Infant Touching Behaviour During Mother-Infant Face-to-Face Interactions

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ABSTRACT

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The study of communication between mothers and infants has largely focused on infants' distal behaviours, such as their gaze and affect, while neglecting their more proximal behaviours, such as touch. Yet touch is an important modality through which infants and mothers communicate, and through which infants explore themselves and their surroundings. The current study investigated the touching behaviour of 44, 5 ½-month-old infants during naturalistic play (Normal) periods and periods where mothers were neutral in their facial expressions (i.e. still-faced), silent, and did not touch. Types and areas of infant touch were coded using the Infant Touch Scale, an observational coding scheme designed to document and code infant touch.

Results revealed that infants spent 85% of their time using touch during their interactions and that the duration of the types and areas of touch varied with changes in maternal availability. Specifically, infants spent significantly more time using stroke, finger, pat, and pull, and they spent more time touching themselves, their clothes, and the infant seat during a period where mothers were still-faced compared to the Normal periods. In contrast, infants spent more time using passive types of touch and touching their mothers during the Normal interaction periods. Moreover, active types of touch co-

occurred with infants' clothes and the infant seat, whereas passive types of touch co-occurred with their mothers.

These findings highlight infants' sensitivity to maternal unavailability and suggest that infants' communicate their emotional states through touch. Furthermore, these findings imply that infants use touch to explore themselves and to regulate their emotions during the still-face period.

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Touch is fundamental to infant growth and development (Montagu, 1986). Because of the early functionality of the tactile system, touch is one of the first sensations experienced by infants. Tactile information is transmitted through the skin, which is the largest sensory organ and infants' first medium of communication (Montagu, 1986). As such, touch plays a pervasive role across the course of infant development. Physiologically, touch contributes to infant growth and weight gain (Field, 2001; Scafidi et al., 1990; White & Lavarba, 1976); psychologically, it is a medium through which infants and their caregivers communicate emotion and affection, and establish a strong connection (Stack, 2001, in press).

Important physiological effects of touch have been well documented in the animal literature. Empirical investigations examining the effects of maternal separation on rat pups have demonstrated that rat pups experience negative bio-behavioural responses when separated from their mothers, such as decreased body temperature and heart rate, an increase in the release of the stress hormone corticosterone, and a decline in ornithine decarboxylase (ODC), which regulates growth and differentiation (Schanberg & Field, 1988). Schanberg and Field (1987) demonstrated that the specific aspect of maternal separation that led to the marked decrease in tissue ODC activity was the absence of maternal licking. Upon reunion with their mothers, the activity level of ODC returned to normal.

Research has also demonstrated that variations in maternal care lead to individual differences in rats' responses to stress. Specifically, handling rats, which involves separating rat pups from their mothers for brief periods of time, is beneficial for pups because it leads to changes in dam-pup interactions, and in particular, increases in

maternal grooming and licking (Liu et al., 1997). Maternal licking and grooming regulate rat pups' endocrine, emotional, and cognitive responses to stress, such that handled rats exhibit a decrease in their level of emotionality during stressful events (Caldji et al., 1998; Champagne, Francis, Mar, & Meaney, 2003; Levine, 1958; Liu et al., 1997). Moreover, handled rat pups have been shown to exhibit an increase in their exploratory behaviours when they become adults, greater levels of curiosity and problem-solving abilities (Montagu, 1986) and, in male rats, an increase in their sexual activity as compared to rats that were not handled (Larsson, 1970).

In nonhuman primates, touch has been found to be critical for social attachment. Harlow's (1959) classic study demonstrated that infant rhesus monkeys spent more time climbing and clinging onto a cloth than a wire surrogate mother, even when being fed only by the wire surrogate. These findings contradicted previous assumptions that attachment was derived from a reduction in the hunger drive (Harlow, 1959) and imply that bodily contact is more important in the formation of the mother-infant bond because it provides warmth, comfort, and security. Moreover, Suomi (1997) has suggested that tactile stimulation is a core component of rhesus monkeys' social activities, including grooming, play and sexual acts. These findings underscore the vital role of touch in normative animal development and in the emergence of social attachment.

In humans, research has documented the importance of tactile stimulation for the physical and psychological development of infants. Infants reared in orphanages in Eastern Europe, deprived of any real physical contact and comfort, have been shown to experience developmental delays and cognitive deficits (Kuhn & Schanberg, 1998). According to Rutter (1998), these negative outcomes resulted from psychological

deprivation more than from the lack of appropriate nutrition. Fortunately, these effects can, at least partially, be reversed once infants are provided with appropriate care and tactile stimulation. In at-risk infants, studies comparing low birth weight/preterm infants with and without massage therapy have demonstrated that infants exposed to supplementary tactile stimulation experienced an increase in their weight gain and rate of cognitive development, spent more time in an awake and active state, and were discharged earlier from hospitals (Field, 1998; Kisilevsky, Stack & Muir, 1991; Scafidi et al., 1990).

The tactile stimulation provided by mothers, in particular, serves important functions for human infants. Through touch, mothers regulate their infants' physiological and behavioural reactions, such as their level of attention and arousal (Brazelton, 1990; Stack, 2001). Moreover, when paired with vestibular-proprioceptive stimulation, touch is effective in soothing newborn infants (Korner & Thoman, 1972). For example, rocking is commonly employed by caregivers to comfort infants in distress. Touch is also beneficial because it provides infants with a sense of security, communicating to infants that their caregiver is nearby and that they are in a safe place (Main, 1990).

Touch plays a pervasive role in many of the activities in which infants engage, including their social exchanges with their primary caregivers (Stack, 2001, in press). In particular, maternal touch has been found to occur for 55-81% of the overall duration of brief interaction periods with infants of 3, 6, and 9 months of age (Stack & Muir, 1990). Within these interchanges, touch is an important means of non-verbal communication through which both partners communicate with each other. However, research examining this important communicative channel is scant. The few studies that have been conducted

have investigated mothers' tactile behaviours during these social interchanges, demonstrating that mothers use different forms of touch to convey various social and emotional messages to their infants (Tronick, 1995; Stack, 2001). Specifically, with a hug or caress, mothers display their love and affection for their infants, whereas when attempting to engage their infants in social play, mothers more commonly use other forms of touch, such as tickling and finger walking (Tronick, 1995). Studies have also revealed that infants are responsive to the messages conveyed through touch and that mothers can elicit specific responses from their infants through touch alone (Stack, 2001; Stack & Arnold, 1998; Stack & Lepage, 1996; Stack, Lepage, Hains & Muir, 2004).

The studies examining the communicative interchanges between mothers and infants also demonstrate that infants are active participants, which contradicts previous postulations that infants enter the world in a confused and passive state (James, 1950). Even in the first six months of life, infants display communicative behaviours that are in tune with their mothers, and they are responsive to changes in their mothers' behaviour and modify their own behaviour accordingly (Cohn & Tronick, 1989). Unfortunately, research examining infants' communicative behaviours during mother-infant interactions has largely focused on the examination of distal behaviours, such as their gaze and affect (e.g. Ellsworth, Muir & Hains, 1993; Lamb, Morrison & Malkin, 1987; Mayes & Carter, 1990; Segal et al., 1995; Tronick, Als, Adamson, Wise & Brazelton, 1978), rather than a more proximal behaviour, such as touch. However, touch is considered another means through which infants communicate and regulate their emotions. Moreover, because infants have not yet developed the ability to communicate their needs and states verbally,

touch becomes even more important in understanding infants' underlying states of affect and arousal.

Taken together, findings indicate that touch is a critical modality through which mothers and infants communicate various social messages during their interactions. Given the importance of touch for infant communication, combined with the paucity of research on infant touch, the present study sought to investigate infant touch within mother-infant interactions in order to better understand the communicative role of this proximal modality.

Early Infant Communication

As active participants within their early social exchanges, infants convey particular messages through their communicative behaviours. These behaviours vary according to changes in context and in their social partners' behaviours, and are indicative of infants' needs and emotions (e.g. Fogel, 1992; Stack, 2001, in press; Weinberg & Tronick, 1994). Despite their focus on distal behaviours, past investigations of these behaviours are nevertheless informative about how infants communicate their underlying affect, goals and desires.

Researchers examining infant gaze have suggested that this modality is a vital aspect of mother-infant interchanges (Stern, 1974) because it informs mothers of their infants' direction of attention (Trevarthen, 1979), and it allows infants to control the quantity of stimulation they obtain from their social partners (Brazelton, Koslowski, & Main, 1974; Stern, 1974). Infant vocalizations, however, are indicative of their affective states (Keller & Scholmerich, 1987). Specifically, research has demonstrated that the type of infant vocalization varies with the state of the mother-infant dyad. Positive

vocalizations occur most frequently and negative vocalizations least frequently when the dyad is mutually engaged (i.e. they are gazing at each other; Keller & Scholmerich, 1987) and non-distress vocalizations signal positive affect in infants (Hsu, Fogel & Messinger, 2001).

Infants also display a wide variety of facial expressions indicative of their underlying emotional states (Izard, 1978; Trevarthen, 1977). Expressions of disgust signal strong dislike of stimuli, whereas social smiles are indicative of a desire to engage in social interchange (Izard, 1978). There are several forms of infant smiling that appear during the course of infant social development and vary with the state of the mother-infant dyad (Messinger, Fogel, & Dickson, 1999). Infants display Non-Duchenne smiles (i.e. no cheek or lip raises) during positive social interactions with their mothers, Duchenne smiles (i.e. lip and cheek raises) when engaged in shared positive affect with their mothers (i.e. their mothers were smiling), Play smiles (i.e. lowered jaw and open-mouth) when they are visually engaged with their mothers, and Duplay smiles (i.e. open mouth and cheek raise) during both mutual visual engagement and shared positive affect with their mothers. Thus, it seems that all forms of infant smiles signal positive experiences, although some smiles demonstrate more intensified positive affect than others (Messinger, Fogel & Dickson, 2001).

The configuration of infant communicative behaviours displayed across modalities during their social encounters is organized, suggesting that infants possess discrete emotions (Weinberg & Tronick, 1994). Weinberg (1989) revealed that positive facial expressions co-occur with infant gaze at the mother, gesturing, and non-distress vocalizations, whereas negative facial expressions occur when infants are gazing away

from their mothers and fussing. By producing the same messages through multiple modalities, these configurations serve to clarify and reinforce infants' communicative messages to their caregivers, thereby increasing the likelihood that caregivers will understand and appropriately respond to these messages (Weinberg & Tronick, 1994). These findings are in agreement with Fogel et al.'s (1992) suggestion that the understanding of infants' emotional responses during mother-infant face-to-face interactions should be based on infants' whole bodies and not merely their faces. Thus, investigating infant communication across modalities is critical for an understanding of infants' underlying affect.

The examination of these distal communicative behaviours provides evidence that infants are active participants and recipients of their environments. From birth, infants display signals that communicate their needs (Fogel, 1992), such as crying during times of distress (Ekman & Oster, 1979), and produce spontaneous limb movements to signal the presence of dangerous stimuli (Izard, 1978). However, this communication becomes increasingly sophisticated over time, and by two months, infants actively respond to changes in their partners' behaviours during social encounters (Trevarthen, 1977). Then, by three and a half months, infants initiate interactive sequences on their own (Kaye & Fogel, 1980), demonstrating yet again the maturation of their communicative abilities as they develop. These communicative skills are developed within the context of their early social encounters with their primary caregivers, demonstrating the importance of mother-infant interactions and the value of research examining these early interchanges.

Mother-Infant Interactions

Through frequent face-to-face interactions within the first few months of life, infants develop their communicative skills (Tronick, Als, Adamson, Wise, Brazelton, 1978) and acquire knowledge of the basic rules of social engagement. In particular, infants develop specific social expectations of reciprocity (Kaye, 1982; Cohn & Tronick, 1989). Moreover, they learn about themselves and others around them, and develop a sense of themselves as unique entities. That is, they learn to differentiate themselves from others and acquire an understanding of their unique emotional characteristics and expressive behaviours (Rochat, 2001). Thus, these interactions are of primordial importance to their socio-emotional and communicative development (Kaye, 1982).

Face-to-face interactions between caregivers and infants form a mutually regulated system that is bi-directional in nature (Tronick, 1989). That is, both mothers and infants are responsive to the communicative signals of their social partners, and based upon these signals, adjust their behaviour and affective displays accordingly (Cohn & Tronick, 1987). The normal sequence of events characterizing interaction periods between mothers and infants is framed by mothers, but remains highly dependent on infants' behaviours. Throughout the interaction, infants typically cycle in and out by shifting their gaze towards and away from their mothers, while mothers continue to gaze at their infants throughout (Fogel, 1977; Kaye & Fogel, 1980). Mothers then exhibit positive facial expressions in response to their infants focusing attention on them. Prior to six months, this change in mothers' facial expressions is generally followed by positive affect in infants. However, as infants continue to develop over time, their displays of positive affect become less dependent on their mothers' and they begin to initiate these

displays on their own, thereby demonstrating sophistication in their communicative abilities (Kaye & Fogel, 1980).

Periods of synchronized engagement are a mutual goal of mothers and infants during their interactions (Gianino & Tronick, 1988; Tronick, Als, & Brazelton, 1977). Mothers structure their behaviours in accordance with those of their infants' (Kaye, 1982), and infants modify their behaviours in response to changes in their mothers' behaviour (Cohn & Tronick, 1989). During periods of desynchronized interaction, then, mothers and infants work together to repair the interactive sequence (Gianino & Tronick, 1988; Tronick, 1989; Tronick, Als & Brazelton, 1977). These attempts at reparation teach infants to regulate their emotions and to trust their mothers as reliable social partners. As a result, infants develop social expectations of reciprocity (Brazelton & Cramer, 1990), which, when violated, disappoint infants' expectations and result in modifications in their behaviours (Trevarthen, 1977).

Infants' sensitivity to changes in maternal behaviours during face-to-face social exchanges has been extensively studied using the still-face procedure (Tronick, Als, Adamson, Wise, & Brazelton, 1978). The still-face procedure consists of three brief periods of mother-infant interactions (i.e. a Normal period, a still-face (SF) period, and a Reunion Normal period). In the normal and reunion periods, mothers are instructed to interact with their infants as they normally would at home. During the SF period, mothers are instructed to gaze at their infants, while maintaining an expressionless face and refraining from touching their infants and vocalizing. The SF period provides conflicting information to infants because their mothers' body postures and gaze invite social interaction, whereas their mothers' unresponsive faces reject it (Stack & Muir, 1990).

Results from numerous studies have documented a SF effect: during the SF period, infants spend less time gazing and smiling at their mothers, they exhibit increased neutral to negative affect (Gusella, Muir & Tronick, 1988; Mayes & Carter, 1990; Muir & Lee, 2003; Segal et al., 1995) and vocalizations, and in some studies, increased grimacing (Ellsworth, Muir, & Hains, 1993; Stack & Muir, 1992). Moreover, carry-over effects have been demonstrated during the reunion period, whereby infants continue to exhibit both positive and negative affect, and they demonstrate an increase in fussiness and crying during this period compared to the SF period (Cohn, 2003; Weinberg, Tronick, 1996).

In addition, changes in infant behaviour in response to unexpected changes in maternal behaviour were demonstrated in a study where mothers of infants between the ages of 96 to 110 days were instructed to simulate depression (Cohn & Tronick, 1983). The infants of these mothers cycled between periods of protest and wariness, and gaze away from mothers. In contrast, infants in the control group cycled between states of positive affect and gaze at their mothers in a well-organized manner. These findings imply that infants detect the quality of their mothers' affective expressions and alter the organization of their behaviours in response to these displays.

Taken together, these findings suggest that infants are sensitive to changes in their mothers' communicative behaviours (i.e. maternal unavailability during the SF period; Weinberg & Tronick, 1996) and that a disruption of the normal interactive cycle between mothers and their infants is distressing to infants. These findings further imply that infants possess strong social expectancies of reciprocity (Brazelton & Cramer, 1990; Frick & Adamson, 2003), and thus have an implicit understanding of themselves and

others as social beings (Rochat, 2001). However, as with the investigations of infant communication, studies examining maternal behaviours during face-to-face social exchanges have mainly focused on their distal behaviours, such as their facial and vocal expressions, without examining their more proximal behaviours, such as touch and gesturing.

Touch During Mother-Infant Interactions

Touch is pervasive in early mother-infant social exchanges (Stack, 2001, in press; Symons & Moran, 1987). As a result, an examination of its role during these interchanges is warranted. Once researchers realized the lack of attention being paid to the tactile modality, investigations of the specific role of touch during mother-infant social exchanges were initiated. For example, Gusella, Muir, and Tronick (1988) compared the responses of 3- and 6-month-old infants receiving tactile stimulation during the first period (i.e. the normal period) of a SF procedure to those of infants who had not received maternal touch. They found that infants of 3 months of age displayed the SF effect (i.e. the response observed in infants during the second period of the SF procedure) only if they had received tactile stimulation during the preceding normal period. In addition, the attention of infants who had not been provided with tactile stimulation declined over time. These findings imply that tactile stimulation plays an important role in the continuity of infant attention and contributes significantly to the SF effect. Thus, it is a critical component of mother-infant interchanges.

Other studies examining the role of touch within mother-infant interactions have employed a modified SF procedure. This procedure differs from the typical SF procedure because mothers are permitted to touch their infants during the SF period, thereby

isolating maternal touch from other communicative modalities and allowing a closer examination of maternal touch. Stack and Muir (1990) compared the responses of infants whose mothers had and had not used touch during the SF period (SF+T) and found that infants of mothers who used touch experienced less distress during the SF period. These infants displayed more smiling and gazed more at their mothers compared to infants whose mothers had not touched them during the SF period. These results were then replicated and generalized to infant interactions with female experimenters (Stack & Muir, 1992), and to infants of depressed mothers, where it was found that touch was even more soothing for infants of depressed mothers than for infants of non-depressed mothers (Peláez-Nogueras, Field, Hossain, Pickens, 1996). Finally, Stack and Muir (1992) found that it was the tactile and not the visual stimulation provided by the adults' hands that moderated the still-face effect, suggesting that touch is an important and independent social component of adult-infant interactions and is beneficial in regulating infant distress.

Continuing to investigate the communicative role of touch within mother-infant face-to-face interactions, Stack and LePage (1996) examined infant responses to changes in their mother's behaviour when mothers were provided with specific instructions, such as eliciting smiling from their infants, during a variation of the modified SF+T procedure. Findings indicated that, during the SF+T periods, infants' gaze shifted from their mothers' faces to their mothers' hands. Moreover, infants displayed more smiling during the period where mothers were instructed to elicit such smiling from their infants.

Extending the investigation of the communicative function of maternal proximal behaviours during mother-infant interactions, Stack and Arnold (1998) examined how

maternal touch, combined with their gesturing behaviours, can be used to elicit specific responses from infants. Mothers were again provided with specific instructions across periods of a modified still-face procedure (i.e. SF+T): to engage their infants in playful interaction during one period, and to draw and maintain their infants' attention to their faces during another period. It was found that mothers were successful at using touch alone to draw their infants' attention to their faces, as demonstrated by an increase in infant gaze at their faces, and to engage their infants in playful interaction, as demonstrated by an increase in infant smiling. Furthermore, although gestures were not part of the original instructions, mothers often combined their touch behaviours with gestures. These findings, in combination with those from the Stack and Lepage (1996) study, imply that proximal forms of non-verbal communication, such as touch and gesturing, play a significant communicative role in social interchanges between mothers and infants; that mothers can use touch and gesturing to obtain specific responses from their infants; and that infants are responsive to changes in their mothers' touch and gestural behaviours.

Despite these important findings, the studies were limited in that the changes in maternal tactile behaviours were merely inferred from the observed infant responses (Stack, 2001). Moreover, while the overall duration of touch was investigated, a comprehensive examination of the quality or quantity of touch, including type, location, intensity, speed, and extent used by mothers was not included. Given the suggestion that different types of touch have varied meanings (Tronick, 1995) and that type of touch, along with other qualitative and quantitative characteristics of touch, are essential for a deeper understanding of the communicative functions of this communicative modality

(Hertenstein, 2002), Stack, LePage, Hains and Muir (2004) developed the Caregiver-Infant Touch Scale (CITS). The CITS documents qualitative and quantitative components of maternal touch during mother-infant interactions. Utilizing the same experimental procedure as the Stack and LePage (1996) study, this study demonstrated that patterns of maternal touch varied significantly across experimental periods of mother-infant interaction, depending on the specific instructions of the period. For example, when mothers were instructed to obtain the maximum amount of smiling from their infants, mothers used more active forms of touch, such as tickling and stroking, and an increased intensity of lifting and stroking were also noted. In contrast, when mothers were instructed to touch their infants in one area of the body only, stroking behaviours increased and shaking decreased, most types of touch that mothers used decreased in speed, and the intensity of tickling and shaking decreased (Stack, in press). These results suggest that the quality of maternal touch varies with the communicative message mothers wish to convey to their infants and, combined with the results from the original study, imply that infants understand these messages.

Infant Touch and Exploration

In addition to being an important modality of non-verbal communication, touch is an important means through which infants explore themselves and others. Through self-touch and the haptic exploration of objects, infants learn about the specific properties of the stimuli in their surrounding environments and the unique features of their own bodies. As a result, infants learn to differentiate themselves from others around them, thereby developing an awareness of what Neisser (1991) labelled the ecological self. Thus, touch is a critical modality through which infants develop their self-identity (Rochat, 2001).

Within the first three days of life, infants begin to touch their own mouth, face, ears, head, nose and eyes (Kravitz, Goldenberg, Neyhus, 1978) and they do so for most of their waking hours (Rochat & Senders, 1991). In particular, they spend 20% of their waking hours touching their faces and mouths (Korner & Kraemer, 1972). This self-touch, also called "double touch," (Rochat, 1995) provides infants with a unique perceptual experience because they sense tactile stimulation on two parts of their bodies. It has been demonstrated that infants can distinguish self-touch from the tactile stimulation by another individual from birth (Rochat & Hespost, 1997), thereby suggesting that infants have an implicit sense of their own bodies as distinct from others in their environment.

Most investigations of early infant tactile behaviours have focused on the haptic exploration of objects. Initially, when manual exploration by the hands and fingers is still undeveloped, infants explore objects with their mouths. The high density of tactile receptors in the mouth enables infants to perceive the tactile and kinaesthetic properties of stimuli (Rochat, 1983). Then, from two months of age, oral and manual exploration of objects occur in combination. Objects placed in infants' hands are frequently transported to the mouth (Rochat & Senders, 1991). This behavioural pattern increases in frequency between two and five months of age, and by five months, is the predominant form of spontaneous exploration by infants (Rochat, 1989), implying that the activity of the hands and mouth do not function independently at these ages (Rochat & Senders, 1991). This alignment of oral and manual responses to the physical properties of objects has been suggested to occur as a result of a functional change within the oral modality: the

nutritive function of the mouth becomes less dominant and its exploratory function increases in importance (Rochat, 1987).

Between two and five months, infants' manual exploration of objects becomes increasingly sophisticated. At four months, fingering, which is considered a fine haptic exploratory behaviour, emerges (Rochat, 1989). In addition, at this stage, infant exploration becomes increasingly multimodal in nature. For instance, when infants finger an object it becomes increasingly likely that they will also gaze at that object. By four or five months of age, infants increasingly transfer objects between hands, indicating a growing appreciation for the symmetrical property of the body (Rochat, 1989).

By six months of age, the hands predominate as instruments of haptic exploration over the activity of the mouth (Bushnell & Boudreau, 1991; Rochat, 1997). As an example, Stack and Tsonis (1999) examined the manual actions used by seven-month-old infants to perceive the textural properties of rough and smooth stimuli. Infants in the experimental group familiarized with one stimulus, were then shown a novel stimulus, and then were re-familiarized with the original stimulus. Infants in the control group touched the same stimulus across all three periods. Results revealed that whereas infants in both groups engaged in high levels of manual contact with the textured stimuli, infants in the experimental group engaged in more manual contact during the re-familiarization phase than infants in the control group. These findings imply that infants' are proficient at obtaining haptic information, and more specifically, making textural discriminations, through touch. Moreover, using an improved infant controlled paradigm, infants as young as 3 months were found to be able to discriminate textures on the basis of haptic exploration alone, and infants' exploratory procedures varied with the haptic features (i.e.

rough versus smooth) of the stimuli by 6 months of age. Specifically, at 6 months, infants displayed more exploratory procedures in response to the rough stimuli, implying that the haptic properties of stimuli may elicit tactile exploration in infants with more refined fine motor skills (Tsonis, 2002). Taken together, these findings suggest that young infants can acquire the textural properties of stimuli through the activity of their hands.

Infant Touch and Regulation: Touch and Manual Activities

The research on infants' use of touch as a means of exploration has almost exclusively occurred outside of the interactive context. In contrast, most studies examining infant manual activities during mother-infant interactions have largely focused on their gesturing behaviours. For example, it has been demonstrated that the frequency and duration of pointing varies during mother-infant interactions. Specifically, in a study investigating infant gesticulations across periods of a still-face procedure, it was found that infants displayed increased pointing during the SF compared to the Normal period (Fogel, Diamond, Langhorst, & Demos, 1982). Moreover, pointing often co-occurs with other forms of non-verbal communication, suggesting that it is an organized act of communication, linked to infants' affective states (Fogel & Hannan, 1985; Hannan, 1987). In particular, pointing occurs before and after mouthing, in conjunction with expressions of neutral affect, and is often followed by vocalizations in nine to fifteen-week-old infants (Platzman, 1983; Fogel & Hannan, 1985).

Other types of gesticulation have also been systematically analyzed during mother-infant interactions. For example, finger curl has been shown to precede or succeed all other actions of the hands and to co-occur with infant vocalizations (Platzman, 1983; Fogel & Hannan, 1985). Thus, Fogel and Hannan (1985) suggest that

finger curl is associated with moderate states of arousal in infants. Finger spread occurs when infants are affectively neutral and gazing away from the mother, suggesting that it is associated with infant withdrawal from social interaction. These findings suggest that, in conjunction with other of their communicative modalities, infant manual actions provide important information about infants' underlying affective states during the pre-verbal stage of infant development.

While some attention has been devoted to the communicative functions of infant manual actions during mother-infant interactions, research examining the role of infant tactile behaviours during these interchanges is sparse. To date, only two studies have investigated infants' use of touch during mother-infant social exchanges. Murray and Trevarthen (1985) examined infant responses to the still-face procedure across modalities, including their proximal behaviours such as touch and gesturing. They found that infants exhibited active gesturing of the limbs, increased handling of the clothes, touching the face and sucking the fingers (i.e. mouthing) during the SF period compared to the other interactive periods. Moreover, infants displayed signs of distress, such as sneering, grimaces of the mouth, frowning, negative affect and gaze away from the mother during the SF period.

Toda and Fogel (1993) found similar results in a study that compared the responses of infants of 3 and 6 months to the still-face procedure. In particular, they found that for both ages, infants increased the amount of grasping, self-touch, and touching of their clothes and the infant seat during the SF compared to the Normal mother-infant interaction periods. However, the specific manner in which infants used their hands changed from three to six months: at three months, infants continued to gaze

at their mothers while touching, whereas at six months, touching of the self, clothes or the chair co-occurred with gazing at the proximal environment, while touching the face and mouthing co-occurred with gazing at the distal environment. These findings provide evidence for developmental changes in infants' emotional self-regulation and suggest that merely looking at infants' distal communicative expressions as responses to the SF ignores important information delivered by infants through more proximal behaviours, such as touch. Taken together, the results of these two studies suggest that the tactile modality, whether alone or in combination with other modalities, provides important information about infants' affective states and regulatory abilities in response to maternal unavailability.

While these studies demonstrate the critical role of infant touch in infant emotional communication and self-regulation during social interchanges, the investigation of infant touch during these studies was quite superficial due to the limited examination of particular types of touch and the areas on the body on which this touch occurred. A more comprehensive analysis of the qualitative and quantitative components of infant touch, comprising an investigation of the particular types and patterns of touch used by infants with their social partners, is warranted. Such an investigation is vital given previous assertions that different types of touch convey varying social messages (Tronick, 1995) and that an understanding of these characteristics are essential for a deeper understanding of the communicative role of touch (Hertenstein, 2002; Stack, 2001; Stack, in press).

The Present Study

The paucity of research on maternal touch is surprising given that it is a critical channel through which mothers convey important messages and elicit specific responses from their infants. However, this paucity is even more salient for infants because at this early stage in their communicative development, they do not yet have the ability to communicate their emotions through verbal means. As such, touch is crucial as a source of information in understanding infants' underlying states of affect and arousal. Furthermore, because infants use touch to explore and learn about themselves and others around them, touch is also of prime importance to the development of infants' self-identity. Thus, an in-depth examination of infant touch is necessary in order to better understand how infants use touch to communicate with their social partners, to regulate their emotions during interactions, and to explore themselves. Given the importance of touch for infant communication and exploration, combined with the paucity of research on touch, the present study was designed to investigate the tactile behaviours of 5 ½-month-old, healthy, full-term infants during mother-infant interactions. Specifically, through the use of a still-face procedure, this study was designed to examine how the duration and location of types of infant touch varied across periods of mother-infant interactions. The still-face procedure, which includes a Normal period, SF, and Reunion Normal period, has been frequently employed in the past to examine infants' sensitivity to their partners' behaviour across interaction periods (Gusella, Muir & Tronick, 1988; Mayes & Carter, 1990; Muir & Lee, 2003; Segal et al., 1995). However, rarely, if at all, has infant touch been examined. In the present study, the primary focus was on touch,

and the dependent measures were the percent duration of: 1) the overall amount of touch, 2) the specific types of touch, and 3) the areas on which this touch occurred.

The specific objectives were to: 1) document the types of infant touch, 2) investigate the duration and location of this touch and how it varied with the interaction periods of a still-face procedure, and 3) examine the co-occurrence between type and area of touch, and how this varied across periods of mother-infant interaction.

Whereas the first objective was descriptive in nature, specific hypotheses were developed with respect to the second and third objectives of the present study. With respect to the second objective, it was hypothesized that differences in infant touch would emerge across interaction periods, and particularly, between the SF and Normal interaction periods. Previous research has documented a SF effect, whereby infants communicated distress to mothers' violations of social expectations of reciprocity during this period (Brazelton & Cramer, 1990; Frick & Adamson, 2003) through their distal communicative modalities (e.g. increased gaze aversion and decreased smiling) (Gusella, Muir & Tronick, 1988; Mayes & Carter, 1990; Muir & Lee, 2003; Segal et al., 1995; Stack & Muir, 1990). Since touch is also an important modality through which infants communicate their underlying affective states, it was anticipated that infants would demonstrate a SF effect through their tactile behaviours as well. For example, it was expected that infants would exhibit more mouthing or stroking during the SF period because it has been suggested that infants put their hands in their mouths in order to soothe themselves during periods of distress (Field, 1994; Mayes & Carter, 1990; Toda & Fogel, 1993).

In addition, it was hypothesized that the overall duration of infant touch would increase during the SF compared to the Normal interaction periods because mothers often initiate contact with their infants during social exchanges (Kaye, 1982) and infant touch was only coded in the present study if it was initiated by the infant or if the infant actively manipulated their hands while in contact with their mothers. It was also expected that infants would often use passive forms of touch, such as static touch, during the Normal interactions with their mothers. Furthermore, it was anticipated that infants' tactile behaviours (e.g. static touch, touching of the self) would vary between the first and third Normal interaction periods. This was expected because of the documented carry-over effect, whereby infants continue to display negative affect and they reveal increased levels of fussiness during the Reunion Normal relative to the SF period (Cohn, 2003; Weinberg & Tronick, 1996).

Also in relation to the second objective of the current study, it was hypothesized that the location of touch would vary as a function of the period of interaction. In line with findings from Toda and Fogel's (1993) study, it was expected that infants would spend more time touching themselves, their clothes and the infant seat during the SF period, when mothers were unavailable, compared to the Normal periods. In contrast, it was expected that during the Normal periods, infants would spend more time touching their mothers because they would be engaged in social play with their mothers during these interaction periods. Moreover, it was expected that infants would spend more time touching their mothers during the first Normal period compared to the Reunion Normal period as a result of a carry-over effect (Weinberg & Tronick, 1996).

With respect to the third objective, it was hypothesized that certain types of infant touch would co-occur with specific areas of their bodies to a greater extent than predicted by chance and that these associations would vary with changes in maternal availability. By examining which types of infant touch co-occurred to a degree greater than predicted by chance with specific areas on infants' bodies, infants' clothes, and the infant seat, additional important information about the communicative role of infant touch during their early social exchanges could be obtained. It has been suggested that discrete behaviours do not reflect the complexity of infant communication (Symons & Moran, 1987) and that co-occurring behaviours serve to enhance the communicative messages infants convey (Weinberg & Tronick, 1994), thereby enabling researchers to better understand these messages. However, if infants' tactile behaviours during their early social exchanges have been the focus of little attention in research, none has been paid to the examination of which infant tactile behaviours co-occur with specific areas of their bodies and which of these co-occurrences vary with periods of interaction. Moreover, by demonstrating how these behavioural pairs vary with changes in maternal availability, additional evidence for infants' sensitivity to changes in their partners' behaviours would be obtained, with the potential to imply that infants use touch to communicate their underlying affective states during their social exchanges.

Consistent with the previous hypothesis that infants would spend more time employing passive forms of touch, such as static touch, when engaged in Normal interactions with their mothers, it was expected that static touch would co-occur with touching of the mothers. Moreover, it was anticipated that other types of infant touch (e.g. stroke, finger, pat, pull) would co-occur with the infant seat or infants' clothes, and

that these associations would occur for a significantly greater proportion of time during the SF period because of the greater opportunity infants had to explore themselves during this period, when mothers were unavailable.

Method

Participants

Participants were recruited from a major community teaching hospital in the Montreal area. Mothers were telephoned and asked to participate in the study. Forty-six mother-infant dyads participated. However, two dyads were excluded from analyses due to: 1) an obstructed view of the infant's hands on the videotape (n = 1); and 2) the mother not following the instructions (n = 1). Thus, forty-four dyads remained in the final sample, including 20 male and 24 female infants. The mean age of infants was 5 months, 13 days (SD = 7.63 days). Infants of 5 ½ months of age were selected for this study because, at this age, infants' fine motor skills are more refined than younger infants and they play a more active role during their face-to-face social-exchanges. All infants were healthy and full-term, born between 38 and 41 weeks gestation and weighing more than 2750g at birth. The mean age of mothers was 30.5 years (SD = 5.15), with a mean level of education of 14.5 years (SD = 2.09). Furthermore, the majority of this sample was Caucasian (90.9%). With respect to occupational status, mothers were classified in the following domains: Professional Specialty (36.4%), Sales (2.3%), Administrative support, including clerical (4.5%), Precision production, craft, and repair (4.5%), Machine operators, assemblers, and inspectors (6.8%), Handlers, equipment cleaners, helpers and labourers (2.3%), Service workers (9.1%), Student (2.3%), Unemployed (15.9%), Freelance art (15.9%).

Apparatus

Mothers and infants were seated facing each other and at a distance of 70 cm. Infants were seated in an infant-seat mounted on a table and located at eye-level to their

mothers. A Sony Video Cassette camera was set up on a tripod behind and to the right of the mothers and facing the infants. The camera was positioned in full view of the infant's face and body and in view of the mothers' hands. A mirror was strategically placed on the table, facing the camera in order to capture a front view of mothers and to be able to record their facial expressions. After the testing session, a Video Timer (FOR.J VTG-22) was used to record a time line on each 8 mm cassette following which second-by-second coding of the videocassettes was conducted using a Sony VTR/TV wireless remote control with slow speed shuttle function for slow motion viewing and starting and stopping of the tape.

Each mother-infant interaction period was timed using a stop clock that beeped at the end of 2 minutes. The beginning of each period was indicated to the mothers by a knock on the wall by the experimenter.

Procedure

This study was part of a larger longitudinal study examining infant socio-emotional development and mother-infant interactions. The testing session took place at the participants' homes in order to increase the ecological validity of the mother-infant interactions by more accurately reflecting typical social exchanges between mothers and their infants. All periods of mother-infant interaction were video-recorded.

Upon entry into the home, the experimenter provided mothers with a consent form to read and sign (see Appendix A). The experimenter then set up the camera and positioned mothers and infants facing each other and at a distance of 70 cm. Mothers were seated in a chair and infants were fastened to an infant-seat mounted on a table and at their mothers' eye-level.

The dyad participated in a still-face (SF) procedure, including three periods: a Normal period, a SF period, and a Reunion Normal period. Mothers were provided with specific instructions prior to each period. Instructions for the first period, i.e. the Normal interaction period, were: "For this period, I would like you to play with your baby as you normally would at home." During the second period, i.e. the SF period, mothers were instructed to gaze at their infant while maintaining an expressionless face, refraining from touching their infants and remaining silent: "For this period, I would like you to look at your infant with a still, neutral facial expression, and refrain from speaking, touching and smiling." Finally, for the third period, i.e. the Reunion Normal period, mothers were instructed to resume playing with their infants as they normally would: "For this period, I would like you to play with your baby as you normally would at home." Each interaction period lasted two minutes, commencing with a knock on the wall by the experimenter and terminating with the beep of the stop clock. Intervals between periods lasted for 20 to 30 seconds. Mothers were informed that they were free to terminate the session at any point if they so desired. If infants fretted for 20 seconds (n = 1) or mothers wished to stop the session (n = 0), the experimental session was interrupted. Mothers were then given the opportunity to soothe, feed, or change their babies. The session was re-initiated only once the mothers felt comfortable to do so. After the three periods of recorded mother-infant interactions, mothers were asked to provide demographic information (see Appendix B) and medical histories of their infants.

Following the testing session and questionnaire, the experimenter thanked the mothers and their infants for participating in the study and provided mothers with an "Infant Scientist Association" award, recognizing their infant's contribution to the

advancement of science. Mothers were also informed that a report on the study's general findings would be mailed to them once the study was completed and analyses were conducted.

Behavioural Coding, Dependent Measures, and Data Reduction

The dependent measures for the current study were percent duration of the types of infant touch and the area of infants' body on which the touch occurred. Percent duration was defined as the percentage of time the infant touched during a 120-second period or the percentage of time the infant used a specific type of touch during a 120-second period.

These measures were derived from the Infant Touch Scale (ITS), a systematic and detailed observational coding measure that was developed to document the duration and location of various types of infant touch within mother-infant interactions and how infant tactile behaviour varies as a function of the interaction period.

Using the ITS, only infant initiated or infant active touch was coded. That is, infant touch was coded only when the infant initiated contact with a stimulus or the infant actively manipulated his/her hand(s) when in contact with a stimulus. If, for instance, the mother initiated contact with the infant's hand(s) and the infant did not actively manipulate his/her hand(s) while in contact with the mother, then infant touch was not recorded (Appendix C provides a detailed description of the coding criteria used to document infant touch).

The ITS consists of eight categories of infant touch and ten categories of areas of this touch. The eight categories of infant touch include: no touch, static touch, stroke/rub/caress/wipe, grasping/clutching/clasping, manipulating/fingering/scrumbling/

poking/prodding, mouthing, tapping/patting, and pulling/pushing/clapping/lifting. These categories of touch are considered to be active types of touch with the exception of no touch and static touch, with this latter category being considered a passive type of touch. The ten areas of the body where infants might touch include: no area, face/head, mouth, hands/arms, shoulder/neck, trunk, feet/legs, mother, chair, and clothes. Operational definitions for each type and area of touch can be found in Appendix C.

Type and area of infant touch were coded for one-second intervals for each of three 120-second periods and infant touch was only coded if the infant's hand(s) were visible to the coder. Within each second, the hand employing the most active form of touch was coded based on pre-established rules (see Appendix C for specific coding criteria). If both hands were engaging in equally active touch behaviours, the hand that was touching for a longer period of time was coded. All coding was completed with the sound off in order to minimize contextual information that could potentially bias the coding of infant touch.

A second coder was trained on videotape examples until a high-level of reliability (r_k>0.80) was achieved with the primary coder. This second coder was blind to the hypotheses of the study and double coded 20% of the sample in order for inter-rater reliability to be determined. Kappa coefficients were calculated for the type (r_k = 80.1%) and area (r_k = 84.1%) of infant touch. Moreover, percent agreement between the two coders was calculated for each category of type and area of touch and ranged from 72.6% to 99.2 % for type of touch and from 82.4 % to 99.2 % for area of touch.

Results

Descriptive statistics were calculated for each dependent variable in order to screen for the presence of outliers and to assess the normality of the distribution. Outliers were brought in according to the Tabachnick and Fidell (2001) method, which consists of assigning the outlier a value of one unit larger than the next most extreme score in the distribution. This method has been suggested to be more practical than eliminating participants from the analyses altogether (Tachnick & Fidell, 2001). The normality of the distribution was then examined for skewness and/or kurtosis, which were considered to be significant if they exceeded the numerical criterion recommended by Tabachnick and Fidell (2001). Due to the presence of a significant level of skewness and kurtosis, square root transformations were applied to the raw data. However, before deciding on the use of such transformations, the effect of the transformations on the data was carefully examined. Specifically, since some measures were not likely to be normally distributed due to their low frequency of occurrence, the nature of the dependent variables was considered. Moreover, the degree to which the transformations corrected for the level of skewness and kurtosis was also taken into account. Finally, how the transformations influenced the results of the analyses was considered by comparing the results of the analyses performed on the transformed and the non-transformed data.

Since the application of transformations did not significantly alter the results of the analyses but did correct for the level of skewness and kurtosis, square root transformations were applied where needed to the raw data. In the text, it is indicated where transformations were applied to the data and the F-statistics and p-values reported in the text are taken from the analyses with the transformed data; these were the values

used to evaluate the significance of the effects and to interpret the data. However, raw means are cited in the text and illustrated in the figures in order for the results to be more easily understood by the reader.

Statistical analyses were performed using the Statistical Package for the Social Sciences for Windows (SPSS, version 11.0). An alpha level of $p < .05$ was used as the critical cut-off for significant results and Bonferroni corrections were performed to reduce the occurrence of type I errors in post-hoc tests. Moreover, the more conservative Greenhouse-Geisser Epsilon Adjusted F was used for all ANOVAs. Only significant findings are reported in the text, while non-significant results can be found in the appendices.

Following descriptive statistics, analyses were conducted for each dependent measure. The first and second objectives of the present study were addressed using analyses of variance. These analyses were initially conducted with gender as a between-subjects factor. However, as no significant main effects or interactions with gender were found, all subsequent analyses were conducted collapsing across this variable. To begin, a one-way repeated measures analyses of variance (ANOVA) was conducted for the percent duration of the overall amount of touch (i.e. all types of touch were collapsed into one overall touch category) in order to determine how much touch infants use during interactions with their mothers and whether the total duration of touch varied as a function of the period of interaction. In order to examine how specific infant touch behaviours and the location of these behaviours varied as a function of mother-infant interaction periods, univariate two-way repeated measures ANOVAs were conducted, with type or area of touch as one within-subjects factor and period of the interaction as

the other within-subjects factor. The dependent measures were the percent duration of types and areas of touch. In the event of significant interactions, simple effects analyses were conducted to isolate the source of the interaction by holding the type of touch or the area of the body on which that touch occurred constant and examining where specific differences between the interaction periods were found.

Follow-up ANOVAs, whereby specific types and areas of touch were grouped together and compared across interaction period, were conducted in order to take the results of the earlier ANOVAs one step further. More specifically, these analyses were conducted to address the specific roles (e.g. communicative, regulatory, exploratory) that infant touch might serve and to investigate which particular types of touch contributed to the possible regulatory and exploratory function(s) of touch during infants' early social exchanges when mothers were exhibiting changes in their availability. The types and areas of infant touch were grouped together based on their hypothesized functions, which were derived in part from the results of the prior ANOVAs of the present study, and from previous research investigating touch.

Finally, the third objective of the present study was addressed using co-occurrence analyses, which will be described later in the text.

Total Touch as a Function of Period

To address the first objective, and more specifically, how the overall percent duration of touch varied across interaction periods, all touch categories were combined into one total touch category. The overall mean percent duration of infant touch collapsed across periods of mother-infant interactions was $\underline{M} = 84.74\%$. A 1-way repeated-measures ANOVA was conducted for the percent duration of overall touch across

interaction periods. Although a significant main effect of Period was not found, a trend was revealed, F (2, 86) = 2.90, p = 0.06 (see Appendix D, Table 1). Pairwise comparisons demonstrated that infants spent a greater amount of time touching during the SF period (M = 87.88%) relative to the first (M = 83.26%) and third (M = 83.08%) Normal interaction periods.

Type of Touch as a Function of Period

With regard to both the first and second objective, an 8 (Type of touch) by 3 (Period) repeated-measures ANOVA was conducted to examine how infant touch varied across interaction periods. Descriptive statistics revealed a significant level of skewness and kurtosis; thus a square root transformation was performed on the data for the percent duration of Type of touch. A significant main effect of Type of touch was found, F (7, 301) = 42.44, $p < 0.001$ (see Appendix D, Table 3). Infants spent the most time using static touch (M = 30.51%), followed by pull (M = 12.05%) and stroke (M = 12.03%), finger (M = 8.41%), pat (M = 7.58%), mouth (M = 6.76%), and finally, grab (M = 4.97%). Furthermore, a significant interaction between Type of touch and Period emerged, F (14, 602) = 8.92, $p < 0.001$, indicating that the types of touch infants used varied with interaction periods. Subsequent simple effects analyses demonstrated that infants spent more time using active forms of touch, such as stroke, finger, pat and pull, during the SF period (M = 16.31%, 11.81%, 11.79%, and 17.18% respectively) compared to the Normal interaction periods (M's for the first period were 10.30%, 7.08%, 5.78%, and 9.76% respectively; M's for the third period were 9.48%, 6.33%, 5.16%, and 9.20% for stroke, finger, pat, and pull, respectively; $p < 0.05$). In contrast, infants spent more time using passive forms of touch, such as static touch, during the Normal interaction

periods (i.e. the first (M = 36.96%) and third (M = 35.60%) periods) compared to the SF period (M = 18.97%; p < 0.001). These findings are illustrated in Figure 1 and the means are presented in Appendix D, Table 2.

Specific Groupings of Infant Touch Across Periods. The emergence of a significant interaction between Types of touch and Period led to the hypothesis that infants may have used certain types of touch to self-regulate during the SF period, a period which has been suggested to be distressing for infants as a result of mothers' violating social expectations of reciprocity (Brazelton & Cramer, 1990). Moreover, it was anticipated that certain types of infant touch might serve a regulatory function for infants since some types of maternal touch (e.g. stroking, caressing) have been suggested to be soothing for infants (Tronick, 1995). Thus, follow-up analyses were conducted in order to examine whether infants spent more time using regulatory types of touch during the SF period relative to the Normal interaction periods. Specifically, all types of infant touch (e.g. stroke, grab, finger, mouth, pat, pull) were grouped into an 'other' types of touch category, with the exception of static touch, which was considered non-regulatory because of its passive nature. Then, 'other' types of touch were compared to static touch across interaction periods to investigate whether infants differed in the amount of time they spent using these two categories of touch as a function of interaction period.

A two-way repeated-measures ANOVA was conducted with Type of touch (static vs. other) and interaction Period as the within-subjects factors. Results revealed a main effect of Touch, F (1, 43) = 50,58, p < 0.001. Infants spent more time using 'other' types of touch (M = 63.38%) than static touch (M = 36.62%) across interaction periods. Moreover, a significant interaction effect was found between Touch and Period, F (2, 86)

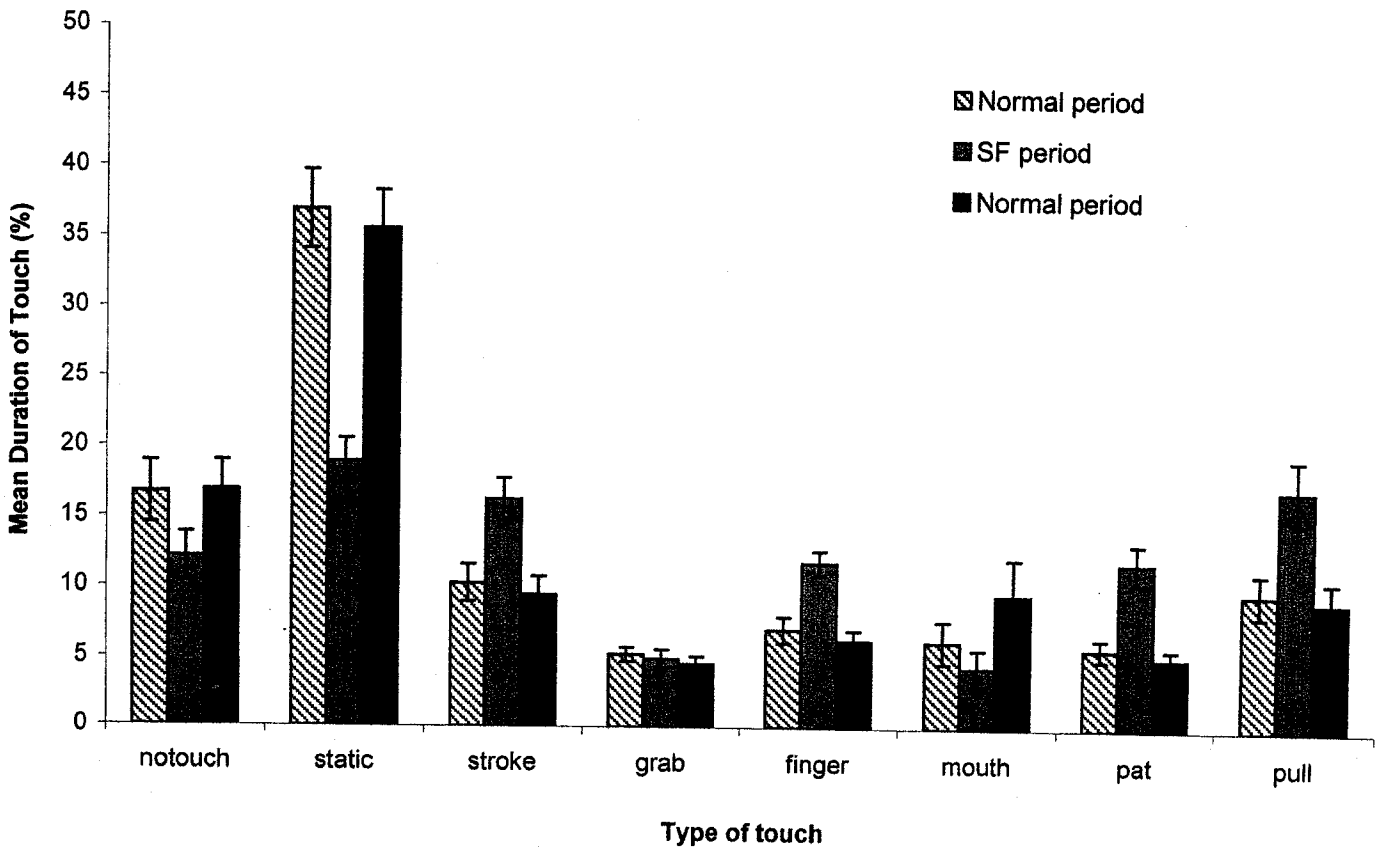

Figure 1. Mean percent duration of types of touch as a function of period (Normal, SF, Normal). Standard errors are shown by vertical bars.

= 26.99, $p < 0.001$ (Appendix D, Table 4). Simple effects analyses conducted to isolate the source of the Touch by Period interaction revealed that infants spent more time using 'other' types of touch during the SF period ($M = 77.74\%$), relative to the first ($M = 55.45\%$) and third ($M = 56.94\%$) Normal interaction periods ($p < 0.001$). In contrast, infants spent more time using static touch during the first ($M = 44.54\%$) and third ($M = 43.05\%$) Normal interaction periods relative to the SF period ($M = 22.25\%$; $p < 0.001$). These findings are shown in Figure 2.

Because a significant interaction effect was found between static and 'other' types of touch, the 'other' types of touch category was further subdivided to continue to investigate whether infant touch served a regulatory function for infants during the SF period and to more precisely pinpoint which types of touch infants used to engage in self-regulation during this period. Thus, stroke, finger, and mouth were clustered into a soothing/regulatory category because it was anticipated that infants might use these types of touch in a calming manner during the SF period. For example, it has been suggested that infants put their hands in their mouths (i.e. mouthing) in order to soothe themselves during periods of distress (Field, 1994; Mayes & Carter, 1990; Toda & Fogel, 1993). In contrast, pat, pull/push, and grab were categorized into a reactive/regulatory category because these types of touch were considered more active and/or possibly indicative of infant distress during the SF period. In particular, it has been suggested that infants attempt to physically distance themselves from their mothers through turning and twisting in the infant seat (i.e. pushing and pulling) during the SF period in order to self-regulate (Gianino, 1985).

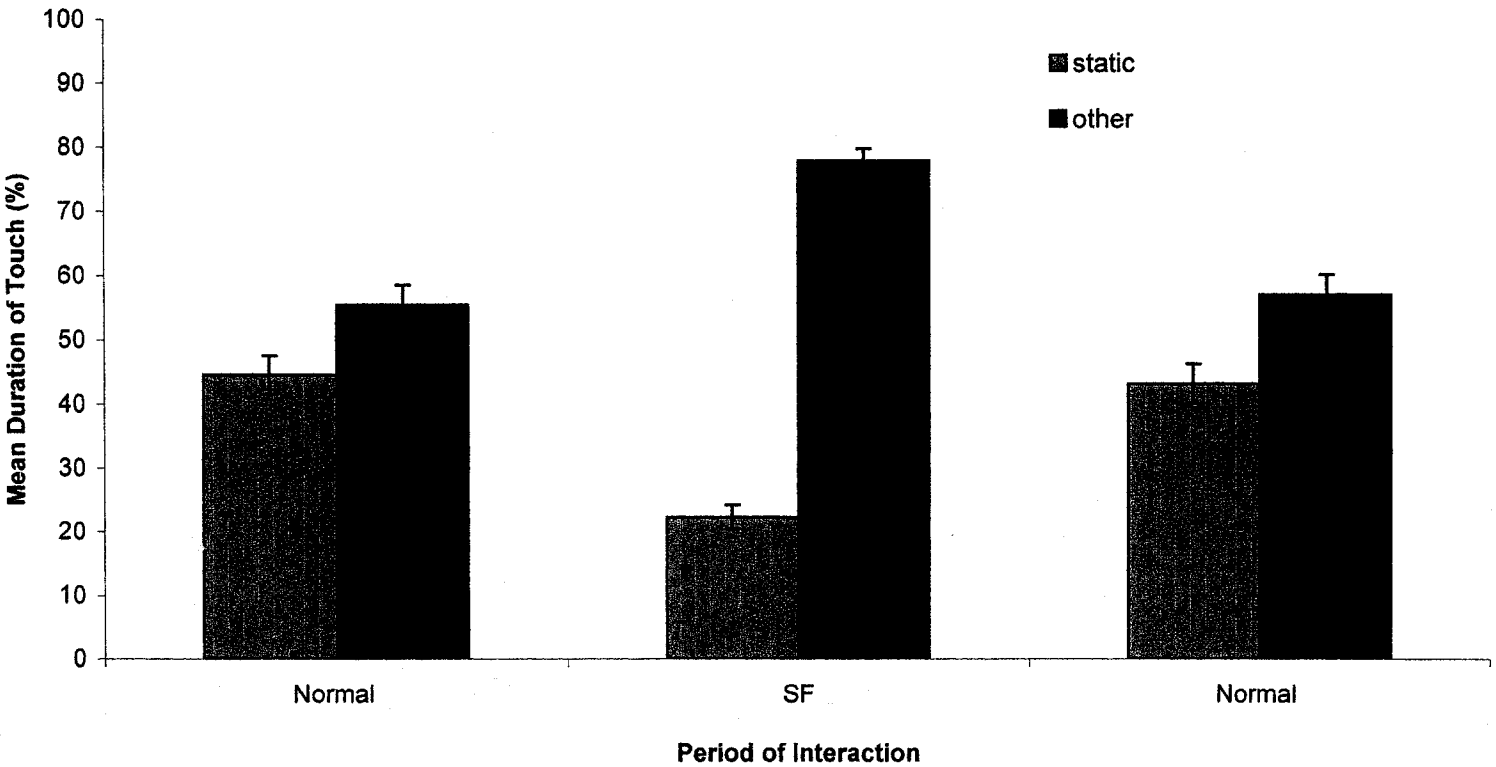

Figure 2. Mean percent duration of static versus other types of touch (i.e. stroke, grab, finger, mouth, pat, pull) as a function of interaction period. Standard errors are shown by vertical bars.

A 3 (Touch) by 3 (Period) repeated-measures ANOVA was conducted, with categories of Touch (static, soothing/regulatory, reactive/regulatory) and Period (Normal, SF, Normal reunion) as the within-groups factors. A significant interaction was revealed between Touch and Period, F (4, 172) = 14.760, $p < 0.001$ (Appendix D, Table 5). Subsequent simple effects analyses demonstrated that infants spent more time using the reactive/regulatory types of touch during the SF period (M = 38.81%) relative to the Normal interaction periods (M's = 25.92%, 23.75% for periods 1 and 3, respectively; $p <$ 0.001) and they spent more time using the soothing/regulatory types of touch during the SF period (M = 38.55%) relative to the first Normal period (M = 29.53%; $p < 0.05$). In contrast, infants spent more time using static touch during the Normal interaction periods (M = 44.54%, 43.05%) for the first and third periods, respectively, compared to the SF period (M = 22.25%; $p < 0.001$). These results are illustrated in Figure 3.

A third follow-up analysis was conducted as a result of a significant interaction effect between Type of touch and interaction Period. More specifically, the earlier analysis examining the percent duration of types of infant touch demonstrated that infants spent more time using seemingly active types of touch during the SF period, whereas they spent more time using passive types of touch during the Normal interaction periods. To more comprehensively investigate whether the amount of time infants engaged in active versus passive types of touch, and more specifically, in exploratory behaviours, differed as a function of interaction period, a two-way repeated measures ANOVA was conducted, with category of Touch (active versus passive) as one within-subjects factor and interaction Period (Normal, SF, Normal reunion) as the other within-subjects factor. Before collapsing the types of touch into an active types of touch (i.e. stroke, finger, pat,

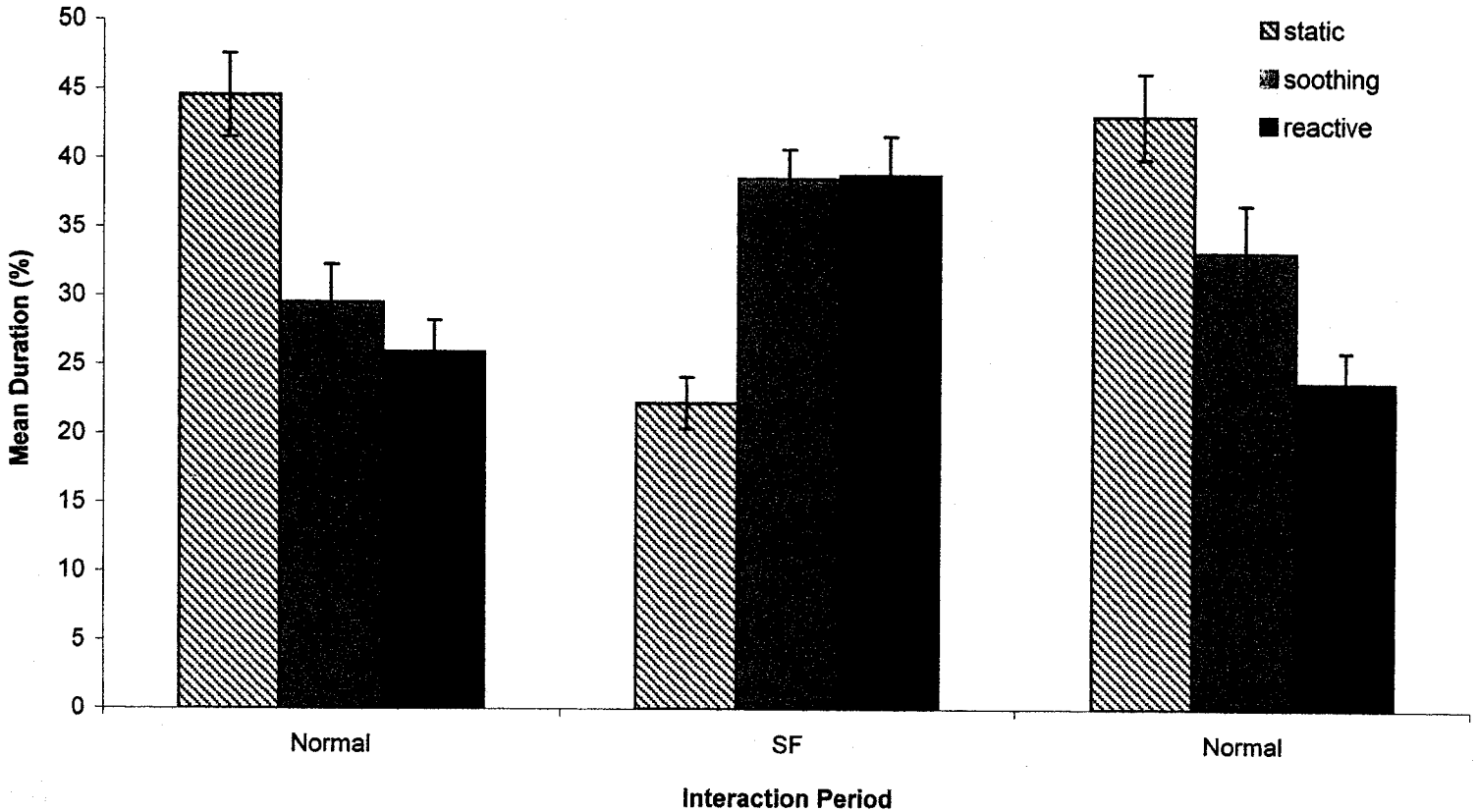

Figure 3. Mean percent duration of static, soothing/regulatory, reactive/regulatory types of touch as a function of interaction period. Standard errors are shown by vertical bars.

and pull) and a passive types of touch (i.e. static, grab) category, the mouthing category was removed (and the data re-proportioned out of 100%). Because mouthing is an oral modality, it was less relevant to the question of how infant manual exploration varies with changes in maternal availability. Moreover, the degree to which infants sucked with their mouths (i.e. used their mouths for exploratory purposes) as opposed to merely putting a part of their bodies in contact with their mouths was not adequately captured with the ITS. Thus, it was not possible to isolate infant exploratory mouthing from more general infant mouthing for the data analyses.

Results demonstrated a significant interaction effect between Type of touch and interaction Period, $\underline{F}$ (2, 86) = 40.14, $\underline{p} < 0.001$ (Appendix D, Table 6), which was then followed up with simple effects analyses. Infants spent more time using active forms of touch ($\underline{M}$ = 69.36%) and less time using passive forms of touch ($\underline{M}$ = 30.66%) during the SF relative to the Normal interaction periods ($\underline{M}$ for active types of touch were 43.42%, 44.52%; $\underline{M}$ for passive types of touch were 56.57%, 55.47% for periods 1 and 3, respectively; $\underline{p} < 0.001$). These results are illustrated in Figure 4.

Areas of Touch as a Function of Period

With regard to the first and second objectives of the present study, a 9 (Area) by 3 (Period) repeated-measures ANOVA was then performed in order to examine how the Area of infant touch varied as a function of Period of interaction. Descriptive statistics revealed a significant level of skewness and kurtosis. Thus, a square root transformation was performed for the percent duration of the areas on which infant touch occurred. The findings revealed a significant main effect of Area, $\underline{F}$ (8, 344) = 49.28, $\underline{p} < 0.001$, and a

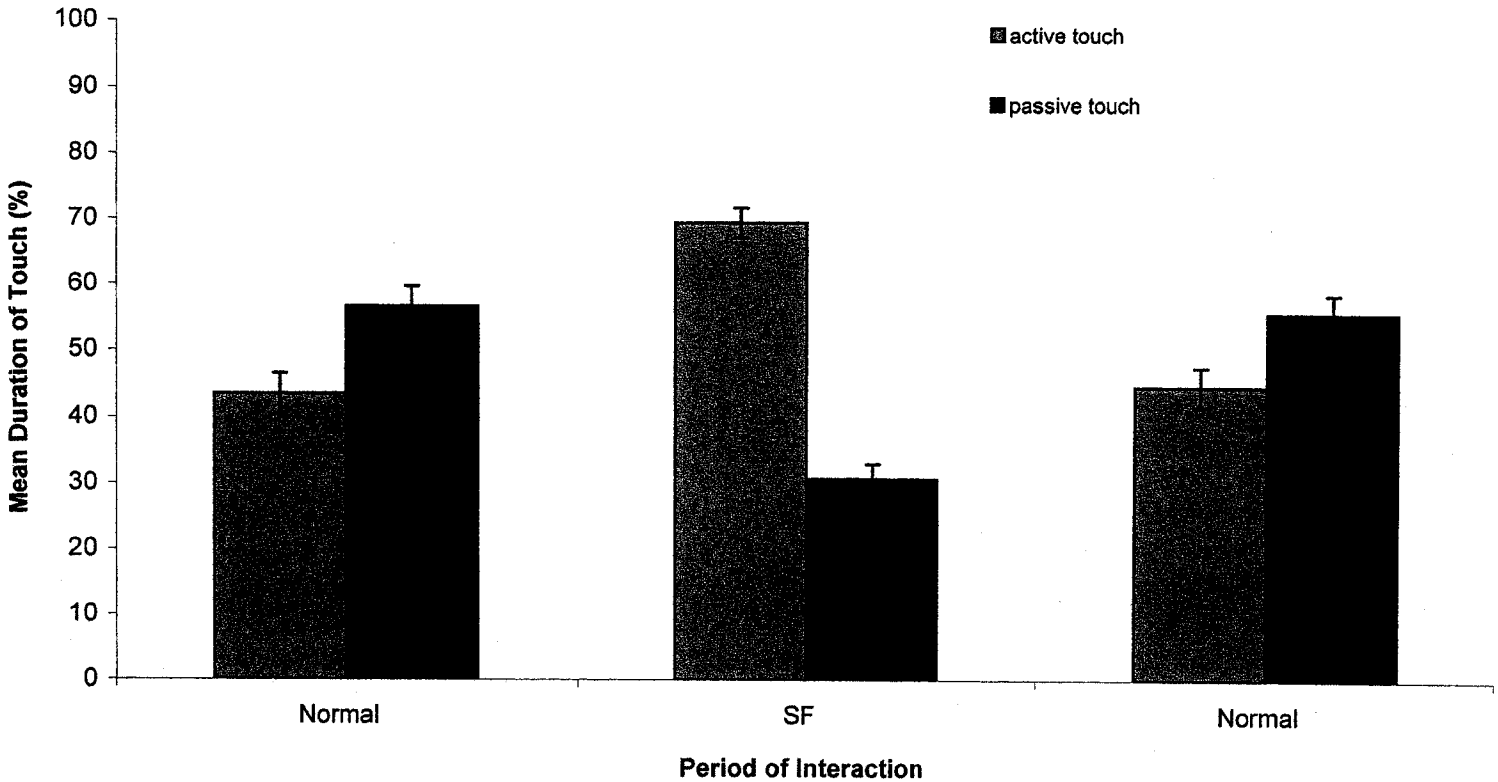

Figure 4. Mean percent duration of active versus passive types of touch as a function of interaction period. Standard errors are shown by vertical bars.

significant interaction effect between Area of touch and interaction Period, F (16, 688) = 24.37, $p < 0.001$ (see Appendix D, Table 8). In particular, it was found that infants spent the most time touching their feet (M = 27.64%), followed by their mothers, (M = 17.84%), the infant seat (M = 15.11%), their mouths (M = 6.76%) their clothes (M = 6.02%), their trunk (M = 4.88%), their arms (M = 1.41%), and finally, their faces and shoulders (M = 1.00%). Moreover, simple effects analyses conducted to isolate the source of the Area by Period interaction demonstrated that infants spent more time touching their faces and shoulders, feet, clothes and the infant seat during the SF period (M = 1.99%, 35.47%, 10.71%, and 23.50% respectively) compared to the Normal interaction periods (M's for period 1 were: 0.42%, 23.85%, 2.72%, and 13.06% respectively and M's for period 3 were: 0.48%, 23.59%, 4.63%, and 8.77% for faces and shoulders, feet, clothes, and seat, respectively; $p < 0.01$) and they touched their arms for a greater amount of time during the SF period (M = 1.83%) relative to the first Normal interaction period (M = 0.78%; $p < 0.05$). Furthermore, infants spent a greater amount of time touching their mothers during the first (M = 28.12%) and third (M = 25.39%) Normal interaction periods relative to the SF period (M = 0.00%; $p < 0.001$), as illustrated in Figure 5. This latter finding was expected because mothers were not engaged with their infants during the SF period. Means and standard deviations for this analysis are presented in Appendix D, Table 7.

Specific Groupings of Areas of Infant Touch Across Periods. Since interactions were found for the follow-up analyses addressing whether infants exhibited an increase in regulatory types of touch during the SF period and because a significant interaction effect was demonstrated for the amount of time infants spent touching various areas of their

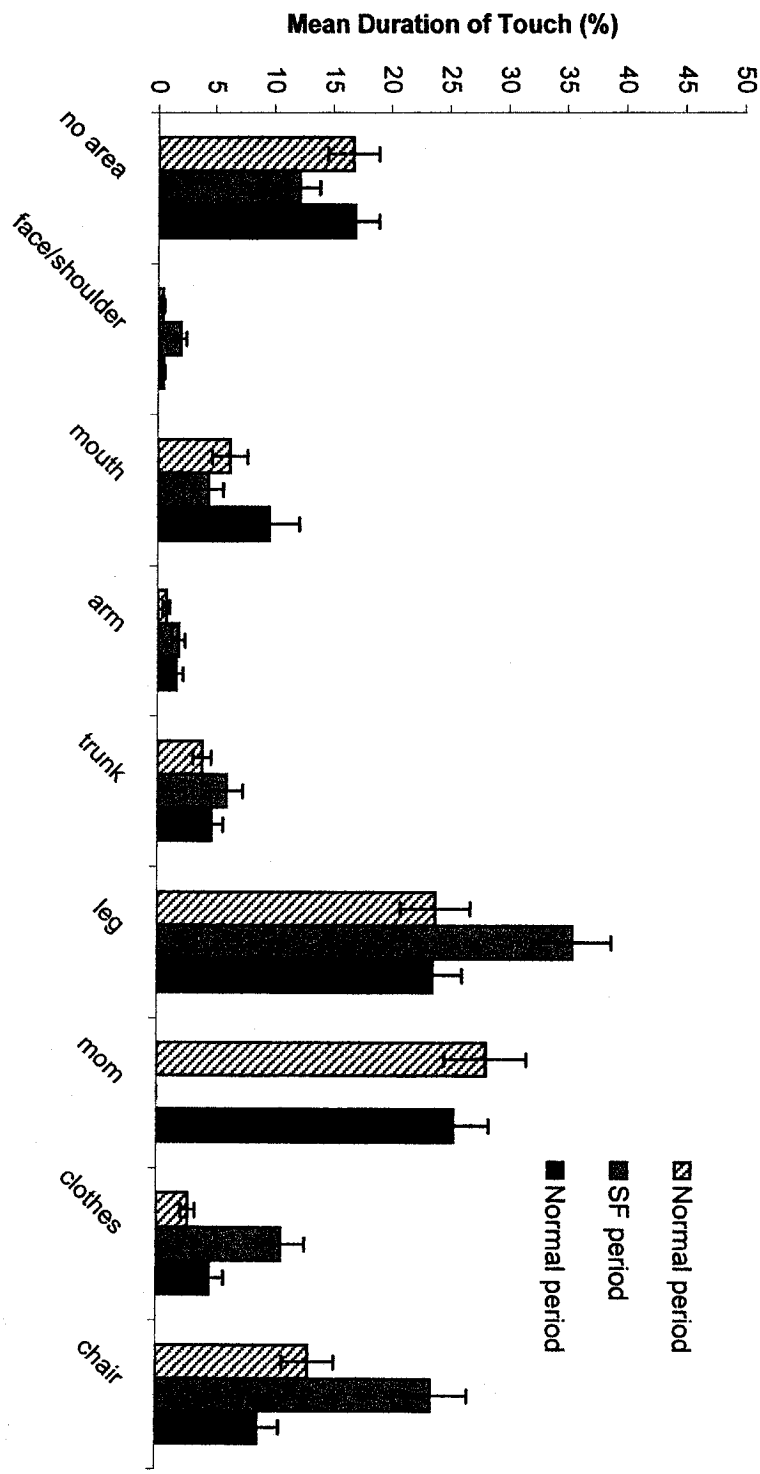

Figure 5. Mean percent duration of area of touch as a function of interaction period. Standard errors are shown by vertical bars.

bodies across interaction periods, a follow-up 5 (Areas of touch) by 3 (Period) two-way repeated measures ANOVA was conducted in order to examine whether the amount of time infants spent touching themselves versus the infant seat, their clothes, their mothers, and not touching anything varied as a function of interaction period. It was hypothesized that infants would spend more time touching themselves during the SF period than during the Normal interaction periods in order to self-regulate during this period. Thus, before analyses were carried out, the areas of the body on which infants could touch themselves were clustered into one category, labelled self.

Descriptive analyses revealed a significant level of skewness and kurtosis; accordingly, square root transformations were performed on the data. Results demonstrated a significant main effect of Area, $\underline{F}$ (4, 174) = 51.02, $\underline{p}$ = 0.00, and a significant interaction effect between Area and Period, $\underline{F}$ (8, 344) = 38.26, $\underline{p} < 0.001$ (Appendix D, Table 9). Specifically, it was demonstrated that, across periods, infants spent the most time touching themselves ($\underline{M}$ = 44.14%), followed by their mothers ($\underline{M}$ = 17.84%), not touching anything ($\underline{M}$ = 15.23%), the infant seat ($\underline{M}$ = 15.11%), and finally, their clothes ($\underline{M}$ = 6.02%). Simple effects analyses conducted to isolate the source of the Area by Period interaction revealed that infants touched themselves more during the SF period ($\underline{M}$ = 51.81%) relative to the first Normal period ($\underline{M}$ = 37.94%; $\underline{p} < 0.001$), and they touched their clothes and the infant seat more during the SF period ($\underline{M}$ were 10.71% and 23.50%, respectively) compared to the first ($\underline{M}$ were 2.72% and 13.06%, respectively) and third ($\underline{M}$ were 4.63% and 8.77%, respectively) Normal interaction periods ($\underline{p} < 0.01$). In contrast, and as expected based on the design of the study, infants touched their mothers more during the first ($\underline{M}$ = 28.12%) and third Normal interaction

(M = 25.39%) periods, when mothers were engaged, relative to the SF period (M = 0.00%; $p < 0.001$). These findings are illustrated in Figure 6.

Co-Occurrence Analyses Between the of Types and Areas of Touch

In order to address the third objective of the present study, and in particular to investigate: 1) which types of infant touch co-occurred to a degree greater or less than predicted by chance during infants' social exchanges with specific areas of infants' bodies, the infant seat, infants' mothers or their clothes, and 2) whether infants demonstrated reliably different co-occurring behaviours across interaction periods (i.e. with changes in maternal availability), Wilcoxon signed-ranks tests were performed. These co-occurrence analyses were conducted in order to clarify the communicative role of touch, especially since it has been suggested that discrete behaviours do not adequately reflect the intricacy of infant communication (Symons & Moran, 1987).

The first goal was addressed following the procedures outlined by Fogel and Hannan (1985) and Legerstee, Corter, and Kienapple (1990), whereby analyses were conducted to determine whether observed co-occurrence values differed significantly from expected co-occurrence values. Observed co-occurrence values were calculated by measuring the percentage of time with which two particular behaviours occurred simultaneously during an interaction period. These values were derived for each infant and for each interaction period from a computer program designed specifically for this purpose (Arnold & Deschenes, 2000). Expected co-occurrence was determined by calculating the joint probability of the two behaviour categories of interest (i.e. multiplying the proportional session durations of these behaviours). All possible behavioural pairs between types and areas of touch for the Normal, SF, and Reunion

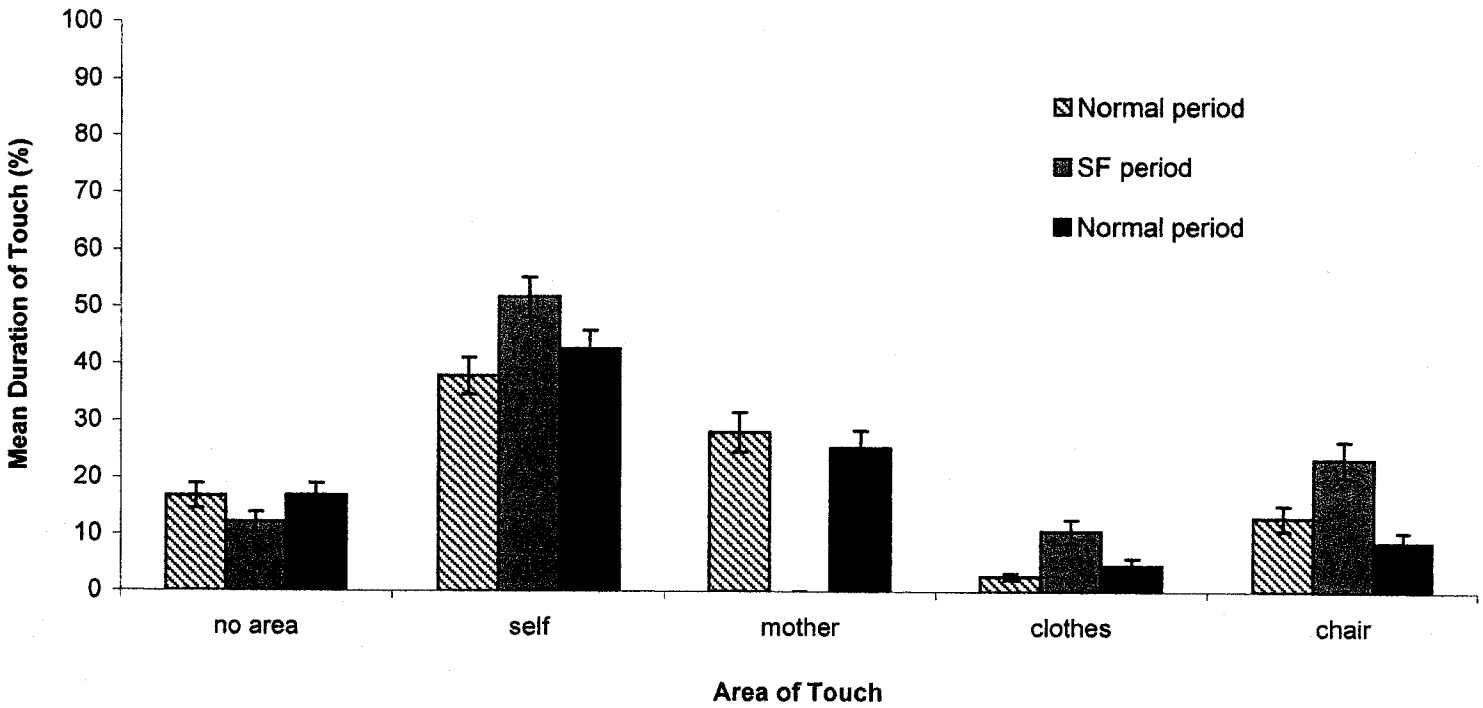

Figure 6. Mean percent duration of self versus other areas of touch as a function of interaction period. Standard errors are shown by vertical bars.

Normal period are presented in Tables 1, 2 and 3, respectively. Significantly co-occurring and non co-occurring behaviours are shown with asterisks.

The second goal was addressed by comparing specific behavioural pairs between interaction periods to determine whether the percent duration with which infants' engaged in these behaviours differed across interaction periods. Only significantly co-occurring and non co-occurring behavioural pairs were compared. For example, if static-mother was found to be significantly co-occurring in the first Normal period, it was compared to static-mother in the third Normal period. Results revealed the following differences in the percent duration of significantly co-occurring and non co-occurring behavioural pairs across interaction periods: stroke-face, stroke-leg, stroke-chair, grab-leg, finger-leg, pat-trunk, pat-leg, pat-chair, pull-leg, pull-clothes, and pull-chair co-occurred for a significantly greater percentage of time during the SF period than during either Normal interaction period. Stroke-clothes and finger-face co-occurred for a significantly longer percentage of time during the SF period relative to the first Normal period, and static-chair, grab-chair, finger-trunk, and finger-chair co-occurred for a significantly longer period of time during the SF period compared to the third Normal period. Moreover, some differences in the percent duration of infants' co-occurring behaviours during the first and third Normal periods also emerged: stroke-clothes co-occurred for a significantly greater amount of time during the third Normal period relative to the first Normal period. In contrast, grab-chair and pull-chair co-occurred for a significantly greater amount of time during the first Normal period relative to the third Normal period. These findings are demonstrated in Table 4.

Table 1

Co-occurrences Between Type and Area of Touch during the First Normal Interaction Period

	Types of touch						
	Static	Stroke	Grab	Finger	Mouth	Pat	Pull
Areas of touch							
Face	3/6	7/2*	0/9**	0/9**	n/a	8/7	0/7*
Mouth	n/a	n/a	n/a	n/a	19/1***	n/a	n/a
Arm	3/6	3/6	8/1*	2/7	n/a	2/7	5/4
Shoulder	0/1	0/1	0/1	1/0	n/a	0/1	0/1
Trunk	15/13	12/16	0/26***	16/10**	n/a	10/17	0/26***
Leg/Feet	37/7***	16/28	7/35**	29/13***	n/a	29/11***	7/34**
Mother	31/9***	8/32***	33/7***	14/24	n/a	8/28**	30/7***
Clothes	2/25***	1/26***	12/13	5/21	n/a	1/24***	20/6***
Chair	9/27*	34/2***	17/20	12/23	n/a	28/7***	5/29**

Note. For each behaviour pair, the values represent the number of observations in which the observed probability of co-occurrence was greater than expected compared with the number of observations in which the expected probability of co-occurrence was greater than the observed (obs.>exp., exp.>obs.).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2

Co-occurrences Between Type and Area of Touch during the SF Interaction Period

	Types of touch						
	Static	Stroke	Grab	Finger	Mouth	Pat	Pull
Areas of touch							
Face	3/17**	14/6**	0/17***	8/11	n/a	6/14	2/16**
Mouth	n/a	n/a	n/a	n/a	18/0***	n/a	n/a
Arm	6/14	7/13	10/9*	6/13	n/a	5/15	4/15
Shoulder	2/1	1/2	0/3	1/2	n/a	0/3	0/3
Trunk	16/17	13/20	1/28***	18/15**	n/a	16/17*	0/31***
Leg/Feet	38/6***	16/28*	12/27	36/7***	n/a	32/12**	10/31*
Mother	0/0	0/0	0/0	0/0	n/a	0/0	0/0
Clothes	3/35***	2/36***	10/25	9/29**	n/a	0/38***	35/1***
Chair	16/23	37/2***	3/33***	10/28*	n/a	24/15*	12/26

Note. For each behaviour pair, the values represent the number of observations in which the observed probability of co-occurrence was greater than expected compared with the number of observations in which the expected probability of co-occurrence was greater than the observed (obs.>exp., exp.>obs.).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3

Co-occurrences Between Type and Area of Touch during the reunion Normal Interaction Period

	Types of touch						
	Static	Stroke	Grab	Finger	Mouth	Pat	Pull
Areas of touch							
Face	1/10*	8/3*	0/10**	1/8	n/a	4/6	1/9
Mouth	n/a	n/a	n/a	n/a	22/0***	n/a	n/a
Arm	8/8	2/14*	5/11	4/12	n/a	3/13	4/12
Shoulder	0/1	0/1	0/1	0/1	n/a	1/0	0/1
Trunk	19/11**	12/17	0/27***	15/14	n/a	14/15	0/28***
Leg/Feet	32/9***	19/20	8/30**	34/7***	n/a	28/11***	5/33***
Mother	28/11***	25/0***	32/4***	10/27*	n/a	8/29**	25/12***
Clothes	2/26***	5/22*	12/14	8/19	n/a	0/26***	18/8***
Chair	9/30**	31/6***	5/31**	6/32**	n/a	23/14**	8/30**

Note. For each behaviour pair, the values represent the number of observations in which the observed probability of co-occurrence was greater than expected compared with the number of observations in which the expected probability of co-occurrence was greater than the observed (obs.>exp., exp.>obs.).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4

Differences Between Behaviour Pairs as a Function of Interaction Period

	SF vs. Normal 1	Normal 3 vs. SF	Normal 3 vs. Normal 1
Behaviour Pair			
Notouch-noarea	24/18	17/25	17/25
static-face	3/6	6/2	3/2
static-arm	n/a	n/a	n/a
static-shoulder	n/a	n/a	n/a
static-trunk	n/a	11/15	13/13
static-leg	21/20	20/23	22/20
static-mom	37/0***	0/35***	24/14
static-clothes	4/7	7/4	5/3
static-chair	n/a	26/8*	19/9
stroke-face	4/15*	16/6*	4/8
stroke-arm	n/a	6/5	2/5
stroke-shoulder	n/a	n/a	n/a
stroke-trunk	n/a	n/a	n/a
stroke-leg	5/34***	32/8**	n/a
stroke-mom	24/0***	0/25***	12/18
stroke-clothes	1/8*	7/5	1/7*

Note. For each behaviour pair, the values represent the number of observations in which the observed probability of co-occurrence was greater in the period to the left than the period to the right compared to the number of observations in which the observed probability of co-occurrence was greater in the period to the right than the period to the left.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4 con'd

stroke-chair	11/29**	28/8***	20/15
grab-face	0/0	0/0	0/0
grab-arm	5/9	10/3	5/5
grab-shoulder	n/a	n/a	n/a
grab-trunk	0/1	1/0	0/0
grab-leg	3/15**	14/6**	6/7
grab-mom	36/0***	0/34***	25/16
grab-clothes	n/a	n/a	n/a
grab-chair	11/15	18/3**	12/2*
finger-face	0/8*	n/a	0/1
finger-arm	n/a	n/a	n/a
finger-shoulder	n/a	n/a	n/a
finger-trunk	10/18	20/10*	13/9
finger-leg	10/32**	32/8***	13/23
finger-mom	n/a	0/23***	14/13
finger-clothes	6/12	12/7	7/9
finger-chair	n/a	22/2***	15/6
mouth-mouth	18/9	11/16	12/16
pat-face	n/a	n/a	n/a
pat-arm	n/a	n/a	n/a

Note. For each behaviour pair, the values represent the number of observations in which the observed probability of co-occurrence was greater in the period to the left than the period to the right compared to the number of observations in which the observed probability of co-occurrence was greater in the period to the right than the period to the left.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4 con'd

pat-shoulder	n/a	n/a	n/a
pat-trunk	5/16**	15/9**	n/a
pat-leg	7/31***	31/10**	15/17
pat-mom	16/0***	0/17***	13/11
pat-clothes	1/5	6/3	1/3
pat-chair	11/20*	25/8***	22/10
pull-face	0/1	2/1	0/1
pull-arm	n/a	n/a	n/a
pull-shoulder	n/a	n/a	n/a
pull-trunk	1/2	2/0	1/0
pull-leg	4/20***	20/2**	7/6
pull-mom	31/0***	0/31***	23/16
pull-clothes	7/29***	30/7***	14/13
pull-chair	5/21***	22/4***	12/4*

Note. For each behaviour pair, the values represent the number of observations in which the observed probability of co-occurrence was greater in the period to the left than the period to the right compared to the number of observations in which the observed probability of co-occurrence was greater in the period to the right than the period to the left.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Discussion

The present study had three main objectives. The first objective was to document the types and areas of touch used by 5 ½-month-old, healthy, full-term infants during their social exchanges with their mothers. The second objective was to investigate how the percent duration of these types and areas of infant touch varied across periods of mother-infant interactions. The third objective was to examine whether specific behaviour pairs of types and areas of touch co-occurred to a degree significantly greater or less than expected by chance, and whether these co-occurrences varied with the period of mother-infant interaction. In general, the results of the present study supported the hypotheses. First, the percent duration of the types and areas of infant touch varied as a function of period of mother-infant interactions. Second, specific behaviour pairs co-occurred to a degree greater or less than expected by chance and these behaviour pairs varied according to mother-infant interaction periods.

With respect to the first objective of the present study, results demonstrated that infants touched for 85% of the time during brief interaction periods with their mothers. Specifically, infants spent most of this time engaged in static touch, followed by stroke, pull, finger, pat, mouth, and grab. With respect to the areas on which this touch occurred, infants spent the most time touching their feet, followed by the infant seat, their mothers, their clothes, their trunks, their mouths, their arms, and finally, their faces and shoulders. Thus, it seems that infants used passive forms of touch more than active types of touch and they exhibited preferences for touching specific areas of their bodies during face-to-face social exchanges with their mothers. These findings suggest that, like their mothers, infants spend a considerable portion of their time using a variety of touch behaviours

during brief periods of mother-infant interactions, thereby supporting previous research (e.g. Stack & Muir, 1992; Stack, 2001) indicating that touch is pervasive during mother-infant interactions.

With regard to the second and third objectives of the current study, results generally supported the hypotheses that the percent duration of Types and Areas of infant touch and their co-occurrences vary as a function of interaction period. Most of the differences emerged between the SF and the Normal interaction periods, suggesting that infants demonstrate their sensitivity to maternal availability through changes in their tactile behaviours during the SF period (i.e. they exhibit a SF effect through touch). Nevertheless, differences were also found between the Normal periods, which supports the hypothesis that a carry-over effect would emerge through infant touch.

Results revealed that infants spent more time using stroke, finger, pat, and pull during the SF compared to the Normal interaction periods, and more static touch during the Normal relative to the SF period. Furthermore, infants spent more time touching their faces and shoulders, their feet, their clothes, and the infant seat during the SF relative to the Normal interaction periods, and they spent more time touching their arms during the SF relative to the first Normal interaction period. Finally, infants demonstrated reliable co-occurrences between their types and areas of touch, some of which were found to vary across interaction periods. In particular, infants spent more time engaging in stroke-face, stroke-leg, stroke-chair, grab-leg, finger-leg, pat-trunk, pat-leg, pat-chair, pull-leg, pull-clothes, and pull-chair during the SF compared to either Normal interaction period.

These findings suggest that infants are sensitive and attuned to changes in their mothers' behaviours during social interchanges. Previous research investigating infants'

sensitivity to changes in their partners' behaviour has mainly focused on infants' distal communicative modalities. For example, during a SF period following a Normal period, infants have been found to display a decreased amount of gazing at their mothers, less smiling, increased grimacing, and more neutral to negative affect (Ellsworth, Muir, & Hains, 1993; Gusella, Muir & Tronick, 1988; Mayes & Carter, 1990; Segal et al., 1995; Stack & Muir, 1992). The results of the current study extend beyond this research by revealing that the SF effect includes infants' tactile behaviours as well. That is, the present results suggest that infants display their responses to maternal unavailability and the violation of social expectations of reciprocity through their touch behaviours. These findings support the SF effect and imply that future investigations of the SF effect should include infants' tactile behaviours.

Although most research examining infant communication across periods of a SF procedure has not focused on infants' proximal behaviours, some studies have nevertheless superficially investigated infant touch. In particular, findings from the present study generally confirm Murray and Trevarthen's (1985) results that 2-month-old infants display increased handling of their clothes, touching of the face, and sucking of their fingers during the SF period compared to the Normal and Reunion periods. Moreover, they are generally consistent with Toda and Fogel (1993)'s findings that 3- and 6-month-old infants exhibit an increase in grasping and touching of the infant seat or their clothing during the SF compared to the Normal interaction periods. However, while infants in the present study did touch the infant seat and their clothes more during the SF compared to the Normal interaction periods, they did not spend more time touching their faces and sucking their fingers (i.e. mouthing), as was found in Murray and Trevarthen's

(1985) study. A possible explanation for this discrepancy is that the occurrence of infant mouthing was low in the present study, and thus, a floor effect likely prevented any differences in infants' mouthing behaviour across periods from being detected. Moreover, infants in the present study were older than those in Murray and Trevarthen's (1985) study, which might also account for differences in infants' mouthing behaviours between these two studies.

In contrast to Toda and Fogel's (1993) study, the present study did not reveal a difference in the amount of time infants spent grasping between interaction periods. One explanation for this inconsistency may be that infant grasping behaviours were coded differently in the two studies. Because the present study used more specific and discrete categories of infant touch than Toda and Fogel (1993), it is possible that in the latter study, a broader array of infant tactile behaviours was coded under the grasping category, and thus, more differences in grasping behaviour emerged across interaction periods. Despite these differences, the present study generally seems to replicate the findings from these earlier studies and also provides a more detailed account of the changes in infant tactile behaviours across periods of mother-infant interaction.

In addition to demonstrating a SF effect through infants' tactile behaviours, a carry-over effect was also observed in the present study. Previous research examining infants' communicative behaviours across interaction periods of a still-face procedure have demonstrated that in the Reunion Normal period, infants continue to display negative affect and they exhibit more grimacing and crying during the Reunion Normal relative to the SF period (Cohn, 2003; Weinberg & Tronick, 1996). In the present study, differences in infants' tactile behaviours between the first and Reunion Normal periods

were also indicative of a carry-over effect. Although it is possible that these differences were a result of time or fatigue effects, this is unlikely since previous studies, some of which had more interaction periods and all using control groups for time (e.g. Gusella, Muir, & Tronick, 1988; Stack & Arnold, 1998; Stack & Lepage, 1996; Stack & Muir, 1990), did not reveal changes in infants' behaviours as a function of time.

In the present study, although there was no support for the hypothesis that specific types and areas of infant touch would vary between the first and Reunion Normal interaction period, differences in co-occurrences of infants' behaviours between these two periods were revealed. In particular, infants spent more time engaged in stroke-clothes during the Reunion Normal relative to the first Normal period and they spent more time engaged in grab-chair and pull-chair during the first Normal relative to the Reunion Normal period. Thus, despite mothers playing with their infants as they normally would in the Reunion Normal period, infants exhibited changes in their tactile behaviours during this period relative to the first Normal period. These findings are consistent with previous research examining infants' distal modalities (Cohn, 2003; Weinberg & Tronick, 1996) and suggest that infants' responses to the SF period are carried over to the Reunion Normal period.

It is possible that no differences emerged in specific infant tactile behaviours between the first and Reunion Normal interaction periods because of the method used to code infant touch. Infant touch was not coded when mothers initiated contact with their infants and if infants did not actively manipulate their hands when in contact with their mothers. Moreover, if infants grabbed their mothers' hands or fingers and then held on while mothers actively moved their infants' hands around, static touch was coded. That

is, if mothers did not display changes in their tactile behaviours when touching their infants during the first and Reunion Normal periods, then the amount of time infants spent not touching or using static touch would not differ. It is possible, then, that any real differences in infants' tactile behaviours between these two periods were not detected because of the method used to code infant touch. In contrast, it is possible that differences between infants' co-occurring tactile behaviours emerged between the first and Reunion Normal interaction periods because more information about infant touch was provided (i.e. touch was combined with area). That such differences were found in infants' co-occurring behaviours highlights the importance of incorporating multiple sources of information and of studying infants' communicative behaviours in combination with each other. These findings, combined with those revealing a SF effect through infant touch, suggest that infants are sensitive to changes in maternal behaviours, that infants exhibit this sensitivity through touch, and that this sensitivity carries over even after mothers are interacting with their infants as they normally would.

The fact that differences in infants' tactile behaviours were found across interaction periods suggests a communicative function for infant touch. By modifying their tactile behaviours according to changes in maternal availability, infants impart information to their social partners about their needs, desires, and goals, thereby suggesting that infants communicate their underlying affective states through touch. These findings are consistent with studies examining *maternal* touch, which demonstrate that different types of touch communicate various social messages (Stack, 2001; Tronick, 1995). Moreover, by demonstrating that certain tactile behaviours co-occur to a degree significantly greater or less than expected by chance with specific locations (e.g. stroke-

chair, grab-leg, pat-trunk, and pull-clothes), the messages infants convey through touch are clarified by the area of the body on which this touch occurs. Nevertheless, since it has been suggested that infants' communicative messages are elaborated through multiple modalities (Weinberg & Tronick, 1994), infant touch should be examined in combination with their other communicative modalities (e.g. gaze, affect, vocalizations) in order to obtain an even greater understanding of the meaning of specific types of infant touch.

Because the SF period has been suggested to be distressing for infants (Brazelton & Cramer, 1990), it is possible that, in addition to a communicative function, infants utilized their tactile behaviours to regulate their emotions when mothers were unavailable and violating social expectations. Furthermore, the increase in infants' active types of touch during the SF relative to the Normal interaction periods suggests that infants used touch to explore when mothers were unavailable. As a consequence, in order to address the possible roles of infant touch (i.e. communicative, regulatory, exploratory) across periods of mother-infant interactions, follow-up analyses were conducted where specific types and areas of infant touch were grouped together based on their hypothesized function. These touch/area groups were then compared across interaction periods.

First, all types of infant touch were compared with static touch across interaction periods in order to examine whether infants used certain types of touch to self-regulate during the SF period. Across interaction periods, it was found that infants spent more time using types of touch from the 'other' category than static touch. Moreover, they displayed a significantly greater amount of 'other' types of touch during the SF period relative to the first and Reunion Normal interaction periods. While these results support the hypothesis that touch serves a regulatory function for infants, they are not precise

enough to firmly conclude that infants actually used touch to self-regulate during the SF period.

To more specifically address whether infants used touch to self-regulate during the SF period and to investigate which types of infant touch serve a regulatory function, the category of 'other' types of touch was broken down into two categories of regulatory behaviours: stroke, finger, and mouth were categorized into a soothing/regulatory category; and pat, pull/push, and grab were categorized into a reactive/regulatory category. Findings revealed that infants spent more time exhibiting types of touch from the reactive/regulatory category during the SF compared to both Normal interaction periods and they displayed more types of touch from the soothing/regulatory category during the SF compared to the first Normal period. These findings support the first set of findings, implying that infants use touch to engage in self-regulation, and suggest that infants may exhibit both soothing and reactive types of touch to self-regulate during periods of distress.

Taken together, these results are consistent with previous research demonstrating that infants use touch for regulatory purposes. The findings revealing that infants engage in more soothing and reactive behaviours during the SF period are consistent with research demonstrating that infants exhibit an increase in mouthing and grasping during the SF relative to the Normal interaction periods (Toda & Fogel, 1993; Murray & Trevarthen, 1985). Mouthing and grasping have been suggested to be comforting behaviours for infants (Braungart-Rieker, Garwood, Powers, & Notaro, 1998; Field, 1994; Mayes & Carter, 1990). In addition, the current results support previous assertions that certain other types of touch serve a regulatory function (e.g. physically distancing

themselves from their mothers through pushing and pulling in the infant seat; Gianino, 1985).

Continuing to investigate whether infants used touch to self-regulate during the SF period, areas of infant touch were categorized into no area, touching of the self, mothers, clothes, and the infant seat. The only difference between this analysis and the original analysis examining areas of infant touch was that all areas on infants' bodies were collapsed into one self-category. Results revealed that, across interaction periods, infants spent the most time touching themselves, followed by their mothers, the infant seat, and finally, their clothes. Of particular interest, infants touched themselves more during the SF compared to the first Normal interaction period, and they touched their clothes and the infant seat more during the SF compared to the both Normal interaction periods (SF effect). These findings are consistent with previous research demonstrating that infants touch their clothes and the infant seat in order to manage their emotions and possible distress during the SF period (Field, 1994; Mayes & Carter, 1990) and thus, suggest that infants regulate their emotions through self-touch, touching of their clothes, and touching of the infant seat. Nevertheless, the findings from the analyses investigating whether infants use touch for regulatory purposes, can also be interpreted as infants engaged in more self- (i.e. touching their bodies) and other- (i.e. touching their clothes and the infant seat) exploration during the SF compared to the Normal interactions periods. That is, it is possible that infants spent more time using 'other' types of touch during the SF period in order to explore their surroundings.

In support of the hypothesis that infants used touch for exploratory purposes and, that they increased their self- and other-exploration during the SF period (i.e. when

mothers were unavailable) infants' tactile behaviours were grouped into two categories: active versus passive types of touch. Specifically, stroke, finger, pat, and pull were grouped into the active types of touch category; and static and grab were clustered into the passive types of touch category. Mouthing was removed from this analysis due to it being an oral modality. Findings revealed that infants displayed more active types of touch during the SF relative to the Normal interaction periods. Moreover, results of co-occurrence analyses demonstrated that active types of infant touch reliably co-occurred with infants' clothes and the infant seat (e.g. stroke-chair, pat-chair, pull-clothes) more during the SF than the Normal interaction periods. Since the active category was representative of exploratory tactile behaviours, these findings imply that when mothers are unavailable, infants engage in more self- and other-exploration. These results are consistent with previous research, demonstrating that 6-month-olds' touching of their clothes and the infant seat co-occurred with gazing at the proximal environment during the SF period, suggesting that infants increase their exploratory behaviours during this interaction period (Toda & Fogel, 1993).

By touching themselves and their environments when mothers are unavailable, infants learn about themselves and the stimuli around them (Rochat, 2001). Neisser (1991) labelled infants' implicit knowledge of the self 'the ecological self,' and this self develops as infants produce actions on objects and self-explore (Rochat, 2001). For example, when infants touch themselves, they experience a unique perceptual experience, called 'double-touch,' whereby both infants' hands and the area on the body on which they are touching receive tactile stimulation. This experience enables infants to distinguish between their own bodies and objects around them. Thus, infant touching

during mother-infant interactions has important implications for the development of infants' self-identities.

The findings that infants exhibited more active touching during the SF period can also be interpreted as infants used touch for regulatory purposes during the SF period. One way to disentangle whether touch serves an exploratory or a regulatory function for infants is for future research to examine how infants' tactile behaviours vary within the SF period itself. For example, the regulatory function of infant touch might be expected to surface towards the end of the period, when infants are no longer attempting to re-engage their mothers and have withdrawn from the interaction (Brazelton & Cramer, 1990).

It is also possible that infants' self- and other-exploration may serve a soothing function for infants during periods of distress, such as the SF period. That is, perhaps it is not a question of whether infants use touch to explore or to self-regulate during the SF period, but rather one of *how* infants use touch to self-regulate, with one method being increasing their exploratory tactile behaviours. This exploration would not only enable infants to learn about themselves and their environments, but would also enable them to re-direct their attention away from stressful stimuli (i.e. their still-faced mothers) and provide an alternate and more positive source of stimulation when mothers are unavailable (Gianino & Tronick, 1988; Rothbart, Ziaie, & O'Boyle, 1992; Tronick, 1989). Consistent with this hypothesis, Weinberg and Tronick (1994) demonstrated that infants display an increase in the affective configuration of object engagement (i.e. facial expressions of interest, looking at the infant seat/strap/clothing, scans, and mouthing the infant seat/strap/clothes) during the SF relative to the Normal periods. However, in this

study, infant tactile behaviours were only superficially examined. Results from the present study, which comprehensively investigated infants' tactile behaviours, suggests that by increasing their exploratory tactile behaviours, infants are also engaging in self-regulation. However, an examination of infants' other communicative behaviours was not conducted in the present study, consequently these results alone cannot lead us to firmly conclude that infants use touch to self-regulate during the SF period. Thus, future research should examine infants' tactile behaviours in combination with their other communicative modalities, such as their gaze and body movements. For example, future research might investigate whether infant gaze at the proximal or distal environment co-occurs with active versus passive types of touch and with touching of their clothes or the infant seat. If infant gaze at the proximal environment is shown to co-occur with active touching of infants' clothing or the infant seat, this would provide more direct evidence for the claims that infants re-direct their attention during the SF period and that self-exploration serves a regulatory function for infants.

Results from the analyses investigating infants' active versus passive types of touch also demonstrated that infants used more passive types of touch during the Normal interaction periods, where they were engaged in playful interaction with their mothers. Moreover, co-occurrence analyses supported these results by demonstrating that passive types of infant touch co-occurred with touching of their mothers (e.g. static-mother, grab-mother) during the Normal periods. It is possible that infants used more passive types of touch when touching their mothers because their mothers were using more active types of touch with them. In line with this interpretation, research examining both maternal and infant touch during their social exchanges has demonstrated that mothers display a

preference for lifting their infants and this type of touch is significantly associated with touching of their infants' hands (Girouard, Jean, Moszkowski & Stack, 2003). Additionally, mothers' lifting was correlated significantly with infant static touch, suggesting that when mothers use active types of touch to stimulate their infants, their infants employ more passive types of touch (Girouard et al., 2003). However, because maternal touch was not examined in the present study, it is not known whether passive types of infant touch co-occurred with active types of maternal touch in the present study.

Implications and Future Directions

The present study provides an in-depth examination of the types and areas of touch used by infants during normal and still-faced interactions with their mothers. The results from the present study are consistent with previous findings (Ellsworth, Muir, & Hains, 1993; Gusella, Muir, & Tronick, 1988; Mayes & Carter, 1990; Segal et al., 1995; Stack & Muir, 1992; Weinberg & Tronick, 1996) suggesting that infants are sensitive to changes in their mothers' behaviours and that they respond to these changes by modifying their own behaviours. The present study extends beyond previous research by demonstrating that infants exhibit these changes through their own tactile behaviours as well. In other words, the previously demonstrated SF and carry-over effects include infants' tactile behaviours.

More importantly, however, the present study underscores the pervasive use of infant touch during mother-infant interactions. During these social exchanges, it seems that touch plays a communicative, regulatory, and exploratory role. That is, infants communicate their underlying affective states to their mother through touch, thereby supplementing the information they supply through their other communicative

modalities. This additional information is especially critical during the pre-verbal stage of development, as infants cannot yet verbalize their needs and wants, and this additional information increases the probability that mothers will appropriately receive and respond to the messages infants convey during their social interchanges (Weinberg & Tronick, 1994). However, while the present study provided an initial step in elucidating the communicative role of infant touch, a more in-depth analysis of infant touch (alone and in conjunction with infants' other communicative modalities) is warranted in order to obtain a greater understanding of the specific messages conveyed through particular types of infant touch. Moreover, while the percent duration of the types and locations of infant touch were examined, the speed, intensity, and extent of infant touch were not investigated in the current study. Since it has been suggested that an examination of these components of touch is critical to obtain a more complete understanding of the communicative role of infant touch (Hertenstein, 2002; Stack, 2001; Tronick, 1995), future research investigating infant touch should also incorporate an examination of these additional characteristics.

The results from the present study also imply that touch serves a regulatory function during the SF period. It is hypothesized that infants regulate their emotions through self- and other-exploration, which enables infants to avert their attention from the source of distress (i.e. their mothers) during the SF period and re-orient themselves towards more positive sources of stimulation (Gianino & Tronick, 1988; Rothbart et al., 1992; Tronick, 1989). As already mentioned, whether infants' exploratory tactile behaviours serve a regulatory function cannot be firmly concluded based on the results of this study alone. Future research should examine infants' tactile behaviours in

combination with other of their communicative behaviours (e.g. gaze, affect, gesticulations, and body movements) across periods of mother-infant interactions. By demonstrating which types of infant touch co-occur with other infant communicative behaviours, *how* infants use touch to regulate their emotions and which types of infant touch serve a regulatory function in conjunction with other communicative modalities will be elucidated.

Finally, the results of the present study suggest that by engaging in active tactile behaviours, infants use touch as a means of self- and other-exploration. More specifically, by engaging in tactile exploration, infants learn about the unique features of their own bodies and they learn to differentiate themselves from others around them (Rochat, 2001). As a result, touch has important implications for infants' developing self-identity and contributes towards the development of infants' ecological self (Neisser, 1991; Rochat, 2001). To more thoroughly examine how infant touch contributes to the development of their sense of self, longitudinal investigations of infant tactile exploration during their early social exchanges is warranted. While previous research has examined infant tactile exploration longitudinally (Tsonis, 2002), this has not been conducted within the context of their early interactions with their mothers.

By investigating infants' tactile behaviours within the context of their early social exchanges over time, a more in-depth understanding of infants' communicative skills and how they develop will be obtained. Previous research has examined how infants' distal communicative behaviours become increasingly sophisticated over time (Trevarthen, 1977) and how mothers modify their tactile behaviours according to the development stage of their infants. For example, Arnold (2002) examined changes in

infants' gaze and affect from 3 ½ to 5 ½ months of age during various interactive contexts and Arnold (2002) and Jean (2003) investigated changes in mothers' tactile behaviours over the course of the first few months of their infants' lives. However, as research has neglected to study *infants'* tactile behaviours during their social exchanges, no attention has been paid to the developmental changes in infant touch within this interactive context. By investigating infant touch longitudinally, the ontogeny of infant touch as a means of communication, how infants become increasingly adept at communicating through touch, and the other roles that infant touch may serve for infants will be elucidated.

Furthermore, as the first study to examine the types and areas of infants' tactile behaviours during their mother-infant interactions, this study provides a baseline of the typical types of touch exhibited by healthy, full-term infants during their social exchanges. An important step for future research will be to compare touch in at-risk (e.g. very low birth weight/preterm infants) and healthy, full-term infants in order to investigate differences in their tactile behaviours. While previous research has compared the distal communicative behaviours of these populations (Arnold, 2002; Segal et al., 1995), no research has compared their tactile behaviours. By comparing touch in these populations, group differences in infants' communicative, regulatory, exploratory, and motor skills as a function of risk-status will be more extensively revealed.

Moreover, to obtain a better understanding of infants' communicative skills and particularly, how infants communicate through touch, future research should investigate the co-occurrence between infant and maternal touch. As with studies examining infants' distal communicative modalities (e.g. gaze, affect; Legerstee, Corter, & Kienapple,

1990), by examining the social context (active or contingent mother, passive or non-contingent mother) under which particular types of infant touch occur, researchers can clarify the meaningfulness of specific types of infant touch. Thus, by examining which types of infant and maternal touch co-occur, researchers will elucidate when infants use particular types of touch, thereby elucidating the messages infants convey through touch.

The communicative function of infant touch will also be more clearly brought to light through sequential analyses investigating infant and maternal touch. By investigating which types of infant touch follow specific types of maternal touch, infants' sensitivity to changes in maternal behaviour will be further illuminated. In the present study, changes in infants' tactile behaviours were examined following alterations in mothers' behaviours across multiple modalities. Moreover, previous research has examined infants' sensitivity to maternal touch through their distal communicative modalities (e.g. Stack & Lepage, 1996; Stack & Arnold, 1998). However, no research has investigated infants' sensitivity to changes in maternal touch through infants' tactile behaviours. Thus, through sequential analyses focused solely on infant and maternal touch, it will be possible to determine how infants respond following specific maternal tactile behaviours and the impact of infant touch on mothers will be elucidated.

Conclusions.

Results from the present study documented the types of touch used by 5 ½ month-old infants during their early social exchanges, thereby providing an initial step in elucidating the role of infant touch during mother-infant interactions. Several important conclusions can be drawn from the present study. First, infants spend a significant portion of their time using touch during interactions with their mothers. Second, the types and

areas of infant touch, and their co-occurrences, vary with the period of mother-infant interactions, which suggests that infants are sensitive to changes in maternal behaviour and that infants communicate through touch. One implication of these findings is that the SF effect should now be extended to include infants' tactile behaviours. Third, infants appear to use certain types of touch to self-regulate during the SF period, and they spend more time touching themselves, their clothes, and the infant seat during this period. As such, touch may serve a regulatory role for infants during periods of distress. Fourth, infants exhibit more active types of touch during the SF period (when mothers are unavailable) relative to the Normal interaction periods, suggesting an exploratory role for infant touch. Such self- and other-exploration during the SF period may also serve a regulatory function for infants by providing them with more positive sources of stimulation (or notably, *a* source of stimulation) when mothers are unavailable. Taken together, the current study underscores the importance of touch as a modality of infant communication, regulation, and exploration during mother-infant interactions and provides a foundation for future research on infant touch during social exchanges.

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Appendix A

English Consent Forms

Consent Forms
Mother-Infant Interactions

This study is designed to look at infants' responses during social interaction and to study the different types of interaction used by caregivers and their role in social exchange.

I understand that my baby and I will participate in a study lasting approximately 60 minutes. In the first part, my baby will be seated in an infant seat directly facing me. The procedure will consist of several interaction periods, each lasting two to three minutes in length, during which time I will be asked to interact in different ways with my baby. During some periods I will be asked to interact with my baby as I normally do, while in others I will be asked to pose a neutral, still facial expression and remain silent for a brief period. There will be brief breaks separating the interaction periods. In the second part, my baby and I will play together on a carpeted floor for approximately 8 minutes in a designated area, during which time I will be asked to play with my baby as I normally would at home. Under no circumstances will any manipulation be harmful to my baby. Finally, I will be asked to complete several brief questionnaires.

The entire session will be videotaped so that at a later point my baby's responses may be scored. However, these recordings are kept in the strictest confidence and are not shown to others without my permission.

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 of my baby 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. I am also aware that I may be asked to participate again when my baby is 12 and 18 months of age.

In the event that I have any unanswered concerns or complaints about this study, I may express these to Dr. Dale Stack (848-2424, ext. 7565), Dr. Lisa Serbin (848-2424, ext. 2255) or Dr. Alex Schwartzman (848-2424, ext. 2251) of the Psychology Department at Concordia University. In addition, the patient representative of the Jewish General Hospital is Mrs. Laurie Berlin (340-8222, ext. 5833). She can be contacted should I have any questions regarding my rights as a research volunteer.

Thank you for your cooperation.

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

Parent's signature on behalf of child: _____ Date: _____
Parent's signature: _____ Date: _____
Witness: _____ Date: _____

Appendix B

Demographic Questionnaire

Mother-Infant Interaction
(Revised, August 28, 1997)

Demographic Information

Order:

Study #: _____
Infant #: _____
Test Date: _____

Infant's Name: _____

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

Mother's Name: _____ Age: _____

Lang. 's Spoken: _____

Father's Name: _____ Age: _____

Lang.'s Spoken: _____

Ethnic origin: _____

Phone #: _____

Address: _____
_____

Birth Weight: _____ Length of Labour: _____

Preg. Complications and Delivery Status: _____
_____

Medical History: _____
_____
_____

Breast fed: _____ Bottle fed: _____

Siblings:	Age	Sex
	_____	_____
	_____	_____
	_____	_____

Mother's Occupation: _____ Education: _____

Father's Occupation: _____ Education: _____

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

_____

Father's 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, since when) :

_____

_____

Comments: _____

_____

_____

Would you be interested in participating in future studies conducted at the Centre for Research in Human Development (CRDH) ? _____

In 6 months: _____ In 12 months: _____

Date: _____

Appendix C

Operational Definitions for Infant Touch Scale

INFANT TOUCH SCALE (ITS)

A coding scheme designed to document infant touch during their early social interactions

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This systematic coding scheme is designed to document the types and areas of touch in 5 ½-month-old infants during their interactions with their mothers. This coding scheme complements the Caregiver Infant Touch Scale (CITS), which documents quantitative and qualitative components of maternal touch within the context of early mother-infant interactions.

Note: Though this coding scheme was specifically developed to document the tactile behaviour of 5 ½-month-old infants, the categories of touch in this scheme are broad enough to be applicable to younger and older infants.

CODING OF INFANT TOUCH

Infant touch is only coded if the infant has initiated contact with the stimulus or if the infant has actively manipulated his/her hands when in contact with a stimulus.

For example, when the mother and infant are in contact with each other, infant touch should only be coded if the infant has actively manipulated his/her hand(s). Alternately, if contact between mother and infant has been initiated solely by the mother while the infant remains passive, then infant touch is not coded so as not to be redundant with the Caregiver-Infant Touch Sale.

If contact with the mother has been initiated by the infant and the mother is actively manipulating the infant's hand, the static touch category of infant touch should be used.

TYPES AND AREAS OF INFANT TOUCH

Types of Touch

1. Static Touch
2. Rub/Caress/Wipe/Stroke
3. Grasping/Clutching/Clasping
4. Manipulating/Fingering/Scrumble/Poke/Prod
5. Mouthing
6. Tap/Pat
7. Pull/Push/Clap/Lift
8. No code
0. No touch

1. Static Touch

Static touch is defined as the infant's hand touching a stimulus without movement.

All or part of the infant's hand is pressed down on a part of the body, the chair, or the mother's body. The palm can be face down, face up, or the side of the hand can be touching the stimulus, the fingers can be extended or curled, and the hands or fingers can be encircling the stimulus.

If the palm is resting on a surface while the fingers are cycling in the air, this category is still used because the movement of the fingers or hands is not on the stimulus. However, if the infant's finger(s) or hand(s) are moving only minutely, this category should still be used. If the infant's hand is pushing against a stimulus, the Pull/Push/Clap/Lift category, and not this one, should be used.

2. Rub/Caress/Wipe/Stroke

Rub: Strong, repetitive back and forth or circular motion over a stimulus with the hand not breaking contact with the stimulus.

Caress: Soft, gentle, repetitive back and forth or circular movement of the infant's hand or finger(s) over a surface.

Wipe: Rubbing motion of the front or back of the palm against a stimulus (e.g. wiping the eyes).

Stroke: Lateral or flat, repetitive movements involving one or more finger(s) that are typically soft, light, gentle, and slow.

All or part of the infant's hand(s) or finger(s) are moving laterally over a surface in a back and forth or circular repetitive motion. The palm may be face up or down.

If only the tip of the finger is moving over the surface, the manipulate/finger/scrumble/poke/prod category, and not this one, should be used.

3. Grasp/Clutch/Clasp

Grasp/Clutch/Clasp: Seizing, firmly gripping, or holding with the hands or fingers.

The infant curls all or some of his/her fingers, including or excluding the thumb, around the stimulus.

If one of the infant's hands is gripping all or part of the other or if one or more finger(s) from both hands are intertwined, this category is used. If the infant is repeatedly curling his/her finger(s) around a stimulus, this category is also used. In contrast, if the hands or

fingers simply brush one another or make any haphazard contact, this category is not used.

4. Manipulate/Finger/Scrumble/Poke/Prod

Manipulate: Handling with the fingers.

Finger: Running of the fingertip(s) over the surface of a stimulus.

Scrumble: Flexing and extending of the fingers in a repetitive manner over the surface of the stimulus. The wrist is usually anchored and there is minimal arm and shoulder movement.

Poke/Prod: Motion of putting pressure over a small surface with one or more finger(s). Usually this type of touch is repetitive and involves the index finger or the first two fingers.

The infant runs the tip of his/her finger(s) over a surface, generally in random fashion.

If the infant's palm(s) is resting on a surface while the fingers are clearly moving over this surface, this category should be used.

5. Mouthing

This category is used when the stimulus (e.g. infant hand or fingers) comes into contact with the infant's mouth, including the lips and outside of the mouth. The infant's hands or fingers may be static, moving around or rotated in the mouth, or they may be pressed against the outside of the infant's mouth.

6. Tap/Pat:

Tap: Focal, light, quick movement using mainly the fingertips. Gentle hitting with a quick light blow.

Pat: Up and down motion of the hand against a surface. This type of touch typically involves slight sweeping movements that are unidirectional and often reflexive.

The pat or tap may occur once or repetitively. The hand may be open or closed.

7. Push/Pull/Clap/Lift:

Push: Pressing of all or part of the hand against a surface with varying degrees of pressure. If the infant pushes the chair with his/her hands in order to readjust his/her position on the chair, this category is used.

Pull: Pulling of a stimulus with the hands.

Clap: Striking of the hands against each other.

Lift: Raising a stimulus to a level higher than its original position.

8. No code

The type of infant touch cannot be coded because part or all of the infant's hand(s) are obstructed or the area where the infant is touching is obstructed.

0. No touch

The infant is not touching a stimulus.

Areas of Infant Touch

1. Face/Head
2. Mouth
3. Hands/Arms
4. Shoulder/Neck
5. Trunk (chest/belly)
6. Feet/Legs
7. Mother
8. Chair
9. Clothes
10. No code
0. No touch

CODING DETAILS

Coding is done by one-second intervals. That is, for each second of the interaction, one type and one area of touch is coded for the hand that is the most active.

One type of touch, lasting approximately 0.33 seconds, is coded for each interval.

A tactile behaviour is considered to begin when the hand begins to move, even if it is before the hand comes into contact with the stimulus. For example, a pat is considered to begin when the hand is in the air and moving toward the stimulus.

When coding the area of touch, the clothing category is only used when it is clear that the infant is touching only the clothing and not a part of his/her body with and the clothes. That is, if the infant is touching both the clothing and a body part, then the body part is coded. If the infant's hand is resting on clothing, the specific body area being touched, and not the clothes, should be the area coded.

If the infant's hands are partially obstructed (approximately 75% or more) by part of the infant's body (e.g. the feet/legs), a part of the mom's body (e.g. hands), or the chair, do not code for that hand.

Coding should be done with the volume of the coding rig turned off to avoid bias from contextual cues.

SPECIAL CASES AND DECISION MAKING

Dominant touch

One hand: If one hand is using two types of touch within a one second period, code the type of touch that is considered to be more active based on the list of dominant types of touch. If both types of touch employed by the hand are equally active, code the one of longer duration.

Two hands: If both hands are touching an area for 0.5 seconds or longer, the hand that is employing the more active form of touch, based on the list of dominant types of touch, should be coded. If both hands are employing types of touch that have been ranked as equally active, the touch of longer duration should be coded.

Most to least dominant types of touch

1) Tat/Pat, Pull/Push/Clap/Lift, Mouth
2) Rub/Caress/Wipe
3) Manipulating/Fingering/Stroke/Scrumble/Poke/Prod, Grasp/Clutching/ Clasping
4) Static touch
5) No touch

Dominant area

Area of the body: If two areas of the infant's body are being touched simultaneously, the area being touched by the more active hand should be coded. If both hands are using the same type of touch, or one hand touches two areas with the same type of touch, the area of the body on which the touch is of longer duration should be coded. In the rare event of this duration being equal, area should be coded in the following order: mother, face/head, shoulder/neck, mouth, hands/arms, trunk, feet/legs, chair, and clothes. This order has been adopted in order to ensure that low frequency events are captured.

Appendix D

ANOVA Summary Tables

Table D1

Analysis of the Percent Duration of Overall Touch as a Function of Interaction Period

Source	df	F
Period (P)	2	2.90
Error	86	(112.45)

Note. Values enclosed in parentheses represent mean square errors.

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

Table D2

Means and Standard Deviations for the Percent Duration of Type of Touch as a Function of Interaction Period

	Normal		SF		Normal	
Period	*M*	*SD*	*M*	*SD*	*M*	*SD*
Types of touch						
No touch	16.73	14.70	12.10	11.56	16.92	13.82
Static	36.96	18.53	18.97	10.76	35.60	17.92
Stroke	10.30	8.77	16.31	9.89	9.48	8.71
Grab	5.29	3.29	4.99	4.12	4.63	3.54
Finger	7.08	6.16	11.81	5.75	6.33	4.84
Mouth	6.26	10.00	4.45	8.51	9.58	17.11
Pat	5.78	5.03	11.79	9.25	5.16	4.17
Pull	9.76	9.89	17.18	14.73	9.20	10.00

Table D3

Analysis of the Percent Duration of Type of Touch as a Function of Interaction Period

Source	df	F
Touch (T)	7	42.44**
Error	301	(3.92)
Period (P)	2	4.09*
Error	86	(0.69)
T x P	14	8.92**
Error	602	(1.74)

Note. Values enclosed in parentheses represent mean square errors.

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

Table D4

Analysis of the Percent Duration of Static Touch versus Other Types of Touch as a Function of Interaction Period

Source	df	F
Touch (T)	1	50.58**
Error	43	(934.49)
Period (P)	2	0.04
Error	86	(0.00)
T x P	2	26.99**
Error	86	(506.22)

Note. Values enclosed in parentheses represent mean square errors.

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

Table D5

Analysis of the Percent Duration of Static versus Soothing/Regulatory versus Distress/Regulatory Types of Touch as a Function of Interaction Period

Source	df	F
Touch (T)	2	2.44
Error	86	(694.87)
Period (P)	2	1.02
Error	86	(0.69)
T x P	4	14.76**
Error	172	(360.96)

Note. Values enclosed in parentheses represent mean square errors.

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

Table D6

Analysis of the Percent Duration of Active versus Passive Types of Touch as a Function of Interaction Period

Source	df	F
Touch (T)	1	1.44
Error	43	(1083.49)
Period (P)	2	0.61
Error	86	(0.00)
T x P	2	40.14**
Error	86	(471.23)

Note. Values enclosed in parentheses represent mean square errors.

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

Table D7

Means and Standard Deviations for the Percent Duration of Areas of Touch as a Function of Interaction Period

	Normal		SF		Normal	
Period	*M*	*SD*	*M*	*SD*	*M*	*SD*
Areas of touch						
Face/shoulder	0.42	0.96	1.98	3.19	0.48	1.01
Mouth	6.26	10.00	4.43	8.52	9.59	17.11
Arm	0.77	2.06	1.82	3.70	1.63	3.95
Trunk	3.91	5.31	5.99	9.15	4.73	6.73
Leg/Feet	23.85	19.72	35.47	21.69	23.59	16.58
Mother	28.12	23.09	0.00	0.00	25.39	19.77
Clothes	2.72	4.12	10.71	13.31	4.63	8.25
Chair	13.06	14.59	23.50	20.68	8.77	12.34

Table D8

Analysis of the Percent Duration of Area of Touch as a Function of Interaction Period

Source	df	F
Touch (T)	8	49.28**
Error	344	(5.49)
Period (P)	2	0.35
Error	86	(0.74)
T x P	16	24.37**
Error	688	(2.13)

Note. Values enclosed in parentheses represent mean square errors.

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

Table D9

Analysis of the Percent Duration of Touching Self versus Other Areas as a Function of Interaction Period

Source	df	F
Touch (T)	4	51.02**
Error	172	(7.59)
Period (P)	2	8.28**
Error	86	(0.66)
T x P	8	38.26**
Error	344	(2.53)

Note: Values enclosed in parentheses represent mean square errors.

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