; CON = contingent condition; NON = noncontingent condition; Standard errors are shown in parentheses.

Table P19

Transformed Means for the Percent Duration of Infant Fretting by Condition during the Reunion Period, Study 3: Log Transformation

Condition	M	SE
CON	0.16	0.06
NON	0.67	0.10

Note. CON = contingent condition; NON = noncontingent condition.

Table P20

Transformed Means for the Percent Duration of 20-s Time Units of Infant Fretting during the Reunion Period, Study 3: Log Transformation

Time Unit	M	SE
FT1	0.74	0.13
FT2	0.23	0.08
FT3	0.28	0.09

Note. FT = 20-s time unit.

Table P21

Transformed Means for the Percent Duration of 20-s Time Units for Infant Fretting during the Reunion Period, by Condition, Study3: Log Transformation

Time Unit	Condition	
	CON	NON
FT1	0.06 (0.06)	1.42 (0.14)
FT2	0.17 (0.10)	0.29 (0.12)
FT3	0.25 (0.12)	0.30 (0.14)

Note. FT = 20-s time unit; CON = contingent condition; NON = noncontingent condition; Standard errors are shown in parentheses.

Appendix Q

Trend Analysis Summary Tables for

Infant Gaze at Face, Gaze Away, Smiling, and Fretting,

Study 3

Table Q1

Trend Analysis for Infant Gaze at Face during the Greeting Period, Study 3

Source	df	F
	Between subjects	
Age (A)	1	1.32
S within-group error	22	(1223.19)
	Within subjects	
Condition (C)	1	0.13
C x A	1	1.96
C x S within-group error	22	(2541.87)
Unit Linear Trend (U1)	1	4.49*
U1 x A	1	0.01
U1 x S within-group error	22	(529.63)
Unit Quadratic Trend (U2)	1	0.52
U2 x A	1	0.06
U2 x S within-group error	22	(381.43)
Unit (U)	1.69	2.82
U x A	1.69	0.03
U x S within-group error	37.17	(455.53)
C1 x U1	1	0.03
(C1 x U1) x A	1	1.52
(C1 x U1) x S within-group error	22	(409.80)
C1 x U2	1	0.03
(C1 x U2) x A	1	2.78
(C1 x U2) x S within-group error	22	(213.50)
(C x U)	1.63	0.03
(C x U) x A	1.63	1.95
(C x U) x S within-group error	35.95	(311.65)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$.

Table Q2

Trend Analysis for Infant Gaze at Face during the Manipulation Period, Study 3

Source	df	F
	Between subjects	
Sex (S)	1	0.01
Age (A)	1	1.99
S x A	1	1.07
S within-group error	20	(25.73)
	Within subjects	
Condition (C)	1	0.37
C x S	1	0.01
C x A	1	0.00
C x S x A	1	0.29
C x S within-group error	20	(21.94)
Unit Linear Trend (U1)	1	1.72
U1 x S	1	2.28
U1 x A	1	0.33
U1 x S x A	1	2.30
U1 x S within-group error	20	(2.61)
Unit Quadratic Trend (U2)	1	1.58
U2 x S	1	6.01*
U2 x A	1	0.04
U2 x S x A	1	0.79
U2 x S within-group error	20	(1.72)
Unit Cubic Trend (U3)	1	0.81
U3 x S	1	2.36
U3 x A	1	0.18
U3 x S x A	1	0.27
U3 x S within-group error	20	(1.76)
Unit Quadratic Trend (U4)	1	1.95
U4 x S	1	0.09
U4 x A	1	0.25
U4 x S x A	1	0.78
U4 x S within-group error	20	(3.93)

Table Q2, continued

Source	df	F
Unit Quintic Trend (U5)	1	0.49
U5 x S	1	0.07
U5 x A	1	0.12
U5 x S x A	1	0.47
U5 x S within-group error	20	(3.93)
Unit (U)	4.27	1.25
U x S	4.27	1.63
U x A	4.27	0.19
U x S x A	4.27	0.93
U x S within-group error	85.47	(2.56)
C1 x U1	1	4.96*
(C1 x U1) x S	1	1.58
(C1 x U1) x A	1	2.57
(C1 x U1) x S x A	1	0.04
(C1 x U1) x S within-group error	20	(2.99)
C1 x U2	1	0.41
(C1 x U2) x S	1	0.01
(C1 x U2) x A	1	0.03
(C1 x U2 x S x A	1	3.27
(C1 x U2) x S within-group error	20	(4.60)
C1 x U3	1	0.78
(C1 x U3) x S	1	1.02
(C1 x U3) x A	1	7.54*
(C1 x U3) x S x A	1	0.13
(C1 x U3) x S within-group error	20	(2.52)
C1 x U4	1	0.20
(C1 x U4) x S	1	0.49
(C1 x U4) x A	1	0.10
(C1 x U4) x S x A	1	0.58
(C1 x U4) x S within-group error	20	(1.74)
C1 x U5	1	2.27
(C1 x U5) x S	1	0.00
(C1 x U5) x A	1	0.00
(C1 x U5) x S x A	1	0.00
(C1 x U5) x S within-group error	20	(2.25)

Table Q2, continued

Source	df	F
(C x U)	4.21	1.71
(C x U) x S	4.21	0.58
(C x U) x A	4.21	1.91
(C x U) x S x A	4.21	1.17
(C x U) x S within-group error	84.25	(2.82)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$.

Table Q3

Trend Analysis for Infant Gaze at Face during the Reunion Period, Study 3

Source	df	F
	Between subjects	
Sex (S)	1	0.14
Age (A)	1	1.46
S x A	1	0.03
S within-group error	20	(1800.12)
	Within subjects	
Condition (C)	1	1.03
C x S	1	1.12
C x A	1	0.24
C x S x A	1	2.01
C x S within-group error	20	(1885.31)
Unit Linear Trend (U1)	1	0.12
U1 x S	1	0.58
U1 x A	1	0.00
U1 x S x A	1	1.62
U1 x S within-group error	20	(349.16)
Unit Quadratic Trend (U2)	1	0.33
U2 x S	1	8.31**
U2 x A	1	1.99
U2 x S x A	1	2.68
U2 x S within-group error	20	(214.04)
Unit (U)	1.88	0.20
U x S	1.88	3.52*
U x A	1.88	0.76
U x S x A	1.88	2.02
U x S within-group error	37.63	(281.60)
C1 x U1	1	3.94
(C1 x U1) x S	1	0.34
(C1 x U1) x A	1	5.74*
(C1 x U1) x S x A	1	0.01
(C1 x U1) x S within-group error	20	(277.34)

Table Q3, continued

Source	df	F
C1 x U2	1	0.82
(C1 x U2) x S	1	0.16
(C1 x U2) x A	1	0.17
(C1 x U2) x S x A	1	1.07
(C1 x U2) x S within-group error	20	(415.26)
C x U	1.87	2.07
(C x U) x S	1.87	0.23
(C x U) x A	1.87	2.40
(C x U) x S x A	1.87	0.64
(C x U) x S within-group error	37.46	(346.30)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$. **$p < .01$.

Table Q4

Trend Analysis for Infant Gaze Away during the Greeting Period, Study 3

Source	df	F
	Between subjects	
Sex (S)	1	4.55*
Age (A)	1	10.68**
S x A	1	0.72
S within-group error	20	(0.58)
	Within subjects	
Condition (C)	1	0.74
C x S	1	0.14
C x A	1	1.37
C x S x A	1	5.13*
C x S within-group error	20	(0.45)
Unit Linear Trend (U1)	1	1.58
U1 x S	1	0.14
U1 x A	1	1.86
U1 x S x A	1	0.00
U1 x S within-group error	20	(0.36)
Unit Quadratic Trend (U2)	1	1.18
U2 x S	1	0.01
U2 x A	1	0.00
U2 x S x A	1	1.75
U2 x S within-group error	20	(0.25)
Unit (U)	1.93	1.42
U x S	1.93	0.09
U x A	1.93	1.10
U x S x A	1.93	0.71
U x S within-group error	38.68	(0.30)
C1 x U1	1	1.00
(C1 x U1) x S	1	0.06
(C1 x U1) x A	1	0.06
(C1 x U1) x S x A	1	0.59
(C1 x U1) x S within-group error	20	(0.33)

Table Q4, continued

Source	df	F
C1 x U2	1	1.69
(C1 x U2) x S	1	0.95
(C1 x U2) x A	1	0.59
(C1 x U2) x S x A	1	0.10
(C1 x U2) x S within-group error	20	(0.26)
(C x U)	1.93	1.30
(C x U) x S	1.93	0.45
(C x U) x A	1.93	0.29
(C x U) x S x A	1.93	0.37
(C x U) x S within-group error	38.62	(0.30)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

$^{*}p < .05$. $^{**}p < .01$.

Table Q5

Trend Analysis for Infant Gaze Away during the Manipulation Period, Study 3

Source	df	F
	Between subjects	
Age (A)	1	7.50*
S within-group error	22	(0.94)
	Within subjects	
Condition (C)	1	4.71*
C x A	1	1.32
C x S within-group error	22	(1.35)
Unit Linear Trend (U1)	1	5.20*
U1 x A	1	1.97
U1 x S within-group error	22	(0.20)
Unit Quadratic Trend (U2)	1	4.37*
U2 x A	1	4.19
U2 x S within-group error	22	(0.24)
Unit Cubic Trend (U3)	1	1.02
U3 x A	1	0.21
U3 x S within-group error	22	(0.26)
Unit Quadratic Trend (U4)	1	0.00
U4 x A	1	0.38
U4 x S within-group error	22	(0.17)
Unit Quintic Trend (U5)	1	0.08
U5 x A	1	3.25
U5 x S within-group error	22	(0.30)
Unit (U)	4.06	2.02
U x A	4.06	2.13
U x S within-group error	89.38	(0.23)
C1 x U1	1	1.72
(C1 x U1) x A	1	1.04
(C1 x U1) x S within-group error	22	(0.30)
C1 x U2	1	0.79
(C1 x U2) x A	1	0.01
(C1 x U2) x S within-group error	22	(0.19)

Table Q5, continued

Source	df	F
C1 x U3	1	5.15*
(C1 x U3) x A	1	0.97
(C1 x U3) x S within-group error	22	(0.30)
C1 x U4	1	0.29
(C1 x U4) x A	1	0.82
(C1 x U4) x S within-group error	22	(0.23)
C1 x U5	1	0.15
(C1 x U5) x A	1	0.47
(C1 x U5) x S within-group error	22	(0.19)
(C x U)	4.22	1.92
(C x U) x A	4.22	0.73
(C x U) x S within-group error	92.94	(0.24)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$.

Table Q6

Trend Analysis for Infant Gaze Away during the Reunion Period, Study 3

Source	df	F
	Between subjects	
Sex (S)	1	1.23
Age (A)	1	1.33
S x A	1	1.93
S within-group error	20	(0.79)
	Within subjects	
Condition (C)	1	4.19
C x S	1	0.04
C x A	1	2.02
C x S x A	1	1.45
C x S within-group error	20	(0.62)
Unit Linear Trend (U1)	1	2.18
U1 x S	1	1.44
U1 x A	1	1.39
U1 x S x A	1	0.10
U1 x S within-group error	20	(0.20)
Unit Quadratic Trend (U2)	1	1.26
U2 x S	1	7.21*
U2 x A	1	0.99
U2 x S x A	1	1.79
U2 x S within-group error	20	(0.13)
Unit (U)	1.90	1.83
U x S	1.90	3.66*
U x A	1.90	1.24
U x S x A	1.90	0.75
U x S within-group error	37.92	(0.16)
C1 x U1	1	0.17
(C1 x U1) x S	1	0.08
(C1 x U1) x A	1	0.25
(C1 x U1) x S x A	1	0.37
(C1 x U1) x S within-group error	20	(0.28)

Table Q6, continued

Source	*df*	*F*
C1 x U2	1	0.61
(C1 x U2) x S	1	0.03
(C1 x U2) x A	1	3.75
(C1 x U2) x S x A	1	0.25
(C1 x U2) x *S* within-group error	20	(0.33)
C x U	1.86	0.41
(C x U) x S	1.86	0.05
(C x U) x A	1.86	2.12
(C x U) x S x A	1.86	0.31
(C x U) x *S* within-group error	37.30	(0.31)

Note. Values enclosed in parentheses represent mean square errors. *S* = subjects.

$^{*}p < .05$.

Table Q7

Trend Analysis for Infant Smiling during the Greeting Period, Study 3

Source	df	F
	Between subjects	
Age (A)	1	5.14*
S within-group error	22	(1020.95)
	Within subjects	
Condition (C)	1	0.25
C x A	1	0.09
C x S within-group error	22	(2948.30)
Unit Linear Trend (U1)	1	5.73*
U1 x A	1	0.03
U1 x S within-group error	22	(401.12)
Unit Quadratic Trend (U2)	1	0.36
U2 x A	1	1.47
U2 x S within-group error	22	(314.05)
Unit (U)	1.87	3.37*
U x A	1.87	0.66
U x S within-group error	41.19	(357.59)
C1 x U1	1	0.49
(C1 x U1) x A	1	2.66
(C1 x U1) x S within-group error	22	(522.11)
C1 x U2	1	0.29
(C1 x U1) x A	1	1.21
(C1 x U2) x S within-group error	22	(853.95)
(C x U)	1.89	0.37
(C x U) x A	1.89	1.76
(C x U) x S within-group error	41.57	(688.03)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$.

Table Q8

Trend Analysis for Infant Smiling during the Manipulation Period, Study 3

Source	df	F
	Between subjects	
Sex (S)	1	0.07
Age (A)	1	3.02
S x A	1	1.15
S within-group error	20	(29.54)
	Within subjects	
Condition (C)	1	0.00
C x S	1	0.74
C x A	1	0.00
C x S x A	1	0.03
C x S within-group error	20	(22.47)
Unit Linear Trend (U1)	1	5.39*
U1 x S	1	0.00
U1 x A	1	0.02
U1 x S x A	1	1.08
U1 x S within-group error	20	(7.63)
Unit Quadratic Trend (U2)	1	0.78
U2 x S	1	0.19
U2 x A	1	0.05
U2 x S x A	1	5.46*
U2 x S within-group error	20	(2.63)
Unit Cubic Trend (U3)	1	0.00
U3 x S	1	1.51
U3 x A	1	0.08
U3 x S x A	1	0.10
U3 x S within-group error	20	(3.92)
Unit Quadratic Trend (U4)	1	1.58
U4 x S	1	0.00
U4 x A	1	0.06
U4 x S x A	1	3.84
U4 x S within-group error	20	(2.67)

Table Q8, continued

Source	df	F
Unit Quintic Trend (U5)	1	0.38
U5 x S	1	0.03
U5 x A	1	1.43
U5 x S x A	1	0.56
U5 x S within-group error	20	(3.65)
Unit (U)	3.27	2.38
U x S	3.27	0.32
U x A	3.27	0.29
U x S x A	3.27	1.72
U x S within-group error	65.47	(4.10)
C1 x U1	1	0.07
(C1 x U1) x S	1	0.97
(C1 x U1) x A	1	0.30
(C1 x U1) x S x A	1	6.67*
(C1 x U1) x S within-group error	20	(5.13)
C1 x U2	1	0.39
(C1 x U2) x S	1	0.49
(C1 x U2) x A	1	1.55
(C1 x U2) x S x A	1	0.13
(C1 x U2) x S within-group error	20	(2.01)
C1 x U3	1	0.65
(C1 x U3) x S	1	0.81
(C1 x U3) x A	1	0.14
(C1 x U3) x S x A	1	1.05
(C1 x U3) x S within-group error	20	(4.45)
C1 x U4	1	0.55
(C1 x U4) x S	1	0.11
(C1 x U4) x A	1	0.16
(C1 x U4) x S x A	1	5.49*
(C1 x U4) x S within-group error	20	(2.89)
C1 x U5	1	0.94
(C1 x U5) x S	1	1.96
(C1 x U5) x A	1	0.00
(C1 x U5) x S x A	1	0.00
(C1 x U5) x S within-group error	20	(1.35)

Table Q8, continued

Source	df	F
(C x U)	3.73	0.43
(C x U) x S	3.73	0.79
(C x U) x A	3.73	0.36
(C x U) x S x A	3.73	3.48*
(C x U) x S within-group error	74.56	(3.17)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$.

Table Q9

Trend Analysis for Infant Smiling during the Reunion Period, Study 3

Source	df	F
	Between subjects	
Sex (S)	1	0.19
Age (A)	1	5.71*
S x A	1	0.17
S within-group error	20	(1744.63)
	Within subjects	
Condition (C)	1	0.09
C x S	1	0.41
C x A	1	0.14
C x S x A	1	0.21
C x S within-group error	20	(3168.62)
Unit Linear Trend (U1)	1	1.90
U1 x S	1	0.11
U1 x A	1	0.00
U1 x S x A	1	7.78*
U1 x S within-group error	20	(223.90)
Unit Quadratic Trend (U2)	1	1.38
U2 x S	1	4.06
U2 x A	1	0.05
U2 x S x A	1	0.61
U2 x S within-group error	20	(166.41)
Unit (U)	1.89	1.68
U x S	1.89	1.79
U x A	1.89	0.02
U x S x A	1.89	4.72*
U x S within-group error	37.82	(195.16)
C1 x U1	1	0.37
(C1 x U1) x S	1	0.02
(C1 x U1) x A	1	0.69
(C1 x U1) x S x A	1	1.71
(C1 x U1) x S within-group error	20	(804.34)

Table Q9, continued

Source	df	F
C1 x U2	1	0.15
(C1 x U2) x S	1	0.24
(C1 x U2) x A	1	0.02
(C1 x U2) x S x A	1	1.94
(C1 x U2) x S within-group error	20	(263.65)
C x U	1.57	0.32
(C x U) x S	1.57	0.07
(C x U) x A	1.57	0.53
(C x U) x S x A	1.57	1.77
(C x U) x S within-group error	31.48	(533.99)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$.

Table Q10

Trend Analysis for Infant Fretting during the Manipulation Period, Study 3

Source	df	F
	Between subjects	
Sex (S)	1	0.07
Age (A)	1	2.59
S x A	1	0.04
S within-group error	20	(0.71)
	Within subjects	
Condition (C)	1	2.28
C x S	1	0.03
C x A	1	0.32
C x S x A	1	0.10
C x S within-group error	20	(1.04)
Unit Linear Trend (U1)	1	5.43*
U1 x S	1	0.02
U1 x A	1	0.41
U1 x S x A	1	0.73
U1 x S within-group error	20	(0.31)
Unit Quadratic Trend (U2)	1	0.14
U2 x S	1	0.85
U2 x A	1	5.48*
U2 x S x A	1	1.57
U2 x S within-group error	20	(0.13)
Unit Cubic Trend (U3)	1	1.43
U3 x S	1	0.03
U3 x A	1	4.78*
U3 x S x A	1	1.82
U3 x S within-group error	20	(0.12)
Unit Quadratic Trend (U4)	1	0.32
U4 x S	1	0.00
U4 x A	1	5.23*
U4 x S x A	1	0.03
U4 x S within-group error	20	(0.05)

Table Q10, continued

Source	df	F
Unit Quintic Trend (U5)	1	10.92**
U5 x S	1	1.04
U5 x A	1	3.00
U5 x S x A	1	0.62
U5 x S within-group error	20	(0.03)
Unit (U)	2.80	3.40*
U x S	2.80	0.23
U x A	2.80	2.79
U x S x A	2.80	1.04
U x S within-group error	55.91	(0.13)
C1 x U1	1	7.36*
(C1 x U1) x S	1	9.72**
(C1 x U1) x A	1	0.12
(C1 x U1) x S x A	1	0.21
(C1 x U1) x S within-group error	20	(0.16)
C1 x U2	1	0.00
(C1 x U2) x S	1	0.30
(C1 x U2) x A	1	2.73
(C1 x U2) x S x A	1	0.14
(C1 x U2) x S within-group error	20	(0.10)
C1 x U3	1	1.17
(C1 x U3) x S	1	2.13
(C1 x U3) x A	1	0.00
(C1 x U3) x S x A	1	0.33
(C1 x U3) x S within-group error	20	(0.13)
C1 x U4	1	0.00
(C1 x U4) x S	1	0.67
(C1 x U4) x A	1	0.07
(C1 x U4) x S x A	1	3.78
(C1 x U4) x S within-group error	20	(0.05)
C1 x U5	1	0.35
(C1 x U5) x S	1	1.28
(C1 x U5) x A	1	1.87
(C1 x U5) x S x A	1	0.21
(C1 x U5) x S within-group error	20	(0.04)

Table Q10, continued

Source	*df*	*F*
(C x U)	3.57	2.82*
(C x U) x S	3.57	4.09**
(C x U) x A	3.57	0.76
(C x U) x S x A	3.57	0.62
(C x U) x *S* within-group error	71.32	(0.10)

Note. Values enclosed in parentheses represent mean square errors. *S* = subjects.

*$p < .05$.

Table Q11

Trend Analysis for Infant Fretting during the Reunion Period, Study 3

Source	df	F
	Between subjects	
Age (A)	1	0.57
S within-group error	22	(0.43)
	Within subjects	
Condition (C)	1	20.14*
C x A	1	0.59
C x S within-group error	22	(0.47)
Unit Linear Trend (U1)	1	14.55*
U1 x A	1	2.47
U1 x S within-group error	22	(0.35)
Unit Quadratic Trend (U2)	1	20.51*
U2 x A	1	4.09
U2 x S within-group error	22	(0.12)
Unit (U)	1.21	16.05*
U x A	1.21	2.88
U x S within-group error	26.67	(0.24)
C1 x U1	1	20.57*
(C1 x U1) x A	1	0.59
(C1 x U1) x S within-group error	22	(0.51)
C1 x U2	1	29.74*
(C1 x U2) x A	1	1.53
(C1 x U2) x S within-group error	22	(0.09)
(C x U)	1.16	21.98*
(C x U) x A	1.16	0.73
(C x U) x S within-group error	25.50	(0.30)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Appendix R

Demographics for Control Study 1

The majority of the families who participated in Control Study 1 were White (92%), two-parent, intact (92%) and middle-class (92%). Specifically, the sample included Non-Hispanic White (92%) and African-American (8%). In terms of educational attainment, families were classified as 8% with high-school but without college education, 17% had some college education, and 75% had degrees from programs requiring 4 years of college or more. In terms of occupational status, the families were classified in the domains of Executive, Administrators, Managerial (17%), Professional Specialty (17%), Technical and Related Support (17%), Machine Operators, Assemblers, and Inspectors (17%), and Service Workers not in private households (25%; categories based on US Bureau of the Census, 1996). In addition, there were some Students (8%).

Appendix S

Consent Form for Control Study 1

CONSENT FORM

This study is designed to look at infants' responses to touch and to changes in their caregiver's eye-direction during brief social interactions. I understand that my baby will participate in one session lasting about 30 minutes. My baby will be seated in an infant seat directly facing me. The procedure will last about 6 minutes, and will consist of four brief interaction periods where different tactile games will be presented on my baby's body. I will be asked to be neutral and unresponsive in facial expression and silent in two of the periods, while using different touch games to interact with my baby. During these periods, I may be asked to look directly at my baby's eyes, or to look above my baby's eyes (i.e., at his or her forehead). There will be brief breaks separating the interaction periods. No manipulation will be harmful to my baby. The entire session will be videotaped so that at a later point my baby's responses can be scored. These recordings will be kept in the strictest of confidence and will not be shown to others without my permission. In any case, all recordings will be destroyed once coding is completed.

I understand that my participation in this study is totally voluntary. I know that I may withdraw at any time and for any reason. I also understand that I may request that the videotape recording be erased. In the event that the results of the study are published, my name and the name of my baby will be kept confidential.

In the event that I have any unanswered concerns or complaints about this study, I may express these to Dr. Dale Stack (848-7565) or Diane LePage (848-7547) of the Psychology Department's Centre for Research in Human Development at Concordia University. In addition, the patient representative at the Jewish General Hospital is Roslyn Davidson (340-8222).

Thank you for your cooperation.

I ________________________ do hereby give my consent for my baby ____________________ to participate in a study conducted by Dr. Dale Stack and Diane LePage at Concordia University, and with the cooperation of the Jewish General Hospital. A copy of the consent form has been given to me.

Signature: ________________________ Date: ____________

Witness: ________________________ Date: ____________

Appendix T

<u>ANOVA Summary Tables for</u>

<u>Infant Gaze at Face, Gaze Away, Smiling, and Fretting</u>

<u>Control Study 1</u>

Table T1

Analysis of Variance for Infant Gaze at Face, Control Study 1

Source	df	F
	Between subjects	
Age (A)	1	5.27*
S within-group error	10	(464.49)
	Within subjects	
Period (P)	2.35	11.07**
P x A	2.35	0.84
P x S within-group error	23.52	(326.21)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$. **$p < .001$.

Table T2

Analysis of Variance for Infant Gaze Away, Control Study 1

Source	df	F
	Between subjects	
Age (A)	1	14.55**
Sex (s)	1	7.45*
A x S	1	0.62
S within-group error	8	(243.85)
	Within subjects	
Period (P)	1.74	1.78
P x A	1.74	1.77
P x S	1.74	0.31
P x A x S	1.74	0.30
P x S within-group error	13.91	(217.19)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .05$. **$p < .01$.

Table T3

Analysis of Variance for Infant Smiling, Control Study 1

Source	df	F
	Between subjects	
Age (A)	1	0.00
S within-group error	10	(577.82)
	Within subjects	
Period (P)	1.85	22.52*
P x A	1.85	0.45
P x S within-group error	18.47	(245.87)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*$p < .001$.

Table T4

Analysis of Variance for Infant Fretting, Control Study 1

Source	df	F
	Between subjects	
Age (A)	1	1.53
S within-group error	10	(72.04)
	Within subjects	
Period (P)	2.18	0.66
P x A	2.18	0.66
P x S within-group error	21.80	(64.95)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

Appendix U

Consent Form for Control Study 2

Adult Perception Study

Consent Form

This study is designed to examine adults' perceptions of different clips of mother-infant interactions. I understand that I will participate in one session lasting about 10 minutes. I will be seated in front of a video monitor on which twelve different 30-second clips of mothers interacting with their infants will be displayed. I will be asked to judge whether the mothers are playing naturally with their infants or if they are imitating another mother playing with her infant.

I understand that my participation in this study is totally voluntary. I know that I may withdraw at any time and for any reason. In the event that the results of the study are published, my name will be kept confidential.

In the event that I have any unanswered concerns or complaints about this study, I may express these to Dr. Dale Stack (848-7565) or Diane LePage (848-7547) of the Psychology Department's Centre for Research in Human Development at Concordia University.

Thank you for your cooperation.

I do hereby give my consent to participate in a study conducted by Dr. Dale Stack and Diane LePage at Concordia University. A copy of the consent form has been given to me.

Signature:____________________ Date:____________

Witness:_____________________ Date:____________

Appendix V

Detailed Instructions and Answer Form for Control Study 2

Adult Perception Study

Subject No:

In a study examining mother-infant interactions there were two groups of mothers and infants. In group A mothers were instructed to maintain a neutral facial expression (still face) and silence while playing with their babies using touch. In group B mothers were instructed to maintain a still face and silence while imitating the touch and hand movements that a mother in group A had used with her baby. Thus, one group of mothers were playing with their babies using only touch while the other group of mothers were imitating the touch and hand movements from a mother from the first group.

In the present study you will be viewing twelve 30-second clips of mothers playing with their babies. For each clip I would like you to decide whether:

A. The mother is naturally playing with her baby (PLAY)

B. The mother is imitating another mother playing with her baby (IMITATE)

In your judgements I would like you to concentrate on the mothers' behaviours, rather than the infants' reactions. The screen consists of two different views of the infants and mothers; one is focused on a facial view of the infants, and the other on a top-down view of the infants' bodies and the mothers' hands. Please focus your attention and concentrate on the left-hand side of the monitor (the frontal view of the infants' faces and bodies). You may, however, look at the right-hand side of the monitor if you are unable to see the mothers' hand movements on the left-hand side.

The clips will be presented in random order. You will first see the subject number for a period of 2 seconds. The 30-second clip will follow. There will be a PAUSE of 6 seconds during which time you will be asked to make your decision by circling either PLAY or IMITATE. The subject number of the next baby will then be displayed. There will be a total of 12 clips.

Thank you for your participation.

Subject No:

Subject Number		Decision
1	PLAY	IMITATE
2	PLAY	IMITATE
3	PLAY	IMITATE
4	PLAY	IMITATE
5	PLAY	IMITATE
6	PLAY	IMITATE

Subject No:

Subject Number	Decision	
7	PLAY	IMITATE
8	PLAY	IMITATE
9	PLAY	IMITATE
10	PLAY	IMITATE
11	PLAY	IMITATE
12	PLAY	IMITATE