Maternal Touch and Infants' Self-Regulatory Behaviors during Face-to-Face Still-Face and Modified Still-Face Interactions

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ABSTRACT

Maternal Touch and Infants' Self-Regulatory Behaviors during Face-to-Face Still-Face and Modified Still-Face Interactions

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Touch serves as one of the primary means of external emotion regulation for infants. Despite the important role for touch in infants' emotion regulation, research examining its relationship to infants' self-regulatory behaviors is scant. Understanding the relationship between internal and external means of regulation, such as touch, is necessary given the pivotal roles caregivers play in infant emotion regulation.

The current dissertation assessed how maternal touch and infants' self-regulatory behaviors contribute to infants' emotion regulation in two studies. Study 1a examined maternal touch and infants' self-regulatory behaviors in full-term and very-low-birth-weight preterm infant-mother dyads during a Still-Face (SF) procedure. Across periods, the functions of touch used by mothers varied while infants increased their use of self-regulatory behaviors during the SF period. Full-term infants displayed more self-comfort regulatory behaviors following the SF period. Furthermore, functions of maternal touch were associated with infants' self-regulatory behaviors. Study 1b examined the association between maternal nurturing touch and infants' self-regulatory behaviors, and infants' smiling and distress level. Mothers of full-term infants were found to increase their use of nurturing touch when their infants exhibited distress. Furthermore, maternal touch and infants' self-regulatory behaviors were associated with infants' smiling.

Study 2 investigated maternal touch and infants' self-regulatory behaviors during a modified Still-Face with Touch (SF+T) procedure consisting of one Normal period followed by three SF+T periods. Maternal touch modulated infants' responses to the SF and their reliance on their own regulatory behaviors. Although mothers varied the functions of touch they used across the periods, infants used similar amounts of self-regulatory behaviors. Finally, maternal touch and infants' self-regulatory behaviors were temporally organized with infants' affect and attention.

Results from these studies highlight the role of maternal touch as a regulatory strategy and mothers' ability to use only one modality of communication, touch, to regulate their infants' affect and attention. Results also extend our knowledge of infants' emotion regulation by documenting the central roles that both mothers and infants play. Finally, results offer insight on the effect of prematurity on infants' self-regulatory abilities and on the quality of maternal touch.

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CHAPTER 1:

GENERAL INTRODUCTION

Touch carries important implication for the developing infant. Its positive influence begins even before the infant is born; touch is the first sensory stimulation experienced by the foetus (Fearon, Hains, Muir, & Kisilevsky, 2002; Kisilevsky, Stack, & Muir, 1991) and serves as the first medium of communication and bonding between mothers and their unborn infants (Montagu, 1986; Stack & Jean, 2011). Benefits of maternal touch for infants' cognitive, neurological, and socio-emotional development are documented throughout infancy (e.g., Feldman, 2011; Field, 2003, 2011; Heller, & Walk, 2011; Stack & Jean, 2011; Underwood, Barlow, Chung, & Stewart-Brown, 2006). For example, positive effects of touch for premature infants have been extensively investigated (e.g., Barnett, 2005; Field, 2010; Feldman, 2011); improvements in infants' self-regulation (arousal and attention), neuromaturation, weight gain, maternal well-being, and features of the parent-infant relationship are also well documented (e.g., Feldman, 2011; Field, Diego, & Hernandex-Reif, 2007; Vickers, Ohlsson, Lacy & Horsey, 2004).

During the first year of life, touch serves as one of the primary means of non-verbal communication (Hertenstein, 2002; Montagu, 1986; Rubin, 1963; Stack & Jean, 2011) and acts as an essential source of external emotion regulation for infants (Hertenstein & Campos, 2001; Stack & Muir, 1990; Weiss, Wilson, Hertenstein, & Campos, 2000). Touch is an essential part of mother-infant interchanges occurring between 33-99% of the total interaction time (Field, 1984; Jean, Stack, Fogel, 2009; Kaye & Fogel, 1980; Symons & Moran, 1987). The duration of maternal touch as well as its

qualitative components such as types, functions, and intensity have been linked to an enhanced overall quality of mother-infant interaction (e.g., Feldman, Singer, & Zagoory, 2010, Peláez-Nigueras, Field, Hossain & Pickens, 1996), to infants' later attachment (e.g., Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1978), and to the development and support of infants' emotion and behavior regulation abilities (e.g., Feldman et al., 2010, Gable & Isabella, 1992; Jean & Stack, 2009; Stack & Jean, 2011).

Early emotion regulation is achieved through internal coping mechanisms, such as self-regulatory behaviors, and with the support of external sources of regulation, such as the caregiver (Adrian, Zeman, & Veits, 2011; Feldman, 2009; Kopp, 1989). In order to support infants' nascent regulation abilities, mothers rely on a number of modalities of regulation such as verbalization, facial expression, and touch. Although maternal touch plays a role in infants' regulation during early social exchanges, research examining its relationship to infants' self-regulating abilities is scant. To date, research has mainly focused on clarifying the influence of touch on infants' emotional expressions while neglecting to investigate its relationship with infants' self-regulating abilities. Understanding the relationship between internal and external sources of regulation, such as maternal touch, is necessary given the pivotal roles caregivers play in the development of infant emotion regulation. Consequently, the two studies making up the present dissertation were designed to simultaneously evaluate the regulatory contributions of maternal touch *and* infants' self-regulating abilities to infants' affect and attention during two modified series of mother-infant interactions, a still-face (SF) paradigm (Tronick, Als, Adamson, Wise & Brazelton, 1978) and a modified SF + touch (SF+T) paradigm (Stack & Muir, 1990, 1992).

The Importance of Mother-Infant Interactions

The relationship between mothers and their infants is fundamental for the developing infant as it builds the foundation for future psychological development while promoting regulation and social understanding (Bridges & Grolnick, 1995; Cohn & Tronick, 1989; Legerstee, 2009; Tronick, 1989). The acquisition of essential communicative, cognitive, social, and emotional skills arises from co-regulated exchanges between mothers and their infants (Cohn & Tronick, 1989; Gianino & Tronick, 1988). During dyadic interchanges, dynamic system theory (Fogel, 1993; Fogel & Garvey, 2007) stipulates that caregivers and infants are constantly influencing and altering each other's behaviors and emotions as a means to reach a state of mutual engagement. This continuous process of mutual influence is referred to as dyadic co-regulation (Fogel & Garvey, 2007). Similarly, the Mutual Regulation Model (Gianino & Tronick, 1988; Tronick & Beeghly, 2011; Tronick & Weinberg, 1997) posits that during mother-infant interactions both partners are constantly trying to achieve a state of reciprocity. Through their affective displays, infants communicate their needs and desires, and in response mothers adjust their behaviors accordingly. By sensitively responding to their infants' bids, mothers are reinforcing infants' sense of efficacy and their emerging self-regulating abilities (Gianino & Tronick, 1988). Although the dyad aims to partake in synchronous and coordinated interaction, dyadic interactions are often asynchronous and miscoordinated. As a result, the dyad must partake in a process of reparation (Tronick, 2008, Tronick & Beeghly, 2011). The dyads's ability to successfully repair the interaction promotes growth, adaptability, and self-consciousness in the infant

and is an indicator of the quality of the mother-infant relationship (Tronick & Beeghly, 2011).

To date, studies addressing the quality and changes in the dyadic interchanges between mothers and their infants have primarily focused on distal modalities, such as facial expressions and gaze (e.g., Feldman, 2003; Lowe et al., 2012; Montirosso, Borgatti, Trojan, Zanini, & Tronick 2010; Moore et al., 2012). While certainly important, in order to acquire a comprehensive understanding of mother-infant communication, an investigation of proximal modalities of communication, such as touch, is necessary. Since the 1990's, a small body of literature on the proximal modality of touch is accruing. One means through which the importance of touch for infants' development has been studied is through the SF procedure (Stack & Jean, 2011; Stack & Muir, 1990, 1992; Tronick et al., 1978).

The Still-Face Procedure

The SF procedure is widely used in developmental psychology as a mean to investigate infants' self-regulating, affective and communicative abilities (Adamson & Frick, 2003; Mesman, van Ijzendoorn, Bakermans-Kranenburg, 2009), and mothers' sensitivity (Conradt & Ablow, 2010; Kogan & Carter, 1996), responsiveness (Bendersky & Lewis, 1998; Lowe et al., 2012), and interactive style (Stroller & Field, 1982, Tronick et al., 1982). Furthermore, the dyads' reactions to the SF procedure serve as an overall indicator of the quality of the mother-infant relationship (Grant, McMahon, Reilly, & Austin, 2010; Tronick et al., 1982), while infants' reactions to the SF have emerged as a predictor of future attachment (Braungart-Rieker, Garwood, Powers & Wang, 2001; Cohn, Campbell, & Ross; 1991), externalizing and internalizing difficulties at preschool

age (Moore, Cohn, & Campbell, 2001), and overall behavioral problems in childhood (Moore et al., 2001; Yato et al., 2010).

The conventional SF procedure consists of two normal periods of social interaction between a caregiver and an infant, separated by a perturbed period of interaction, the SF period (Tronick et al., 1978). During the SF, mothers are asked to assume a neutral facial expression, maintain eye contact with their infant, remain still and silent, and refrain from touching their infant. Given that the caregiver is thought to be central to infants' regulation (e.g., Bridges & Grolnick, 1995; Kopp, 1989; Thompson, 1994; Tronick, 1989), including a period of maternal unresponsiveness (SF period) in the research design permits the examination of infants' abilities to resort to their own regulatory skills when their mothers' regulation is absent (Manian & Bornstein, 2009; Mayes & Carter, 1990). The SF period can be challenging for infants since they have to cope with the sudden loss of their mothers' availability and responsiveness, modulate their own emerging negative emotions, while at the same time attempt to reengage their caregiver into mutual regulation (Manian & Bornstein, 2009).

A large body of evidence suggests that infants react to maternal unavailability experienced during the SF period by displaying a typical SF signature effect; a decrease in infants' smiling and gazing at their mothers with a concurrent increase in fretting and neutral affect (Adamson & Frick, 2003; Ekas, Haltigan, & Messinger, 2012; Mesman et al., 2009). Physiological markers of infants' distress, such as decreased vagal tone, increased heart rate and increased cortisol levels are also reported during the SF period (Feldman et al., 2010; Haley & Stansbury, 2003; Moore & Calkins, 2004). Since maternal regulatory support is absent during the SF period, infants are forced to rely on

their own coping mechanisms. Hence, an increase in infants' self-regulatory behaviors, such as gaze away and self-touch, has been documented (Ellsworth, Muir, & Hains, 1993; Mayes & Carter, 1990; Mozskowski & Stack, 2007; Shapiro, Fagen, Prigot, Carroll, & Shalan, 1998; Toda & Fogel, 1993; Weinberg & Tronick, 1996). Following the SF period and the resumption of normal mother-infant interaction, a carry-over effect has been observed in the Reunion Normal Period (Carter, Mayes, & Pajer, 1990; Cohn, 2003; Field et al., 1986; Weinberg & Tronick, 1996). Specifically, infants exhibit negative affect while displaying an increase in smiling and gazing at their mothers, thus displaying both avoidant and approach behaviors (Cohn, 2003; Weinberg & Tronick, 1996). Reactions to the SF have been replicated with infants from 1 ½ to 12 months of age (see Mesman et al. 2009) and with infants with a wide range of ethnic backgrounds and risk status (e.g., premature, cocaine exposed, autistic, Down syndrome, infants of depressed mothers, etc.; see Adamson & Frick, 2003 and Mesman et al. 2009 for reviews).

Several theoretical explanations have been proposed for the robust SF findings (Field 1994; Fogel, 1982; Gianino & Tronick, 1988; Stroller & Field, 1982). One explanation posits that infants' reactions to the SF are caused by a violation of infants' expectancies about maternal social behavior. Over time, infants develop expectancies of their mothers' social behaviors and assume that mothers will respect the social rules governing reciprocal social interactions (Adamson & Frick, 2003; Mesman et al. 2009; Tronick et al., 1978). During the SF, mothers' gaze signifies a desire to interact while her unresponsive facial expressions suggest the contrary. Mothers are "communicating Hello and Goodbye simultaneously" (p. 11, Tronick et al., 1978). This conflictual message

results in a stress reaction in infants and a subsequent withdrawal from the interaction (Shapiro et al., 1998). This explanation is further reinforced by findings indicating that infants express more negativity during a SF period with their mothers than with a stranger, thus underscoring infants' expectations about mothers' engagement (Melinder, Forbes, Tronick, Fikke, & Gredebäck, 2010). In addition, Tronick (1980; 1989) proposed that mothers' lack of responsiveness disrupts infants' goal of social engagement. As such, infants' inability to engage in reciprocal social interaction generates stress as well as negative affect. Finally, another complimentary explanation states that since mothers are not providing contingent responses and any regulatory support to their infants, infants are left to regulate using their own self-regulatory abilities (Field, 1994; Stack & Muir, 1990). Given that infants' self-regulating abilities are still developing, they experience difficulties maintaining an organized affective state.

To further clarify the SF phenomena, modified SF procedures aimed at isolating the impact of mothers' vocal and facial cues, attention, or touch have been utilized to underscore the unique contribution of each maternal communicative modality in the explanation of the SF effect. Thus far, most studies have focused on examining the contribution of distal modalities since it was believed that infants' negative behavior during the SF was largely due to a lack of contingent vocal or facial responses from mothers (Tronick, 1989; Walker-Andrew, 1997). For example, D'Entremont and Muir (1997) explored the contribution of facial cues by asking mothers to present a happy, sad, or neutral face to their infants during the SF period. Infants displayed the signature SF effect no matter which facial expression mothers displayed. In addition, direction of adult gaze, such as gazing above the infants or at another person, did not affect infants'

responses (Delgado, Messinger, & Yale, 2002; Striano, 2004). Similarly, the addition of a contingent vocal cue did not change infants' reaction to the SF (Gusella, Muir, Tronick, 1988; Striano & Bertin, 2004). However, research findings suggest that the absence of maternal touch plays an important role in producing the SF effect. For example, Stack and Muir (1990; 1992) demonstrated that when touch is present in the SF period, the SF effect is significantly diminished, thereby positing a regulatory as well as a communicative role for maternal touch. While important, more studies are warranted to further our knowledge of the regulatory roles of maternal touch.

The Roles of Maternal Touch during Early Social Interactions

During mother-infant exchanges, touch is pervasive (Hertenstein & Campos, 2001; Kaye & Fogel, 1980; Montagu, 1986; Stack & Jean, 2011) and serves various functions such as caregiving (Ferber, Feldman, & Makhoul, 2008; Polan & Ward, 1994), attraction and maintenance of infants' attention (Gusella et al., 1988; Kaye & Fogel, 1980), physical stimulation (Field, 2010), non-verbal communication (Hertenstein & Campos, 2001; Koester, Brooks, & Traci, 2000; Stack, 2010), as well as emotion regulation (Gusella et al., 1988; Montagu, 1986; Moreno, Posada, & Goldyn, 2006).

Touch is believed to be the first modality of communication between mothers and their neonates (Montagu, 1986). Immediately following the infants' birth, beneficial aspects of touch for mother-infant interaction and its roles in infants' positive and negative regulation have been reported (Kaitz, Lapidot, Bronner & Eidelman 1992; Rubin, 1963). For example, early tactile contact between mothers and their neonates was shown to be related to an increase in maternal affective behaviors (Carlson et al., 1978; de Château, 1976) and its positive influence continued when the infants were 3-months of

age. Specifically, infants who received extra contact at birth displayed an increase in smiling and a decrease in crying (de Château, 1976). Benefits of early maternal physical contact for infants and for dyadic co-regulation have been reported throughout the first year of life (Bigelow & Power, 2012; Bystrova et al. 2009; Neu & Robinson, 2010). The powerful communicative role of touch was emphasized in Kaitz and colleagues' work (Kaitz et al., 1992; Kaitz, Meirov, Landman & Eidelman, 1993) where they demonstrated that mothers could recognize their own infants 5-88 hours after delivery by solely touching the hand or the cheek of the child. These findings indicate that touch is an essential component of mother-infant interchange early in development and highlight the relationship between maternal sensitivity and maternal tactile behaviors.

Past studies have focused on the regulatory roles of maternal touch on infants' affect and attention (e.g., Jean & Stack, 2009; Peláez-Nogueras et al., 1996; Stack & Muir, 1990; 1992). For example, infants were found to smile and respond positively to their caregivers the most when the interaction included touch and physical stimulation (Dickson, Walker, & Fogel, 1997; Fogel, Hsu, Shapiro, Nelson-Goens, & Secrits, 2006). Moreover, the reinforcing nature of stroking and soothing tactile behavior on infants' smiling has been documented (Peláez-Nogueras et al., 1996; Perez & Gewirtz, 2004). Similarly, Tronick and Brown (cited in Tronick, 1995) reported that the lowest level of infant crying was observed in a touch-only condition compared to a series of conditions which included other forms of maternal soothing behaviors. Along the same lines, Gusella, Muir, and Tronick (1988) demonstrated that 3-month-old infants displayed the SF effect only when touch was part of the prior Normal period. Finally, Koester, Brooks, and Traci (2000) found that mothers provided more touch to their 6-month-old infants

following the SF period. Together, these findings underscore the regulatory roles of maternal touch.

The regulatory benefits of touch were further documented through the use of a SF + Touch (SF+T) paradigm. Stack and Muir (1990) demonstrated that by using only touch, mothers could increase infants' positive affect, decrease negative affect, and maintain gaze during the SF period (at least for a brief period of time), therefore reducing infants' distress. Furthermore, Stack and Muir's (1992) subsequent findings indicate that it was the tactile stimulation as opposed to the visual stimulation of mothers' hands that moderated the SF effect. Feldman and colleagues (2010) further documented the regulatory benefits of touch by examining the effects of maternal touch on 6-month-old infants' stress levels during a SF+T period. The presence of maternal touch during the SF period was found to attenuate infants' physiological stress responses, specifically their cortisol levels and cardiac vagal tone. In addition, compared to the standard SF period, lower levels of gaze aversion, fussing, and crying, and higher levels of laughing and cooing were observed in the SF+T condition. These findings highlight the regulatory contributions of maternal touch in infants' emotion regulation.

Despite these important implications, most studies addressing the contributions of touch have measured the effect of its presence (Gusella et al., 1988; Stack & Muir, 1990; 1992; Weiss, 2011) and its frequency (Herrera, Reissland, & Shepherd, 2004; Symons & Moran, 1987). While these methods of analysis are important in establishing a general role for touch and its incidence, they do not provide us with an indication of the specific communicative or regulatory properties of maternal touch in mother-infant exchanges (Stack & Jean, 2011; Weiss & Niemann, 2011). The types of touch used by mothers are

considered to be a better index of the communicative properties of touch (Hertenstein, 2002; Stack, 2001, 2004; Weiss, 1979). Accordingly, different types of touch could communicate different meanings (Tronick, 1995). For example, stroking might indicate that you are safe, while poking might suggest danger (Tronick, 1995).

Systematic investigations of the quality of maternal touch have documented the use of different types of touch by mothers such as nurturing, affectionate, holding, caregiving, poking, stroking, and proprioceptive stimulation (e.g., Jean & Stack, 2009; Koester et al., 2000; Landau, Shusel, Eshel & Ben Aaron, 2003; Weiss & Niemann, 2011). For example, Moreno, Posada, and Goldyn (2006) observed that mothers used mostly nurturing and stimulating touch when interacting with their 3 ½-month-old infants. Evidence further suggests that mothers adapt their tactile behavior according to the age of their infants and interaction context (Ferber et al., 2008; Polan & Ward, 1994; Stack & Arnold, 1998). For example, Ferber and colleagues (2008) examined changes in the use of affectionate, stimulating, and instrumental touch during interactions between mothers and their 3, 6, 9, and 12 month-old infants. Findings revealed that maternal affectionate and stimulating touch decreased as infant matured. Similarly, Jean et al. (2009) documented a decrease in stroking from 1 to 5 months of age an increase in passive touching from 3 to 5 months of age, and decreased tactile stimulation in lap versus floor contexts. Together, these studies illustrate mothers' use of different tactile behaviors and underscore how maternal touch evolves as infants mature.

Observations of different maternal tactile behaviors have paved the way for researchers to begin to document the specific communicative properties of touch. Using a SF+T procedure, Stack, LePage, Hains, and Muir (1996) investigated the types of touch

used by mothers during different instructional contexts (e.g., increase your infants' smiling, get your infant relaxed). Findings indicated that in order to maximize their infant's smiling, mothers used high levels of tickling and lifting, and low levels of passive touch. In a subsequent study, mothers used more stroking when asked to get their infants relaxed (Arnold, 2002). Taken together, these results suggest that specific types of touch are used in order to elicit a specific reaction from infants, inferring that touch serves various functions (Stack, 2010; Stack & Jean, 2011).

While these studies were clearly essential in demonstrating that different types of touch can serve various functions, a direct assessment of the functions of touch, as opposed to inferences made on the basis of verbal instructions given to mothers, is imperative to understanding the communicative properties of touch. As underscored by several researchers, the examination of the communicative properties of touch should not be made in isolation. Rather, its investigation should take into account the non-verbal and verbal behaviors that accompany each function of touch and the context in which each function occurs (Hertenstein, 2002; Jones & LeBaron, 2002; Jones & Yarbrough, 1985; Muir, 2002; Stack, 2001). In order to address these issues, Jean, Girouard and Stack (2007) developed the Function of Touch Scale (FTS), a systematic observational measure used to assess the types of functions of maternal touch while taking into consideration other modalities of verbal and non-verbal communication such as mothers' verbalizations and infants' affect and attention. Jean and Stack (2009) examined the role of maternal touch during a SF procedure with 5 ½- month-old full-term infants and established the baseline functions of maternal touch used during social exchanges. Mothers used various functions of touch such as nurturing, attention getting, and playful functions of touch. In

addition, these functions changed across the periods of the SF; that is, more attention-getting touch was observed at the beginning of the Normal period while more nurturing touch was observed following the SF period. Similarly, Moszkowski, Stack and Chiarella (2009) documented the use of different functions of touch but this time in infants. Infants' touch served various functions such as regulation and exploration. Furthermore, infant touch was directly related to infants' pattern of gaze, thus demonstrating that infants' non-verbal communication is organized in meaningful patterns of regulation. In summary, cumulative evidence suggests that touch serves various functions, and provides further support to the contention that the specific ways mothers and infants use touch is related to infants' emotional expression and attention.

Hertenstein (2002) and Stack (2001; 2004; 2010) argue that examining the relationship between touch and affect is essential in order to understand the roles of touch in mother-infant interaction and its specific roles in infants' emotion regulation. In addition, two fundamental principles must be taken into consideration while examining maternal touch: the principles of *equifinality* and *equipotentiality* (Barrett & Campos, 1987; Hertenstein, 2002; 2011). *Equifinality* refers to the notion that the same communicative message can be achieved through different means (e.g., happiness may be communicated through a tickle on the leg or a pinching on the nose) while *equipotentiality* refers to the notion that the same tactile stimulation may represent a different meaning for a person (e.g., leg pulling might be considered playful for one infant and attention-getting for another). Therefore, in order to better understand the functions of maternal touch it is essential to take into account infant's behaviors (affect and attention) around touch.

To date, maternal touch has been demonstrated to be effective in regulating infants' behavior and affect (Field, 1994; Moreno et al., 2006; Moszkowski & Stack, 2007; Pelàez-Nogueras et al., 1996; Stack & Muir, 1990; 1992). What remains unknown is how different functions of touch are used in order to influence infants' affect. Moszkowski, Jean, and Stack (2005) investigated the co-occurrence between infant/maternal touch and infant smiling during a SF procedure. Increased infant smiling was observed when active tactile stimulation was provided by themselves or by their mothers. Consistent with this finding, Jean (2006) demonstrated that mothers used more nurturing function of touch when their infants were fretting or distressed, whereas they used more playful function of touch in order to get their infants to smile. Similarly, Moreno et al. (2006) directly assessed the influence of mothers' quality of touch on dyadic co-regulation. The presence of maternal touch only influenced asymmetrical co-regulation; that is, when mothers increased their affectionate touch, infants became less active, calmer and less focused on the interaction. The use of affectionate touch allows the infant to take a break from mutual attuned and synchronous interaction (Moreno et al., 2006). In contrast, stimulating touch signals infants to focus their attention on their mothers. Taken together, results from these investigations provide evidence for the role of specific maternal tactile behaviors in the emotion regulation of healthy, full-term infants.

The aforementioned research took important first steps in the investigation of the roles of maternal touch during mother-infant interactions. Yet, further research is needed to clarify the regulatory roles of maternal touch. Understanding the relationship between maternal touch and infants' emotion regulation is important given the paramount roles

caregivers play in the development of emotion regulation (e.g., Bridges & Grolnick, 1995; Kopp, 1989; Thompson, 1994; Tronick, 1989). Although maternal touch and infants' self-regulatory abilities have been studied separately, no study thus far has brought together both external (maternal touch) and internal (infants' self-regulatory behaviors) means of regulation in the same study.

Infants' Self-Regulating Abilities

Emotion regulation is one of the major milestones in infant social development (Derryberry & Rothbart, 1988; Kopp, 1989). Although its importance is widely acknowledged, there is a lack of consensus regarding its precise definition (Calkins, 1994; Cole, Martin, & Dennis, 2004; Rothbart, Sheese, Rueda, & Posner, 2011). According to Kopp (1989), emotion regulation describes the processes involved in coping with increased positive and negative emotional arousal. Infants' abilities to modulate their behaviors according to the cognitive, social, and emotional demands of a situation develop within the first three years of life (Derryberry & Rothbart, 1988; Kopp, 1989). Emotion regulation is critical for future social interactions and emotional functioning (Cicchetti, Ganiban, & Barnett, 1991; Dodge & Coie, 1987), since failure to acquire adaptive regulation abilities is linked to greater internalizing and externalizing behavioral problems (Eisenberg et al., 2000; Zahn-Waxler, Cole, & Barnett, 1991), lower social competence (Dodge, Pettit, McClaskey & Brown, 1986) and increased vulnerability to psychopathology (Adrian et al., 2011).

During the first year of life, infants' emotion regulation is achieved through their own developing self-regulatory mechanisms (intrinsic mechanisms) as well as regulatory mechanisms provided by others (extrinsic mechanisms), namely their caregivers (Bridges

& Grolnick, 1995; Kopp, 1989; Thompson, 1994; Tronick, 1989). Although infants are born with rudimentary self-regulating behaviors, such as sucking and head turning, they almost exclusively rely on their mothers to deal with distress (Gianino & Tronick, 1988; Kopp, 1989). Between 3 and 6 months, infants develop more sophisticated methods of dealing with positive and negative emotions, such as gazing away, exploring and reaching for objects, self-touch and the ability to directly communicate their emotional state to their caregivers (Derryberry & Rothbart, 1988; Sroufe, 1996). However, they still need their caregivers in order to cope with disruptions in their emotional states (Calkins, 1994; Gianino & Tronick, 1988), especially with higher levels of arousal (Kopp, 1989; Saarni & Crowley, 1990). In addition, caregivers also contribute to infants' emotion regulation by teaching them the appropriate emotional responses based on social and cultural beliefs (Fox & Calkins, 2003; Thompson, 1994; 1998).

During the process of emotion regulation, mothers influence infants' developing regulatory abilities through their sensitivity and responsiveness to infants' behavioral and emotional cues (Lowe et al., 2012; Tronick, 1989), through direct feedback regarding the effectiveness of infants' regulatory strategies (Thompson, 1994; 1998), and by providing contingent social responses during periods of joint attention (Dunham & Dunham, 1995; Morales, Mundy, Crowson, Neal, & Delgado, 2005; Raver, 1996). Mothers provide regulatory support to their infants through different modalities, such as verbalizations, attention, touch, and gesture (Jahromi, Putnam, & Stifter, 2004). With time, infants internalize effective regulatory strategies provided by their caregivers and they begin to play a more active and independent role in their own regulatory processes (Kopp, 1982; 1989). Thus, early emotion regulation is a dyadic process influenced by infants'

physiological, cognitive, and emotional development as well as mothers' abilities to provide efficient and sensitive responses during times of stress (Braungart-Rieker et al., 2001; Conradt & Ablow, 2010; Kopp**,** 1989; Manian & Bornstein, 2009; Thompson, 1991).

Investigations pertaining to the processes of infants' emotion regulation have largely focused on infants' overall regulation, however, in recent years focus has shifted to specifically evaluating infants' behaviors aimed at maintaining and reducing infants' arousal (e.g., Bridge & Grolnick, 1995; Kopp, 1989; Rothbart, Ziaie, & O'Boyle, 1992). For example, Weinberg and Tronick (1994) investigated the regulatory strategies used by 6-month-old infants during a SF procedure. Findings indicated that infants used various strategies, such as social or object engagement, self-comfort, and distancing themselves away from mothers, and escape. In addition, these self-regulating behaviors were found to be organized with infants' affect thereby serving to communicate messages regarding the infants' emotional states and intentions. For example, infants' smiling co-occurred with looking at mothers while anger co-occurred with escape behaviors. Along the same lines, Morales and colleagues (2005) identified several strategies used by 6-month-old infants to self-regulate such as active play alone, active engagement with parents, low-level play alone, self-soothing, and comfort seeking. Such investigations permit the identification of effective regulatory strategies and patterns that lead to positive socio-emotional outcomes. Findings from research suggest that the strategies employed by infants and caregivers depends on several factors such as infants' developmental abilities (i.e., motor, social, perceptual, and cognitive), infants' and mothers' emotional and behavior states, risk factors (e.g., prematurity, neurological disorder, or maternal

depression or anxiety), interaction context, as well as well as cultural and social practices (Adrian et al., 2011; Fox & Calkins, 2003; Kopp, 1989; Manian & Bornstein, 2009; Rothbart et al., 2011).

Infants' self-regulating abilities have been investigated using several experimental paradigms (see Adrian et al., 2011), one of which is the SF paradigm. Given the transition between periods of maternal availability and a period of maternal unresponsiveness, the SF paradigm offers a unique opportunity to investigate infants' abilities to regulate their emotions with and without the assistance of their mothers (Kogan & Carter, 1996; Weinberg & Tronick, 1996). Cumulating evidence indicates that infants increase the use of their self-regulating strategies during the SF period as a means to overcome maternal unavailability. For example, Weinberg and Tronick (1996) documented an increase in "pick-me-up" gestures, distancing, gaze aversion, and higher object engagement during the SF compared to the Normal periods. Furthermore, during a period of stress infants relied on more self-soothing, orienting toward caregiver, and less use of complex strategies such as distraction (Calkins, Dedmon, Gill, Lomax, & Johnson, 2002; Diener, Mangelsdorf, McHale, & Frosch, 2002). Braungart-Rieker, Garwood, Powers and Notaro (1998) reported that an increased reliance on self-comforting, exploring, or looking at their caregiver resulted in lower levels of distress during the SF period for 4-month-old infants. However, when infants were 5 and 10-months of age, Stifter and Braungart (1995) reported that self-soothing was preferred over avoidance or orienting toward object or mothers as a means to deal with negative reactivity. Similarly, Staples (2010) documented that infants displaying high levels of distress during the SF allocated their attention differently than those exhibiting no sign of distress. Specifically,

infants who did not become upset during the SF paid more attention to surrounding objects and their environment and less attention to their mothers. In contrast, infants exhibiting high levels of distress looked at their mothers' faces more during the SF. Hence, distraction might be effective during low-distress situations, while it might not be sufficient for infants experiencing a high level of arousal who require their mothers' regulatory support. Taken together, findings indicate a clear association between infants' abilities to successfully deal with the distress resulting from the SF procedure and the specific strategies selected to self-regulate.

Thus far, existing literature suggests that infants possess a wide range of self-regulatory strategies, which are organized with their affect and attention. However, during the first year of life evidence also indicates that parents' contribution to infants' regulation is paramount (e.g., Bridges & Grolnick, 1995; Kopp, 1989; Thompson, 1994; Tronick, 1989). Nevertheless, as stipulated by the Transactional models of development (Sameroff, 2009; Sameroff & Chandler, 1975), caregivers' role can support or undermine the development of infants' emotional development. Specifically, the Transactional model (Sameroff, 2009; Sameroff & Chandler, 1975) posits that the quality of mother-infant interactions, including mothers' ability to regulate her infants' affect and attention, can be negatively affected by mothers' or infants' risk status, such as maternal depression or infants' birth status (e.g., Bosquet Enlow et al., 2011; Kaitz, Maytal, Devor, Bergman & Mankuta, 2010; Manian & Bornstein, 2009). Results from studies described earlier support this contention. For example, differences in the types of regulatory strategies were observed within a sample of 5-month-old infants of depressed or nondepressed mothers (Manian & Bornstein, 2009). Similarly, Kaitz and colleagues (2010) documented

that compared to control infants, 6-month-old infants of anxious mothers had more difficulty regulating their affect during the SF period. For infants' risk status, most studies have focused on the influence of prematurity. To date, evidence suggests that preterm infants' regulatory abilities are often hindered (e.g., Gianino & Tronick, 1988; Treyvaud et al., 2010). However, most studies have focused on the neonatal period or have investigated preterm infants with medical complications. Less is known about the consequences of prematurity on healthy developing preterm infants.

Very-Low-Birth-Weight Preterm and Preterm Infants

According to the Canadian Perinatal Health Report (2008), an increase in preterm birth incidence and survival rates have been documented in the last 30 years, reported to be 8.2 per 100 live births in 2004. Potential explanations for this increase include advances in obstetric care, increased number of multiple-gestation pregnancies, and older maternal age. An increase has also been noted in preterm birth before 32 weeks of gestation, from 1.0 per 100 live births in 1995 to 1.2 lives birth in 2004. This increase in birth rates of preterm and very-low-birth-weight preterm (VLBW/PT) infants has lead to a proliferation in the number of investigations examining the impact of prematurity on infants' development. In addition to the negative medical sequelae associated with prematurity, the negative long-term psychological impact of prematurity has been reported in the cognitive, educational, sensory integration, language and communication, physical and neuromotor domains (i.e., Baron & Rey-Casserly, 2010; Brooks-Gunn, Klebanov, Liaw, & Spiker, 1993; Hille et al., 2001). In addition, preterm infants are at an increased risk for developing future attention deficits, internalizing problems and

externalizing disorders (i.e., Delobel-Ayoub et al., 2009; Hack et al., 1992; Hoff, Hansen, Munck, & Mostensen, 2004; McCormick, Gortmaker, & Sobol, 1990; Sykes et al., 1997).

Evidence also suggests that prematurity has long-lasting implications for the quality of mother-infant interactions (Barnard, Bee, & Hammond, 1984; Bussière et al., 2012; Feeley, Gottlieb, & Zelkowitz, 2005; Minde, 2000; Schmücker et al., 2005) and on infants' socio-emotional abilities (Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983; Nadeau, Tessier, Lefebvre, & Robaey, 2004; Sykes et al., 1997). From an early age, preterm infants present as more challenging and qualitatively different social partners than full-term infants (Als, 1983; Sykes et al., 1997). During interactions with their mothers, they are less socially responsive (Malatesta Grigoryev, Lamb, Albin, & Culver, 1986; Wolf et al., 2002), express their needs using ambiguous behavioral cues (DiVitto & Goldberg, 1979; McGehee & Eckerman, 1983), vocalize less (Crawford, 1982), and display more negative affect and gaze aversion (Brachfeld, Goldberg, & Sloman, 1980; de Schuymer, de Groote, Striano, Stahl, & Roeyers, 2011; Eckerman, Hsu, Molitor, Leung, & Goldstein, 1999; Feldman, 2009; Garner & Landry, 1992). In addition, preterm infants are described as easily excitable, and more irritable and disorganized than full-term infants, suggesting poorer emotion and behavior regulation strategies (e.g., Als, 1983; Clark, Woodward, Horwood, & Moor, 2008; Eckerman, Oehler, Medvin, & Hannan, 1994; Feldman, 2009; Korja et al., 2008; Poehlmann et al., 2011; Wolf et al., 2002). Emotion regulation difficulties in preterm infants have been noted as early as in the first weeks of life (e.g., Als, 1995) and throughout childhood and adolescence (Clark et al., 2008; Delobel-Ayound et al., 2006; Feldman, 2009; Spittle et al., 2009).

Simultaneously, evidence suggests a link between prematurity, the psychosocial

well-being of mothers and the quality of their caregiving (Forcada-Guex, Borghini, Pierrehumbert, Ansermet, & Muller-Nix, 2011; Poehlmann et al. 2011). Compared to mothers of full-term infants, during face-to-face interactions mothers of preterm infants are described as less responsive and sensitive to their infants' cues (Malatesta et al., 1986; Muller-Nix et al., 2004), while being intrusive and overstimulating (Field, 1979; Golberg & DiVitto, 1995). At the same time, these mothers report experiencing more psychological distress than mothers of full-term infants (Åhlund, Clarke, Hill, & Thalange, 2009; Davis, Edwards, Mohay, & Wollin, 2003; Eiser, Eiser, Mayhew, & Gibson, 2005; Feldman & Eidelman, 2007) which in turn impedes their abilities to sensitively detect changes in their infants' behavior and emotional expressions (Feldman, 2007; Gianino & Tronick, 1988). Consequently, their ability to support preterm infants' emerging regulatory abilities is often impeded (Gianino & Tronick, 1988; Treyvaud et al., 2010).

Given the negative impact of premature birth for both infants and mothers, the quality of the dyadic interaction has been described as less optimal than in full-term dyads (Barnard et al., 1984; Beckwith & Cohen, 1989; Crnic et al., 1983; Feldman, 2007; Holditch Davis & Thoman, 1988; Segal et al., 1995; Sykes et al., 1997). Interactions between mothers and their preterm infants are typically characterized by less mutually synchronous and co-regulated exchanges (Feldman, 2007; Feldman & Eidelman, 2007; Lester, Hoffman, & Brazelton, 1985). For example, during face-to-face interactions, preterm infants spent less time in eye contact with their mothers while in return, their mothers exhibited less contingency and displayed less matching of their infants' facial expression (Malatesta et al., 1986). Similarly, Crnic et al.'s (1983) findings depicted

interactions between the preterm dyads as being less enjoyable and positive for both partners, with observable maternal overstimulation and decreased infants' responsiveness. Taken together, the development of sensitive, co-regulated, and contingent interactions that is characteristic of normative mother-infant interaction is often hindered in preterm dyads.

In contrast, results from some studies have suggested that mothers of preterm infants have the abilities to compensate and overcome the negative effect of infants' prematurity. Specifically, these mothers have been described as being more active (Crnic et al., 1983) and vocally responsive to their infants (Barratt, Roach, & Leavitt, 1992; Schmücker et al., 2005). For example, Barratt et al.'s (1992) examination of maternal responsiveness and sensitivity revealed that mothers of preterm infants were more sensitive to infants' vocal signals. Consequently, infants were more successful in their attempts to capture their mother's attention. Furthermore, maternal characteristics such as sensitivity, responsiveness, and ability to provide contingent responses have been showed to be associated with better future social and cognitive abilities in preterm infants (Beckwith & Rodning, 1996; Bee et al., 1982; Greenberg & Crnic, 1988; Poehlmann & Fiese, 2001). Together, findings suggest that mothers can play a significant role in mitigating some of the negative effects associated with prematurity.

Numerous studies have demonstrated that one way in which mothers can counteract the negative effect of prematurity is through the use of touch. From the time preterm infants are born, extra skin-to-skin contact and massage have been found to have beneficial effects on the physiology, intellectual abilities, and behavior of premature infants (see Field, 2011; Vickers et al. 2004). For example, Field, Hernandez-Reif, and

Feijo, and Freedman (2006) documented an increase in weight and decrease in hospitalization stay for preterms receiving massage therapy. Various potential underlying mechanisms have been identified thus far to explain the link between massage and weight gain: increase in vagal activity and food motility, increase in body temperature, increase in serum insulin and decrease in energy expenditure and stress behaviors (e.g., Diego, Field, & Hernandez-Reif, 2008; Field et al., 2006; Field, 2010; Lahat, Mimouni, Ashbel & Dollberg, 2007). Beneficial effects of touch have also been observed for mothers of preterm infants' psychological well-being (e.g., Bigelow, LittleJohn, Bergman, & McDonald, 2010; Feijó et al., 2006; Goldstein-Ferber et al., 2005). Mothers providing massage therapy to their infants have reported an increased ability to read their infants' signal, to provide appropriate stimulation, and an overall feeling of empowerment as a parent (Affonso, Bosque, Wahlberg, & Brady, 1993; Bigelow et al., 2010; Neu, 1999; Tessier et al., 1998).

While the significance of touch for VLBW/PT infants' cognitive and physical development has been established and comprehensively investigated (Field, 2011; Vickers, Ohlsson, & Horsley, 2004), the impact of touch on infants' sociomotional development and on the quality of dyadic exchanges is warranted. Yet few studies have attempted to study the quality of maternal touching and its impact on the quality of mother-infant interaction on VLBW/PT dyads. Results from studies on the duration of maternal touch while mothers interact with their low birth weight infants have revealed inconsistent and contradictory findings. Although results from some studies have found increases in the duration of mother-infant touching compared to full-term dyads (e.g., Als & Brazelton, 1981; Brachfeld et al., 1980; Crnicet al., 1983), others have found the

opposite (e.g., DiVitto & Goldberg, 1979; Stern & Hildebrant, 1986). Therefore, clarifying the prevalence of maternal touch within preterm dyads is a necessary first step in appreciating the positive impact of maternal touch for preterm dyads.

The beneficial influence of touch for preterm infants' socio-emotional development and the mother-infant realtionship has been only sparsely investigated. Korja and colleagues (2008) documented that an increase in holding and physical closeness at 5 months of age was related to better quality of mother-infant interaction at 6 and 12 months of age for preterm infants. In addition, Weiss and colleagues demonstrated that nurturing touch was related to an increase in attachment security at 1 year of age (Weiss, Wilson, & Morrison, 2004). Furthermore, studies have attempted to establish a relationship between the quality of maternal touch and infants' self-regulatory abilities. One study investigated the effect of early skin-to-skin contact on infant's self-regulatory abilities at 3 and 6 months of age (Feldman, Weller, Sirota, & Eidelman, 2002). Results suggested that increased mother-infant skin-to-skin contact resulted in more developed self-regulatory behaviors during the first 6 months of the infant's life. For example, at 3 months, infants who received extra skin-to-skin contact were more efficient at regulating their arousal level. Furthermore, Neu and Robinson (2010) documented an increase in co-regulation during the SF procedure for dyads that received extra holding during the early weeks of life.

However, as pointed out by Goebel (2001) little is known about the qualitative characteristics of touch, such as the types and the functions, used by mothers of preterm infants and its implications for infants' socio-emotional development. Given that VLBW/PT infants have fragile nervous systems which can be easily over-stimulated and

overwhelmed (Field, 1987), mothers' sensitivity to their infants' cues and accordingly adjusting the qualities of their tactile behaviors may have vital implications for infants' socio-emotional development and well-being (Goebel, 2001). In addition, what remains unknown is whether the quality of maternal touch affects full-term and preterm infants in similar ways during dyadic face-to-face interactions. Furthermore, given mothers' active role as a source of external regulation particularly for young infants, investigating how maternal touch is related to infants' self-regulating behavior is warranted to better understand the role of touch in infants' emotion and behavioral regulation.

The Present Dissertation

Based on the literature to date, the evidence indicates a strong association between infants' self-regulatory behavior and infants' affect and attention. In addition, evidence indicated that mothers act as an important source of external regulation. As previously mentioned, maternal behaviors, especially touch, have been associated with infants' emotional expressiveness and have been speculated to play a role in infants' regulation. Yet, an important limitation in the current literature is that no study to date has directly measured how maternal touch and infants' self-regulating behavior are related.

The present dissertation was designed to investigate the influence of maternal touch on 5 ½-month-old infants' emotion regulation during mother-infant face-to-face interactions. Specifically, the present investigation simultaneously evaluated the regulatory contribution of maternal touch and infants' self-regulating abilities on infants' affect and attention using a face-to-face SF paradigm and a SF+T paradigm. Five-and-a-half-month-old infants were selected for this study because at this age: a) infants have

developed efficient self-regulating abilities (Adrian et al., 2011; Kopp, 1989; Rothbart et al., 1992; Stifter, & Braungart, 1995), b) infants are effective communicators and bidirectional exchanges and co-regulation processes are well-established (Cohn & Tronick, 1989; Legerstee, 2009; Toda & Fogel, 1993; Tronick & Cohn, 1989), and c) for consistency with previous research in this area (Mesman et al., 2009; Stack & Jean, 2011).

The current dissertation is composed of two studies which were both designed to clarify how maternal touch and infants' self-regulating behavior are related to infants' affect and attention. The SF procedure was employed in both studies since the SF period is usually mildly distressing for infants, and its use permits the investigation of infants' abilities to self-regulate while their mothers cannot act as an external source of regulation (Kogan & Carter, 1996; Weinberg & Tronick, 1996). In addition, since infants' emotional expressions vary considerably across period (e.g., Ekas et al., 2012; Mesman et al., 2009), it allow for the comparison of differences in infants' self-regulatory abilities during positive and negative situations. In addition, it permits the examination of the role of touch and infants' self-regulating behavior during the dyadic re-engagement process following the SF period (e.g., Carter et al., 1990; Cohn, 2003; Conradt & Ablow, 2010; Weinberg & Tronick, 1996).

The first part of Study 1 (Study 1a) was designed to investigate the functions of maternal touch and their association with 5 ½ month-old infants' self-regulating abilities in full-term and VLBW/PT infant-mother dyads. Specific objectives were to: 1) systematically investigate functions of maternal touch and infants' self-regulating abilities in full-term and VLBW/PT infants and their mothers during a SF procedure, and

2) clarify the relationship between maternal touch and infants' self-regulating abilities. This study was designed to obtain a thorough comprehension of the roles of maternal touch and infants' self-regulatory behaviors during mother-infant interactions. Consequently, a normative or typical touching pattern and self-regulatory behaviors would be documented in full-term, healthy and at-risk sample will be obtained. Furthermore, results from this study would extend existing literature by investigating the associations between maternal functions of touch and infants' affect and attention. This is a vital step in elucidating the different functions of touch and their respective roles in infants' emotion regulation.

The second part of Study 1 (Study 1b) was designed to examine how maternal touch and infants' self-regulating behavior are related to infants' negative and positive emotion displays. Specifically, the objectives were to: 1) examine differences in nurturing touch and infants' self-regulatory behaviors across infants' distress level displayed during the SF period, and 2) investigate the association between maternal touch, infants' self-regulatory behaviors, and infants' smiling. Findings were anticipated to clarify the contribution of both maternal functions of touch and infants' self-regulatory behaviors to infants' affect thereby clarifying the regulatory role of maternal touch.

Study 2 was designed to investigate the regulatory contributions of maternal touch to 5 ½-month-old infants' emotion regulation by examining how mothers regulate infants' affect, attention, and distress level during a SF with touch procedure (SF+T). Specifically, the objectives were to: 1) observe the overall amount of maternal touch and its specific functions during a Normal and three SF+T periods between, 2) provide a systematic observation of infants' self-regulating abilities across the Normal and SF+T

periods, 3) examine the co-occurrence between each maternal function of touch and infants' affect, gaze, and self-regulatory behaviors, and to examine the co-occurrence between infants' self-regulatory behaviors and infants' affect and gaze, and to finally 4) observe the association between infants' distress level and maternal touch and infants' self-regulatory behavior. This unique modification to the standard SF procedure (SF+T; a SF period during which mothers are allowed to touch their infant) was used to provide important insight into the reasons mothers use touch when other forms of communication are unavailable. In addition, it had the potential to contribute to increased knowledge on the roles of the mother in infants' emotional and behavioral regulation. Furthermore, the examination of co-occurring behaviors was expected to clarify how these behaviors are organized during infants' emotion regulation.

As a whole, the present dissertation was designed to assess how internal (i.e., infants' self-regulating behavior) and external (i.e., maternal touch) sources of regulation contribute to infants' emotion regulation behaviors in Normal, SF, and SF+T periods. These contextual differences in the interactions offer the opportunity to observe how infants regulate during normal interactions, when mothers are emotionally unavailable (SF period), and when mothers are unavailable except through their touch (SF+T), thus providing a baseline of infants' regulation during normative mother-infant interactions and during periods of varying maternal unavailability.

CHAPTER 2:

STUDY 1A

Full-term and Very-Low-Birth-Weight Preterm Infants' Self-Regulating Behaviors during a Still-Face Interaction: Influences of Maternal Touch

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Abstract

The present study was designed to examine maternal touch and infants' self-regulating behavior in full-term and very-low-birth-weight preterm (VLBW/PT) infant-mother dyads. Mothers and their 5½-month-old Full-term (n = 40) and VLBW/PT (n = 40) infants participated in a Still-Face (SF) procedure. Mothers used high levels of touching (82% of the interaction) and the functions of touch changed across periods. More attention-getting touch was used during the Normal period and more nurturing and playful touch during the Reunion Normal period. Mothers of VLBW/PT infants engaged in more playful touch across periods. Similar amounts of self-regulatory behaviors were observed for both groups across all three periods; however, full-term infants exhibited greater self-comfort regulatory behaviors during the Reunion Normal period. Finally, for both groups the presence and quality of maternal touch were associated with infants' self-regulating behavior; thus providing evidence for the regulatory roles of maternal touch. These findings underscore how both maternal touch and infants' self-regulating behaviors are important and effective components of infants' emotion regulation.

keywords: mother-infant interaction, prematurity, maternal touch, infant self-regulation, Still-Face procedure, infant affect

Prematurity has been shown to have a negative impact on the quality of mother-infant interactions (e.g., Feldman, 2007; Forcada-Guex, Borghini, Pierrehumbet, Ansernet, & Muller-Nix, 2011; Sykes, Hoy, Bill, McClure, Halliday, & Reid, 1997; Treyvaud, et al., 2010). Preterm infants are described as easily excitable, more irritable and disorganized, and less socially responsive than full-term infants, suggesting poorer emotion regulation abilities (e.g., Als, 1983; Feldman, 2009; Korja et al., 2008; Wolf, Koldewijn, Beelen, Smit, Hedlund, & Groot, 2002; Treyvaud, et al., 2010). According to the Mutual Regulation Model (Gianino & Tronick, 1988; Tronick & Weinberg, 1997) and the dynamic systems perspective (Fogel, 1992; Fogel & Garvey, 2007), mothers and infants are constantly influencing each other during face-to-face interactions. Through their affective displays, infants communicate their needs and desires, and in response mothers adjust their behavior accordingly. Compared to mothers of full-term infants, mothers of preterm infants are reported to be less responsive to their infants' cues, while being intrusive and overstimulating (e.g., Feldman & Eidelman, 2007; Field, 1979; Minde, Perrotta & Marton, 1985; Muller-Nix, et al., 2004). As a result, their abilities to sensitively detect changes in their infants' behaviors and emotional expressions are often diminished which in turn impedes their capacity to effectively regulate their infants' affective states. Consequently, the development of sensitive, co-regulated, and contingent interactions that are characteristic of typical mother-infant interactions (e.g., Fogel, 1992; Gianino & Tronick, 1988) are frequently hindered in preterm infant-mother dyads. However, some studies have reported no differences in the quality of mother-infant interactions (e.g., Arnold, 2002; Korja et al., 2008; Montirosso, Borgatti, Trojan, Zanini, & Tronick 2010) while others have demonstrated that mothers of preterm infants are

more stimulating and responsive to their infants' cues (e.g., Barratt, Roach, & Levitt, 1992; Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983; Schmücker, al., 2005).

Those studies that have reported differences in the quality of mother-infant interchanges in preterm dyads have argued that this difference in the quality of the exchanges may directly affect the development of emotion regulation (e.g., Braungart & Stifter, 1991; Clark, Woodward, Horwood, & Moor, 2008; Montirosso et al., 2010; Sykes et al., 1997), which emerges in part through caregiver-infant interactions (e.g., Braungart & Stifter, 1991; Kopp, 1989; Tronick & Gianino, 1986). During the first year of life, infants' emotion regulation is achieved through their own developing self-regulating mechanisms (e.g., gazing away, self-touch, exploration, distancing) as well as regulatory mechanisms provided by others, namely their caregivers (Gianino & Tronick, 1988; Kopp, 1989). With time, infants acquire the skills that are necessary to play more active and independent roles in their regulatory processes (Kopp, 1989).

Studies assessing infants' self-regulatory behavior have reported less advanced emotion regulation capacity in preterm infants compared to their full-term counterparts. Specifically, limited capacities in self-calming and behavior and stress regulation (Als, 1983; Feldman, 2009; Eckerman, Hsu, Molitor, Leung, & Goldstein, 1999; Wolf et al., 2002) have been observed. In their investigation of infants' self-regulatory abilities, Montirosso and colleagues (2010) found that 6- to 9-month-old preterm and full-term infants used different strategies to self-regulate during a Still-Face (SF) procedure. In a conventional SF procedure, mother-infant dyads participate in two Normal face-to-face periods (Normal and Reunion Normal periods) separated by a SF period in which mothers are instructed to gaze at their infants, while maintaining a neutral facial

expression and refraining from vocalizing or touching their infants (Tronick, Als, Adamson, Wise, & Brazelton, 1978). The SF procedure permits examination of the dyads' abilities to regulate infants' behavior and affect before, during, and following a stressful period (Mesman, van Ijzendoorn, & Bakermans-Kranenburg, 2009; Weinberg & Tronick, 1996). In Montirosso and colleagues' investigation, preterm infants used more distancing across all periods of the SF procedure and more social monitoring during the Reunion Normal period. Such findings suggest that in contrast to full-term infants, preterm infants are relying more on external regulatory strategies (i.e., caregivers) as a way to compensate for their own inadequate abilities.

Based on the evidence that preterm infants have limited regulatory abilities, (Als, 1983; Mouradian, Als, & Coster, 2000), the contribution of their caregivers to the maintenance of their affective states becomes especially important. A mother's interactive style, specifically her timely and sensitive responses during moments of stress, influences how infants regulate their emotions (e.g., Braungart-Rieker, Garwood, Powers & Wang, 2001; Conradt & Ablow, 2010; Gable & Isabella, 1992). However, little is known about how mothers of preterm infants facilitate the process of infants' emotion regulation. In full-term dyads, among other modalities, mothers have been shown to sensitively and positively affect infants' emergent regulatory abilities through the use of touch (e.g., Feldman, Singer & Zagoory, 2010; Hertenstein & Campos, 2001; Stack, 2004; 2010). Occurring between 55-99% of the time during face-to-face interactions (see Stack & Jean, 2011), touch has been demonstrated to be effective and sufficient in regulating infants' behavior, affect, and attention at least for brief periods of time (e.g., Field, 1994; Moreno, Posada, & Goldyn, 2006; Stack & Muir, 1990, 1992).

Interestingly, it is not the mere presence or absence of touch that regulates and influences infants' emotion displays and behavior, but the specific quality of that touch (Hertenstein, 2002; Jean & Stack, 2009; Moreno, et al., 2006; Stack & Muir, 1992; Stack, 2010). For example, in order to maximize 6-month-old infants' smiling, mothers used high levels of playful touch (tickling and lifting) while they used nurturing and affectionate touch to get their infants relaxed and calm (Moreno, et al., 2006; Stack & Jean, 2011). Similarly, to better understand the roles of touch during mother-infant interactions, Jean and Stack (2009) directly measured the various functions that maternal touch serves during a SF procedure with 5 ½ month-old full-term infants. While interacting with their full-term infants mothers used more attention-getting touch at the beginning of the procedure and more nurturing touch in the re-engagement (Reunion Normal) period. Moreover, mothers sensitively adapted their touching behavior according to infants' distress level and affect. That is, they used more nurturing touch when their infants were distressed, whereas increased playful touch was associated with infants' smiling. Taken together, results from these investigations provide evidence for the role of specific tactile behaviors in the emotion and behavior regulation of healthy, full-term infants.

To date, studies investigating the quality of maternal touching during interactions between preterm infants and their mothers have been sparse and those that exist have revealed inconsistent and contradictory findings. Reports of greater duration of maternal touch in preterm dyads in comparison to full-term dyads have been documented (e.g., Als & Brazelton, 1981; Crnic et al., 1983), while other studies have suggested the opposite (e.g., Arnold, 2002; DiVitto & Goldberg, 1979; Stern & Hildebrandt, 1986). In an

attempt to investigate differences in maternal tactile behavior, Crnic and colleagues (1983) established that during the first year of life, mothers of preterm infants used more stimulating tactile behavior than mothers of full-term infants; nevertheless, preterm infants were found to exhibit less enjoyment and responsiveness than full-term infants. In their work with low-birth-weight infants, Weiss and colleagues demonstrated that stimulating touch at 3 months of age lead to better visuo-motor abilities at one year of age (Weiss, Wilson, & Morrison, 2004) and better neuropsychological outcomes at two years of age (Weiss, 2005). Similarly, the amount of nurturing touch at 3 months of age was found to be associated with attachment status at 1 year (Weiss, Wilson, Hertenstein, & Campos, 2000). For healthy infants, nurturing touch was associated with secure attachment while it was associated with less secure attachment in more vulnerable infants.

Although evidence implies that touch is central to infants' emerging self-regulating behaviors (Hertenstein, 2002; Stack, 2010; Tronick, 1995), attempts to replicate this finding with preterm infants are sparse. One exception is the study by Feldman, Weller, Sirota, and Eidelman (2002), which investigated the effect of early skin-to-skin contact (i.e., Kangaroo care) on infant's self-regulatory abilities at 3 and 6 months of age. Increased mother-infant skin-to-skin contact led to improved self-regulatory behaviors and behavioral organization during the first six months of infants' lives. Although these findings suggest a link between maternal touch at birth and infants' self-regulating abilities, touch is an important mode of communication and regulation throughout infancy (Hertenstein, 2002; Stack, 2010), thus its roles in mother-infant

interaction and its link to infants' self-regulation warrants research attention beyond the neonatal period.

Given that deficits in self-regulating abilities in preterm infants are hypothesized, and since touch has been showed to positively influence infants' emotional regulation, understanding the relationship between infants' self-regulating abilities and touch is essential. The present study was designed to investigate the functions of maternal touch and their association with 5 ½ month-old infants' self-regulating abilities in full-term and very-low-birth-weight preterm (VLBW/PT) infant-mother dyads. To our knowledge this is the first study examining maternal touch and infants' self-regulating behavior during a SF period in both full-term and VLBW/PT mother-infant dyads. In addition, although the SF paradigm has been used extensively in the literature (Adamson & Frick, 2003, Mesman et al., 2009), only a few studies have investigated infants' reactions to the SF in both full-term and preterm infants (Hsu & Jeng, 2008; Montirosso et al., 2010; Segal et al., 1985) and none have focused on VLBW/PT infants. VLBW/PT infants were chosen because it is believed that given their high-risk nature (weight, early gestation, time spent in the NICU), the quality of dyadic interchanges and infants' self-regulatory behaviors might be further impaired. However, all the VLBW/PT infants were healthy in order to control for confounds related to medical problems.

The first objective of the present study was to compare the functions of maternal touch and infant' self-regulating behaviors across the interaction periods of the SF procedure and across the two groups of infants (full-term vs. VLBW/PT). It was expected that maternal touch would serve various functions and that these functions would change across periods of the SF (Jean & Stack, 2009; Moreno et al., 2006). In addition, mothers

of VLBW/PT infants were hypothesized to use more playful touch, a more stimulating tactile behavior. For self-regulation, an increase in self-regulating behaviors was expected in the SF period (Toda & Fogel, 1993; Weinberg & Tronick, 1996) while an increase in bidirectional exchanges and decreased gaze aversion were expected in the Reunion Normal period indicating infants' desire to re-engage (Gusella, Muir, & Tronick, 1988). Finally, based on previous literature (Feldman, 2009; Montirosso et al., 2010; Mouradian et al., 2000; Wolf et al., 2002) full-term infants were expected to use more advanced regulatory strategies such as gaze aversion and self-comfort regulatory and exploratory behaviors compared to VLBW/PT infants.

The second objective consisted of examining the relationship between maternal functions of touch and infants' self-regulating behaviors. In general, it was hypothesized that an increase in overall maternal touch and in playful touch would be associated with an increase in bidirectional exchanges between infants and mothers and a decrease in infants' self-regulating behaviors such as self-comfort regulatory and exploratory behaviors, gaze aversion and escape**.** In addition, since mothers have been shown to use more nurturing touch when their full-term infants are distressed (Jean & Stack, 2009) and since there is an increased use of self-regulatory behaviors during period of stress (e.g., Montirosso et al., 2010; Moszkowski & Stack, 2007; Stifter & Braungart, 1995; Shapiro, Fagen, Prigot, Carroll, & Shalan, 1998) nurturing touch was hypothesized to be associated with an increase in infants' self-regulation behaviors such as self-comfort regulatory and exploratory behaviors, gaze aversion, and escape.

1. Method

1.1. Participants

Following ethics approval by both Concordia University and a major community teaching hospital (Montreal, Quebec) and in collaboration with the chief Neonatologist, VLBW/PT infants were pre-screened for medical status variables by a nurse during their follow-up visit when they were between 3 and 4 months of age. In order to be considered for the study, VLBW/PT infants' birth weight had to be between 800-1500 g (1.76 - 3.30 pounds) and they had to be healthy and living with their biological mothers. Finally, the following exclusion criteria were also applied: infants who suffered from Grade IV intra-ventricular hemorrhage or other medical complications, illnesses, or syndromes (e.g., hydrocephalus, severe neurological impairment, hearing loss, retinopathy); infants who had been diagnosed with congenital abnormalities; infants who had experienced prolonged and/or repeated hospitalizations since the neonatal period; infants of diabetic or teenage mothers (<18 years); and mothers at psychological risk due to a history of inadequate prenatal care, drug-abuse, mental illness or rape. Mothers of VLBW/PT who met inclusion criteria were provided with a letter explaining the purpose of the study and if interested, they were contacted by telephone by a research coordinator, were explained the purpose of the study and were asked to voluntarily participate.

Using birth records from the same hospital as the VLBW/PT infants, mothers of normal birth weight (at least 6 pounds or 2720 grams) full-term infants born between 37 to 41 weeks of gestation with uncomplicated medical histories received a letter and were contacted and recruited by telephone. Full-term infants were recruited from the same hospital as the VLBW/PT infants to control for socio-economic status (SES) and ethnic

backgrounds. For additional control, full-term and VLBW/PT infants were matched for infant sex, maternal age (within 5 years) and maternal education.

Participants included 111 mothers (48 Full-term and 63 VLBW/PT) who agreed to participate with their 5 ½-month-old-infants. Thirty-one mother-infant dyads were excluded from the analyses due to: mothers' failure to follow instructions (FT: n=0, VLBW/PT: n=10), infants' gaze obstructed (FT: n=2, VLBW/PT: n=0), procedural error (FT: n=1, VLBW/PT: n=7), SF period repeated more than once due to infants' fussiness (FT: n=2, VLBW/PT: n=4), and excessive infant crying (FT: n=0, VLBW/PT: n=1). In addition, if mothers touched their infants for less than 10% of the time in the first Normal period (FT: n=3, VLBW/PT: n=1), the dyads were excluded from the analysis. This criterion was used as a way to ensure that touch was a prevalent mode of communication utilized by the dyad, and is consistent with the literature whereby touch is typically used for more than 65% of the time during normal face-to-face interactions (see Stack & Jean, 2011). The final sample consisted of 80 infants, 40 full-term (20 female and 20 male) and 40 VLBW/PT (22 female and 18 male) with a mean age of 5 months and 12 days (*SD* = 6.70 days) for full-term infants and 5 months and 14 days (*SD* = 8.21) for VLBW/PT infants. To correct for prematurity, corrected age (i.e., postnatal age minus the number of weeks the infant was premature) was employed for VLBW/PT infants. Table 1 presents the demographic and medical characteristics for both groups.

1.2. Procedure and Apparatus

The present study was part of a longitudinal study in which participants were tested in their homes beginning at 5 ½ months of age during two experimental conditions: a face-to-face SF procedure followed by a free play on the floor. The SF procedure,

which consisted of three 2-minute interaction periods: Normal, SF, and Reunion Normal periods (see Jean & Stack, 2009 for a detailed description of the procedures and apparatus), was the focus of the present study.

1.3. Behavioral Coding, Dependent Measures

A time-line (in minutes, seconds, and milliseconds) was recorded on each video record prior to coding. An adjustable speed remote control was used for coding to allow for slow motion frame-to-frame and second-by-second coding, as well as real time coding. Each Normal period of interaction was coded from the videorecords for infants' (1) smiling, (2) fretting, (3) gazing, and (4) self-regulatory behavior, and for (5) functions of maternal touch and (6) maternal sensitivity. During the SF period, infants' (1) smiling, (2) fretting, (3) gazing, and (4) self-regulatory behavior were coded. To establish inter-rater reliability, a trained second coder who was blind to the hypotheses of the study re-coded 20-30% of a random portion of the video records; the results were compared to the original coding. In addition, in order to assure that coding in one domain did not influence coding in another domain, different trained coders were used to uniquely observe infants' affect, self-regulation, and maternal functions of touch and sensitivity.

1.3.1. Infants' emotional displays and attention. Infants' smiling and fretting, and gazing at their mothers' faces were coded frame-by-frame. Infants' smiling was operationally defined as an upturned mouth (either open or closed). Fretting was coded when the infant was crying or when his/her mouth was turned down or curled. Infants' gazing was recorded when infants looked at their mothers' faces. These infant behaviors have been reliably used and coded in a number of studies (e.g., Jean & Stack, 2009; Moszkowski, Stack, & Chiarella, 2009). Kappa coefficients (Cohen, 1968) were

calculated for infants' affect and gaze, and were found to be higher than $K > 0.90$.

1.3.2. Infants' self-regulatory behavior. Infants' self-regulatory behavior was coded using the Infant Self-Regulation Scheme (ISRS; Millman, Jean, & Stack, 2009), which is based on Weinberg and Tronick's Infant Regulatory Scoring System (IRSS; 1996). The original IRSS codes for: infants' direction of gaze, vocalizations, gestures, self-comforting, distancing, and autonomic stress indicators. The IRSS was adapted to better reflect some of our research findings on infants' touching (Moszkowski & Stack, 2006; Moszkowski, Stack, & Chiarella, 2009). Our revised version, the ISRS, is an observational coding scheme that evaluates the duration of six types of self-regulatory behavior that infants exhibit: self-comfort regulatory, self-comfort exploratory, attention-seeking, escape, gaze aversion, and bidirectional exchanges. One of our adaptations consisted of dividing the original self-comforting category into two categories that focused on different ways infants use touch to self-regulate (regulatory and exploratory). Furthermore, we added the bidirectional exchange category, which documents instances during which infants are relying on mothers' regulatory contributions by gazing and interacting with their mothers. For each second of the interaction, one of the six types of self-regulatory behavior was coded (see Table 2 for brief operational definitions). A kappa coefficient (Cohen, 1968) was calculated ($K = 0.90$).

1.3.3. Functions of maternal touch. The functions of maternal touch were coded using the Functions of Touch Scale (FTS; Jean, Girouard & Stack, 2007). The FTS is an observational coding measure, which assesses the duration of nine functions of maternal touch. The coding takes into account the quality of maternal touch, and other dyadic behaviors such as maternal affect, verbalizations, and infants' affect and attention. For

each second of the interaction, one of the nine functions of touch was coded (see Table 3 for brief operational definitions). A kappa coefficient (Cohen, 1968) was calculated (K = 0.89).

1.3.4. Maternal sensitivity. Maternal sensitivity was coded using the sensitivity scale of the Emotional Availability (EA) Scales, which was adapted for the very young infant (Biringen, Robinson, & Emde, 1993; Carter, Little, & Garrity-Rokous, 1998). Following the end of each Normal period, mothers were rated for their levels of sensitivity (appropriately responding to infants' cues) using a 9-point scale, ranging from 1 (highly insensitive) to 9 (highly sensitive). Coding of the EA was not conducted on the SF as mothers were not engaged in interaction.An intraclass correlation coefficient was calculated to assess agreement between the two coders (Shrout & Fleiss, 1979) and was 0.89.

2. Results

The data obtained for each independent variable were reduced to obtain the percent duration of behavior during each period. In addition, since the frequency and duration of harsh or negative, accidental, and unspecified functions were absent or very low, they were removed from subsequent analyses. Descriptive statistics were conducted to assess for the presence of outliers, and to verify the normality of the distribution. When significant skewness or kurtosis was found, outliers were brought in according to the method described by Tabachnick and Fidell (1996), where the score is brought in to the next acceptable level and 1 is added to the score. As a result of bringing in outliers, there was no skewness or kurtosis in the data hence no transformations were required. When ANOVAs revealed significant interactions, Šidāk pairwise comparisons were used to

isolate the source of the significance (Šidāk, 1967). Furthermore, for significant ANOVAs, partial eta-squared (η_p^2) are reported as a measure of effect size; a η_p^2 of .01, .06, and .14 indicate small, medium, or large effect sizes (Clark-Carter, 1997).

2.1. Preliminary Analyses

Preliminary analyses were conducted on the percent duration of infants' smiling, fretting, and gazing at mothers in order to assess for the presence of standard SF effects. Three one-way repeated measures ANOVAs (Period x Group) were performed and indicated that as expected for a Still-Face procedure, both groups of infants exhibited the signature SF effect: decreased smiling, $F(2, 150) = 85.92$, $p < .001$, $\eta_p^2 = .53$ (Normal: $M = 39.81$, $SE = 2.64$, SF: $M = 12.21$, $SE = 1.65$, Reunion Normal: $M = 41.07$, $SE = 2.83$), and gazing at mothers' faces, $F(2, 150) = 156.42$, $p < .001$, $\eta_p^2 = .68$ (Normal: $M = 54.77$, $SE = 2.65$, SF: $M = 19.85$, $SE = 1.75$, Reunion Normal: $M = 64.20$, $SE = 2.48$), and increased fretting, $F(2, 150) = 3.66$, $p < .05$, $\eta_p^2 = .05$ (Normal: $M = 0.43$, $SE = 0.19$, SF: $M = 1.71$, $SE = 0.41$, Reunion Normal: $M = 1.61$, $SE = 0.50$), during the SF period. An increase in gazing at mothers' faces in the Reunion Normal was also observed from the Normal to the Reunion Normal periods.

In addition, as a means to control for levels of maternal sensitivity, a one-way repeated measures ANOVA (Period x Group) was conducted and revealed no differences in maternal sensitivity across group and period, $F(1, 78) = 0.54$, $p = .57$, $\eta_p^2 = .00$, demonstrating that mothers of full-term and VLBW/PT infants were responding sensitively ($M = 7.79$, $SE = 0.11$).

2.2. Objective 1: Compare the Functions of Maternal Touch and Infants' Self-Regulating Behaviors across Interaction Period and Group

To examine how the overall duration of touch varied across interaction period and across group, a 2 x 2 (Period x Group) repeated measures ANOVA was conducted. The overall amount of touch occurring during each Normal period was obtained by summing up all percent durations of each function of touch category from the FTS in order to form one total touch category. Results indicated that there was no significant difference in the amount of touch provided to infants across the two Normal periods and across full-term and VLBW/PT infants, indicating that mothers of full-term and VLBW/PT infants provided consistent amounts of touch across period (M = 82.33%, SE = 1.72; see Table 4 for percent durations of touch and functions of maternal touch across period and interaction periods).

In contrast, mothers were found to utilize different functions of touch across period and group. A 6 x 2 x 2 (Function of Touch x Period x Group) repeated measures ANOVA revealed a significant main effect for the Function of Touch, $F(5, 390) = 97.42$, $p < .000$, $\eta_p^2 = .56$. The functions that mothers spent the most time using were: playful (M = 32.50%, SE = 1.90), followed by active and passive accompaniment (M = 17.94%, SE = 1.30; M = 16.07%, SE = 1.26), nurturing (M = 4.96%, SE = 0.56), attention-getting (M = 4.05% SE = 0.50), and finally utilitarian (M = 1.97%, SE = 0.28). A significant interaction between Function of Touch and Period, $F(5, 390) = 4.28$, $p < .001$, $\eta_p^2 = .05$, indicated that there was more attention-getting in the Normal compared to the Reunion Normal period. In addition, there was more nurturing and playful function of touch in the Reunion Normal period compared to the Normal period (see Figure 1). Furthermore, a significant interaction between Function of Touch and Group, $F(5, 390) = 2.57$, $p < .03$, $\eta_p^2 = .03$, indicated that mothers of VLBW/PT infants used more playful and utilitarian

function of touch compared to mothers of full-term infants (see Figure 2).

To examine the types of self-regulating behaviors used by full-term and VLBW/PT infants across interaction periods, a 6 x 2 x 2 (Self-Regulating Behavior x Period x Group) repeated measures ANOVA was conducted. A main effect for Self-Regulating Behavior, $F(5, 380) = 118.42$, $p < .001$, $\eta_p^2 = .61$, indicated that infants spent the most time engaged in bidirectional exchanges with their mothers ($M = 35.79$, $SE = 1.75$), gaze aversion ($M = 31.63$, $SE = 1.88$), self-comfort regulatory ($M = 21.07$, $SE = 1.79$), followed by self-comfort exploratory ($M = 4.76$, $SE = 0.88$), and finally, escape ($M = 0.88$, $SE = 0.13$) and attention-seeking ($M = 0.85$, $SE = 0.15$). A significant interaction between Self-Regulating Behavior and Period, $F(10, 760) = 82.20$, $p < .001$, $\eta_p^2 = .52$, revealed that infants used more self-comfort regulatory and exploratory, escape and attention seeking in the SF period compared to both Normal periods. Decreased gaze aversion was observed from the SF to the Reunion Normal period. Finally, bidirectional exchanges occurred more in the Reunion Normal period compared to the Normal and SF periods, and more frequently in the Normal than SF period (see Figure 3). A significant interaction between Self-Regulating Behavior, Period, and Group, $F(10, 760) = 1.91$, $p < .04$, $\eta_p^2 = .03$, indicated that full-term infants used more self-comfort regulatory behavior than VLBW/PT infants in the Reunion Normal period (Table 5).

2.3. Objective 2: Assess the Relationship between Maternal Functions of Touch and Infants' Self-Regulatory Behaviors

Bivariate correlations were carried out to assess the relationship between maternal functions of touch and the type of infants' self-regulatory behavior (Table 6). In the instance where both full-term and VLBW/PT dyads exhibited a significant correlation for

a specific pair of variables, Fisher's transformations were used to assess statistical significance between each pair of correlation coefficients to determine whether the strength of one correlation was stronger then another. Of note, since attention-seeking did not occur in either the Normal or Reunion Normal periods, it was removed from the analyses.

Overall Touch. During the Normal period, a positive correlation between overall maternal touch and bidirectional exchanges for full-term infants was observed, while negative correlations were obtained between self-comfort regulatory and exploratory behaviors and overall maternal touch for VLBW/PT infants. In the Reunion Normal period, overall maternal touch and infants' self-regulatory behavior were only related in full-term dyads: overall maternal touch was negatively associated with self-comfort exploratory behavior and positively associated with gaze aversion.

Playful Touch. In the Normal period, a positive association was obtained for playful touch and bidirectional exchanges for both groups. In addition, playful touch was negatively associated with self-comfort exploratory behaviors for VLBW/PT infants. Since both groups reported a significant correlation between playful touch and bidirectional exchanges, Fisher's transformation was used. Results indicated that the strength of the correlation between playful touch and bidirectional exchanges tended to be stronger in VLBW/PT dyads ($z = -0.53$, $p = 0.60$, two-tailed). In the Reunion Normal period, playful touch was negatively associated with self-comfort exploratory behavior in full-term infants only.

Attention-Getting Touch. In the Normal period, attention-getting touch was positively associated with gaze aversion and negatively associated with bidirectional

exchanges in both groups. Fisher's transformations were computed and results indicated that the strength of the correlation between attention-getting touch and gaze aversion tended to be stronger in VLBW/PT dyads ($z = -0.53$, $p = 0.59$, two-tailed) while no differences were obtained across group for attention-getting touch and bidirectional exchanges ($z = -0.15$, $p = 0.88$, two-tailed). In the Reunion Normal period, attention-getting touch was positively associated with gaze aversion in both groups and negatively associated with bidirectional exchanges in VLBW/PT dyads. Fisher's transformation indicated that the strength of the association was stronger for VLBW/PT dyads than in full-term dyads ($z = -0.66$, $p = 0.05$, two-tailed).

Discussion

The present study examined both maternal touch and infants' self-regulating abilities in a sample of 5 ½ month-old full-term and VLBW/PT infants and their mothers during a SF procedure. Our systematic evaluation of maternal touch revealed that during Normal periods of interaction, both groups of mothers touched their infants on average 82% of the time, supporting existing evidence that touch is a prevalent mode of communication and regulation within the dyad (e.g., Feldman, 2011; Hertenstein, 2002; Stack & Jean, 2011; Tronick, 1995). Maternal touch was found to serve various functions during dyadic interactions such as attention-getting, playful, nurturing, utilitarian functions, and served as an accompaniment to other maternal modalities of communication (e.g., vocalization, gesture, and facial expression). In line with previous research (e.g., Jean, Stack, & Fogel, 2009; Moreno et al., 2006; Polan & Ward, 1994), the observed changes in the function of touch across periods suggest that mothers adapted their tactile behavior based on their infants' affect and behavior, and based on the

demands and context of the interaction. Specifically, more attention-getting touch was observed at the beginning of the procedure and served to actively engage infants in the interaction. Increased playful and nurturing touch were demonstrated during the Reunion Normal period implying that mothers are intentionally and effectively using touch to stimulate and soothe their infants, thereby facilitating the re-engagement and co-regulation processes (Arnold, 2002; Moreno et al., 2006). As expected, mothers of VLBW/PT infants used more playful touch, thus providing further support for the contention that mothers of preterm infants provide a more stimulating style of interaction (Crawford, 1982; Crnic et al., 1983). This finding may have important implications for VLBW/PT infants neurodevelopment consistent with Weiss and colleagues' (Weiss et al., 2004; Weiss, 2005) findings that preterm infants whose mothers used more stimulating tactile behaviors had better visual-motor skills, fine motor abilities, and more advanced language acquisition skills. Given the positive association between playful touch and bidirectional exchanges in VLBW/PT dyads in conjunction with the observed high levels of infants' smiling and maternal sensitivity, it can be argued that preterm mothers' stimulating interaction style was positive. In addition, it reflected mothers' knowledge of their infants' preferences for different tactile stimulation. In contrast, others have speculated that preterm mothers' increased stimulation results from a lack of sensitivity to infants' affect, a lack of knowledge of infants' interactive preferences, or as a way to compensate for infants' lack of responsiveness (Bozzette, 2007; Crawford, 1982; Crnic et al, 1983). Finally, although utilized for less than 3% of the overall interaction, mothers of VLBW/PT infants used more utilitarian touch than mothers of full-term infants. The utilitarian touch category is comprised of caregiving touches such as readjusting the

infants' posture or fixing the infants' clothes. As such, the observed significant difference in the amount of utilitarian touch might be indicative of VLBW/PT mothers' sensitivity toward their infants' needs or might suggest that VLBW/PT infants needed slightly more caretaking behaviors. Along the same lines, a decrease in the use of utilitarian touch as been empirically documented as infants mature (Ferber, Feldman, & Makhoul, 2008; Jean, Stack, & Fogel, 2009). Consequently, a lower level of utilitarian touch in full-term dyads may be indicative of a somewhat higher level of maturity and autonomy.

Results from our study support research documenting that 5 ½-month-old infants possess a wide range of regulatory behaviors (Braungart-Rieker & Stifter, 1996; Feldman et al., 2002; Weinberg & Tronick, 1996). Infants' increased reliance on their own self-regulatory behavior during the SF period replicates earlier research demonstrating an increase in self-touch, exploration, and gazing away during a period of maternal unavailability (Braungart-Rieker & Stifter, 1996; Moszkowski & Stack, 2007; Toda & Fogel, 1993), but this time with both a full-term and a VLBW/PT infant sample. These findings, along with the observed low levels of attention-seeking and escape and in combination with the low level of fretting experienced during the SF period, are indicative of 5 ½ month-old infants' ability to successfully self-regulate without their mothers' assistance at least for a brief period of time (Mayes & Carter, 1990). Yet, the high duration of bidirectional exchange observed during both Normal periods underscores mothers' important role in regulation.

Partial support was obtained regarding differences in emotion regulation capacity between full-term and preterm infants. Although full-term infants were expected to use more advanced self-regulatory strategies, specifically more gaze aversion and self-

comfort regulatory and exploratory behavior (Rothbart, Ziaie, O'Boyle, 1992; Stifter & Braungart, 1995), group differences were only obtained for self-comfort regulatory during the Reunion Normal period. These results suggest that although their mothers' availability was renewed following the SF, full-term infants were still relying on their independent regulatory abilities. In line with this assumption, Montirosso and colleagues (2010) documented an increase in preterm infants' gaze at their caregivers during the Reunion Normal period, indicating that following the SF period preterm infants are seeking regulatory support from their mothers (Gianino & Tronick, 1988; Montirosso et al., 2010). Results from our study indicate that, although not significant, VLBW/PT dyads spent more time engaged in bidirectional exchanges in the Reunion Normal period compared to full-term dyads (60.70% vs. 52.15%) thus reflecting the reduced need of VLBW/PT infants to engage in other forms of self-regulation. This finding suggests that either VLBW/PT infants are relying more on their mothers for regulation because they possess less autonomous regulatory abilities or because they seek and prefer the support of their mothers when available. Based on our findings, it is possible to assert that at 5 ½ months of corrected age, healthy VLBW/PT infants have acquired appropriate self-regulatory abilities however they are still seeking the regulatory support of their mothers when available (Melinder, Forbes, Tronick, Fikke, & Gredebäck, 2010; Mesman et al., 2009; Montorisso et al., 2010).

Perhaps most novel in this experiment was the examination of the possible relationships between maternal touch and infants' self-regulatory behaviors. For both groups, the presence and quality of maternal touch was associated with infants' self-regulating behavior, thus providing further evidence for the role of mothers in infants'

regulation (Gianino & Tronick, 1989; Kopp, 1988), as well as underscoring the regulatory roles of touch (Hertenstein, 2002; Jean & Stack, 2009; Stack & Jean, 2011; Tronick, 1995). In both groups, an increase in the overall amount of touch was associated with decreased use of specific self-comforting strategies; thus implying that when maternal touch is available infants do not have to rely as much on their own self-regulating abilities. In addition, playful touch was positively related to bidirectional exchanges in both groups during the Normal period. This result is consistent with Moreno and colleagues (2006) who documented that infants were more active and focused on their mothers when mothers provided stimulating touch. Finally, a positive relationship between attention-getting and gaze aversion was observed in both periods. Consistent with previous literature, this finding suggests an association between infants gazing away from their mothers and the use of touch as a mean to recapture infants' attention (Kaye & Fogel, 1980; Jean & Stack, 2009). Contrary to our hypothesis, no significant associations were obtained between nurturing touch and infants' self-regulatory abilities. We believe that these variables may be related when infants are experiencing higher levels of negative affect or distress than observed during this current study. In addition, other statistical strategies such as sequential analysis, co-occurrence analysis or temporal contingency assessment (Cole, Martin, & Dennis, 2004; Jahromi et al. 2004; Kaye & Fogel, 1980) may better capture the association between nurturing touch and infants' self-regulatory behaviors.

Taken together, these findings suggest clear associations between maternal touch and infants' self-regulatory behaviors. Previous studies using the SF paradigm have provided evidence for the regulatory role of maternal touch when other sources of

regulation such as maternal voice or facial expression are not present (see Stack & Jean, 2011). Results from the current study provide evidence that maternal touch is not only a compensatory regulation mechanism when other sources of maternal regulation are absent, but that it is an important and influential source of regulation on its own. However, it is important to note that correlational analysis only provides a measure of association between variables; it does not inform us on the direction of the effects. Future studies should use more advanced statistics such as those mentioned above to investigate how touch and self-regulation influence each other.

Together, findings from the current study extend our knowledge on the implications of prematurity on maternal touch and self-regulating abilities, as well as VLBW/PT infants' reactions to the SF procedure. To our knowledge, this is the first study using the SF procedure specifically with 5 ½ month-old full-term and VLBW/PT infants. During face-to-face interactions with their mothers, VLBW/PT infants displayed enjoyment and responsiveness to their mothers, and reacted to the SF in a manner generally expected for 5 ½ month-old infants, hence demonstrating a socio-emotional maturity that is expected for their age (Melinder et al., 2010; Montirosso et al., 2010). Nevertheless, based on our findings VLBW/PT infants seem to possess less autonomous regulatory abilities. Understanding the mechanisms of self-regulation in premature infants and their parents' positive influence may have direct implications for supportive programs aimed at improving premature infants' socio-emotional outcomes.

The aforementioned findings must be considered in the context of the methodological strengths of this study. First, our VLBW/PT sample was composed of healthy infants who met rigorous inclusion/exclusion health criteria. As a result, infants

with complicated medical histories were excluded from our study. Consequently, our findings can be generalized to preterm infants without medical complications and not to preterm infants with complicated medical histories who generally exhibit increased self-regulating difficulties (e.g., Feldman, 2009; Korja et al., 2008; Wolf et al., 2002). Secondly, VLBW/PT infants were investigated at 5½ months of corrected age, instead of their chronological age. Finally, mothers of full-term and VLBW/PT infants were matched on three factors: SES status, education level, and age. Although this conservative approach increases validity and generalizability, it also decreases the chances of finding group differences. We expected more pronounced group differences in maternal touch and infants' self-regulating abilities. For example, we anticipated that across all three periods, VLBW/PT infants would display less advanced regulatory abilities. Future research would benefit from investigating other samples of preterm infants such as those having suffered from medical complications and chronic health conditions since early difficulties in self-regulation abilities have been observed in high-risk dyads (e.g., Feldman, 2009; Korja et al., 2008; Wolf et al., 2002). Moreover, evidence suggests that deficits in emotion regulation and in the quality of mother-infant interactions have generally dissipated in the second half of the first year for healthy preterm infants (Brachfeld, Goldberg, & Sloman, 1980; Forcada-Guex, Pierrehumbert, Borghini, Moessinger, & Muller-Nix, 2006). Consequently, longitudinal investigations are warranted to better understand the normative as well as the atypical development of self-regulation.

Results from the present study extend prior research by providing evidence for the relationship between maternal touch and infants' self-regulatory behaviors in the

regulatory process of full-term and VLBW/PT dyads. A rich description of the strategies employed by full-term and VLBW/PT infants to regulate was provided, underlining the diversity in infants' self-regulatory strategies at such a young age. Findings also add to existing research on the implications of prematurity for infants' social-emotional competence by underscoring the positive and normative nature of healthy VLBW/PT infant-mother interactions. Finally, results extend our knowledge of infants' emotional and behavioral regulation by underscoring the central roles that both mothers and infants play.

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Figure Captions

Figure 1. Mean percent duration of functions of maternal touch as a function of interaction periods. Error bars represent standard errors. * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 2. Mean percent duration of functions of maternal touch as a function of group. Error bars represent standard errors. * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 3. Mean percent duration of infants' self-regulatory behaviors as a function of interaction periods. Error bars represent standard errors. * $p < .05$, ** $p < .01$, *** $p < .001$

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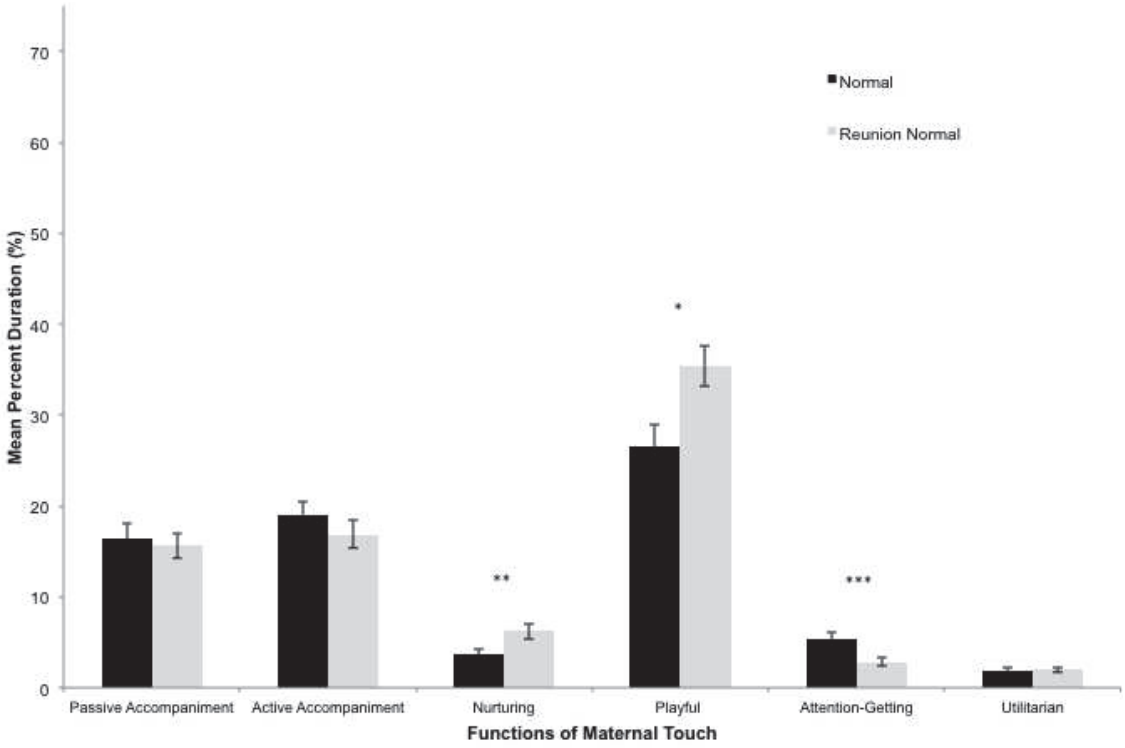
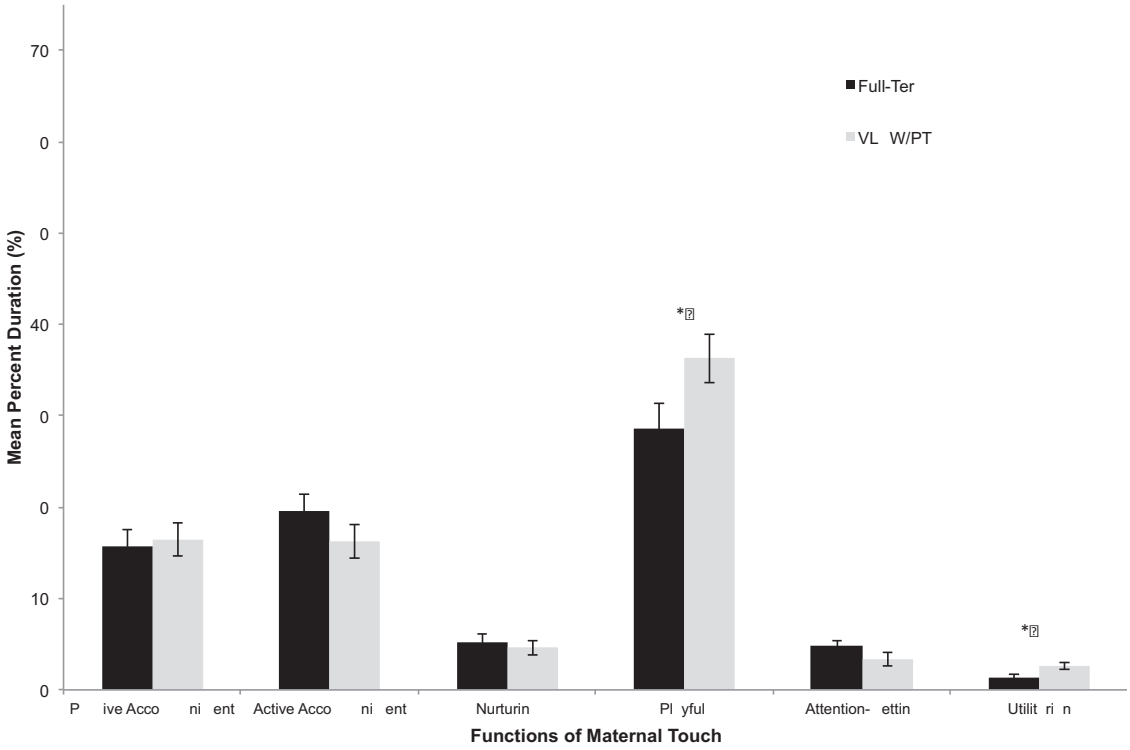


Figure 2. Mean percent duration of functions of maternal touch as a function of group. Error bars represent standard errors. * $p < .05$, ** $p < .01$, *** $p < .001$



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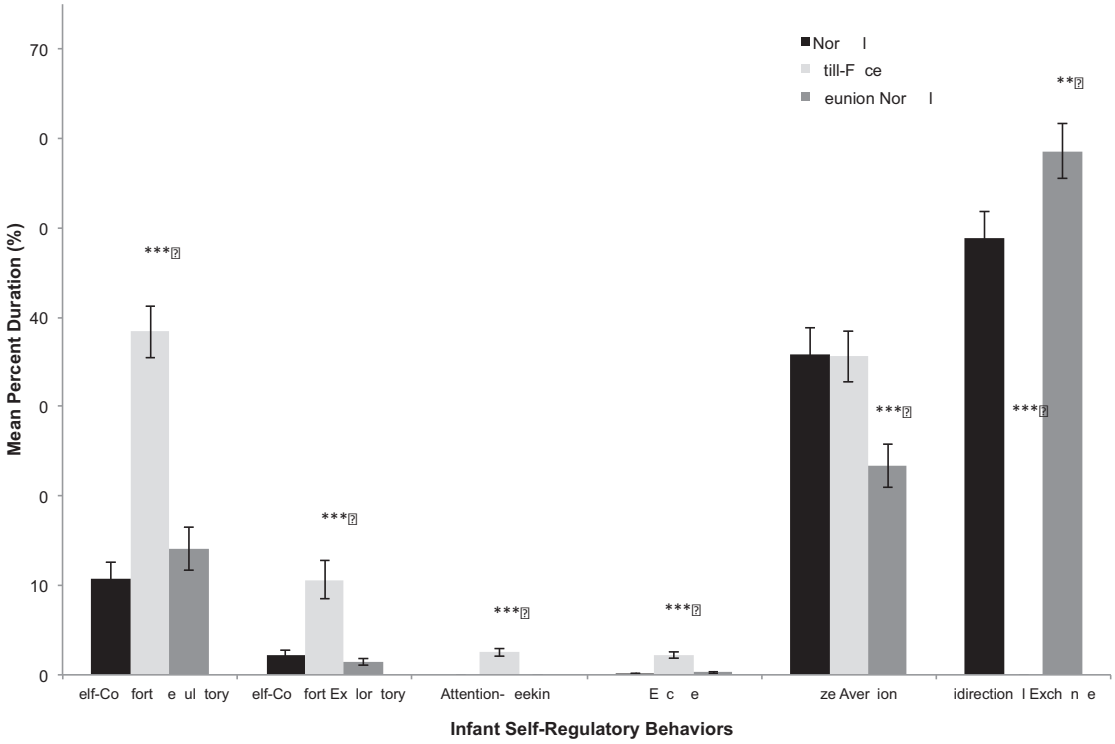

Table 1

Demographic and Medical Characteristics for Full-Term and VLBW/PT Infants

	Full-Term (n = 40)		VLBW/PT (n = 40)	
	M	*SD*	*M*	*SD*
Maternal age of birth (years)	30.62	5.13	32.86	5.68
Maternal education at birth ***	14.75	1.92	13.12	2.11
Infant birth weight (gram) ***	3476	395	1092	237
Infants gestational age (weeks) ***	39.74	1.08	28.51	2.29
Emergency C-section (%) **	30.00		81.00	
1 min APGAR ***	8.56	1.08	6.29	2.12
5 min APGAR ***	8.25	0.60	8.00	1.38
Length of hospital stay (days) ***	3.75	3.81	63.25	28.77
Infant length at birth (cm) ***	50.58	4.81	37.40	3.68
Infant head circumference (cm) ***	34.94	1.57	26.60	2.27
Infant weight at 5 ½ months (gram)	6800	0.89	6750	1.04
Infant height at 5 ½ months (cm)	64.18	4.41	62.65	3.54
Infant age at 5 ½ months (months and days)	5.12	6.70	5.14	8.21

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

Table 2

Brief Operational Definitions for Infant Self-Regulation Scheme (ISRS; Millman, Jean, & Stack, 2009)

Self-Comfort Regulatory	Infant is using touch as a way to self-regulate. Infant's gaze must be directed away from self or objects. Examples: mouthing of self or object, self-grasp, pulling clothes.
Self-Comfort Exploratory	Infant is touching him/herself or an object and his/her gaze must be directed toward the self or object of interest. Examples: using touch to explore his/her chair, playing with the chair's belt.
Attention-Seeking	Infant is trying to get his/her mother's attention during situations when the mother is not interacting with the infant, such as during the Still-Face, or when she is gazing away. Examples: infant is vocalizing in an exaggerated manner, reaching, or making motor movements toward mother.
Escape	Infant is attempting to get out of the chair. Generally, this behavior is accompanied by negative vocalizations. Examples: twisting and trying to get out of the chair.
Gaze Aversion	Infant is not looking at his/her mother. Infant is not interested in interacting with the mother and/or has his/her attention elsewhere.
Bidirectional Exchanges	Infant is regulating by being engaged in an interaction with his/her mother. Infant must be engaged in the interaction by reciprocating or simply gazing at mother's face, body, or hands. The dyad is typically in a state of joint-attention. Bidirectional exchanges are not possible during a Still-Face. Examples: infant and mother are playing peek-a-boo.

Table 3

Brief Operational Definitions for the Functions of Touch Scale (FTS; Jean, Girouard, & Stack, 2007)

Passive Accompaniment	Touch serves as an accompaniment to another modality of communication. The focus is not on touch. The tactile behavior of the mother is generally passive (e.g., almost static, not a lot of movements.)
Active Accompaniment	Touch serves as an accompaniment to another modality of communication. The focus is not on touch. The tactile behavior of the mother is active, with a lot of movement and repetition. The mother is typically lifting, moving, grabbing, or squeezing her infant's limbs. There is no game or playful aspect to the mother's behavior.
Nurturing	Touch is soothing and slow. The mother is typically kissing, stroking, or massaging her infant in an attempt to be affectionate with her infant or regulate her infant's negative affect. The mother is generally speaking in a soft tone of voice, and/or she is acknowledging her infant's emotion or behavior (e.g., "you are crying", "that was hard for you").
Playful	Touch is very active, playful, dynamic, repetitive and fast paced. The mother tends to tickle, shake, squeeze, lift, move, extend, or flex the infant's limbs. Typically, the goal is to make the infant smile and laugh. It is not only the presence of active types of touch that is important, but that there is a playful aspect to the touching event that is clearly evident. Touching is accompanied by maternal singing, game playing, noise making, or motherese.
Attention-Getting	Touch serves to get the infant's attention. The mother is typically tapping, patting, squeezing, pinching, or stroking the infant. Touching is accompanied by similar maternal attention-getting strategies in other modalities, such as calling the name of her infant, making noises with her mouth to get her infant's attention.
Accidental	Maternal tactile behavior is very brief, unintentional and fortuitous.
Utilitarian	Touch is used to accomplish a specific instrumental task such as removing the infant's hands from his/her mouth, or fixing the infant's clothes or posture.
Harsh or Negative	Maternal touch serves to control the infant's behavior. It is typically intrusive and performed in a negative manner.
Unspecified Function	No apparent function of maternal touch. No other maternal behaviors are present.

Table 4

Percent Duration of Touch and Function of Maternal Touch across Group and Interaction Periods

Periods	Normal		Reunion Normal	
Groups	Full-term	VLBW/PT	Full-term	VLBW/PT
Overall Touch	81.10	80.67	82.52	85.03
	(19.53)	(20.20)	(19.53)	(17.06)
Function of Touch				
Passive Accompaniment	16.42	16.58	14.98	16.29
	(13.77)	(15.43)	(12.23)	(12.56)
Active Accompaniment	20.46	17.55	18.79	14.96
	(12.08)	(15.02)	(15.02)	(11.88)
Nurturing	4.19	3.24	6.40	6.00
	(4.84)	(3.71)	(7.85)	(7.14)
Playful	26.06	33.22	31.29	39.44
	(18.41)	(23.00)	(19.35)	(19.95)
Attention-Getting	6.67	3.95	2.88	2.72
	(7.80)	(5.01)	(4.44)	(3.62)
Utilitarian	1.46	2.42	1.23	2.77
	(2.38)	(3.98)	(1.61)	(3.47)

Note. Numbers in parenthesis are standard deviations.

Table 5

Percent Duration of Full-Term and VLBW/PT Infants' Self-Regulatory Behaviors across Interaction Periods

Period	Normal		Still-Face		Reunion Normal	
Group	Full-Term	VLBW/PT	Full-Term	VLBW/PT	Full-Term	VLBW/PT
Self-Comfort Regulatory	12.55[a] (15.10)	9.99[a] (13.70)	37.46[a] (23.57)	38.83[a] (23.91)	19.40[a] (24.83)	7.85[b] (9.89)
Self-Comfort Exploratory	2.69[a] (4.39)	2.58[a] (4.81)	14.87[a] (18.74)	10.45[a] (16.85)	1.50[a] (3.08)	1.49[a] (3.00)
Attention-Seeking	0.00[a] (0.00)	0.00[a] (0.00)	2.72[a] (4.10)	1.79[a] (3.15)	0.00[a] (0.00)	0.00[a] (0.00)
Escape	0.25[a] (0.89)	0.08[a] (0.41)	1.58[a] (3.08)	1.59[a] (2.85)	0.21[a] (0.62)	0.34[a] (1.03)
Gaze Aversion	32.44[a] (23.81)	38.79[a] (24.43)	33.67[a] (22.88)	37.71[a] (23.05)	23.85[a] (18.88)	28.19[a] (20.89)
Bidirectional Exchanges	48.65[a] (24.58)	46.72[a] (23.78)	0.00[a] (0.00)	0.00[a] (0.00)	52.15[a] (27.27)	60.70[a] (23.33)

Note. Numbers in parenthesis are standard deviations. Means in a row and in the same period that do not share the same superscript differ at $p < .05$.

Table 6

Correlations between Functions of Maternal Touch and Infants' Self-Regulatory Behaviors

	Infants' Self-Regulatory Behaviors									
	Full-Term					VLBW/PT				
	SCR	SCE	ESC	GA	BID	SCR	SCE	ESC	GA	BID
Functions of Maternal Touch										
					Normal Period					
Overall Touch	-.12	-.14	.05	-.16	.32*	-.63***	-.35*	-.15	.23	.26
Passive Accompaniment	-.11	.22	.17	.01	-.07	-.12	.04	.01	.05	-.01
Active Accompaniment	-.09	-.20	.09	.03	.09	-.17	.07	.10	.22	-.11
Nurturing	-.03	-.08	.29	.08	.03	-.02	.05	-.18	-.14	.17
Playful	.09	-.16	-.20	-.29	.38**	-.23	-.44**	-.11	-.20	.48**
Attention-Getting	-.08	.04	-.16	.39*	-.36*	-.21	-.12	-.07	.49***	-.33*
Utilitarian	-.01	.24	.11	.19	-.25	-.12	.19	-.03	.13	-.16
					Reunion Normal Period					
Overall Touch	-.05	-.51***	.07	.35*	.03	-.02	-.04	.02	.14	-.14
Passive Accompaniment	-.17	-.14	-.12	.43**	-.06	.01	.29	.03	.19	-.26
Active Accompaniment	-.12	-.16	-.05	-.10	-.04	.01	-.12	.17	.11	-.09
Nurturing	.15	-.04	.25	-.10	-.04	.15	-.20	.21	-.11	.08
Playful	.20	-.41**	.03	-.16	.12	-.06	-.20	-.14	-.14	.22
Attention-Getting	-.20	.08	.07	.40**	-.09	.01	.27	-.03	.52***	-.54***
Utilitarian	-.08	.20	-.09	.17	-.12	.07	.25	-.13	.12	-.25

Note: SCR = Self-Comfort Regulatory, SCE = Self-Comfort Exploratory, ESC = Escape, GA = Gaze Aversion, BID = Bidirectional Exchanges.
* $p < .05$, ** $p < .01$, *** $p < .001$.

CHAPTER 3:

STUDY 1B

While Study 1a was integral in understanding the role of maternal touch and infants' self-regulatory behaviors in the emotion regulation of full-term and VLBW/PT dyads, several issues warrant further investigation.

First, findings from Study 1a documented clear associations between the functions of maternal touch and infants' self-regulatory behaviors. Moreover, it demonstrated that maternal touch is an integral part of infants' external regulatory mechanisms suggesting that maternal functions of touch and infants' self-regulatory behaviors are involved in infants' emotion regulation. However, it remains unclear how both specifically contribute to the regulation of infants' affect. Furthermore, clarification is needed to understand how infants' affect is associated with maternal and infants' regulatory behaviors**.** This examination is central to further elucidating the role of touch in emotion regulation.

Second, evidence suggests that infants react to the SF period by exhibiting a "signature" SF effect (i.e., increased fretting, and decreased smiling and gazing at mother; Adamson & Frick, 2003). However, previous studies have predominantly focused on infants' individual emotional and attentional responses to the SF period, relative to a more global measure of infants' behavior (e.g., infants' distress level). Although infants' affect and gaze are considered strong indicators of infants' reactions to the SF (Mesman, van Ijzendoorn, & Bakermans-Kranenburg, 2009), a measure of infants' distress could simultaneously consider infants' affect, attention, vocalizations, and motor movements. Thus, such a measure may better represent what mothers are

perceiving or responding to than a subtle change in infants' affect or gaze alone. Few studies have investigated infants' distress level; however the existing literature indicates that infants' distress impacts on subsequent maternal behavior (Calkins, Hungerford, & Dedmon, 2004; Mayes, Carter, Egger, & Pajer, 1991). In addition, since prematurity has been hypothesized to affect maternal responses to infants' distress and infants' abilities to clearly communicate emotion dysregulation (Muller-Nix et al., 2004; Segal et al., 1995), investigating how infants' distress influences both infants' self-regulatory behavior and maternal touch is important.

Currently, scientific evidence suggests that maternal touch is effective in regulating infants' behavior and affect (e.g., Bigelow & Power, 2012; Feldman, Singer, & Zagoory, 2010; Jean & Stack, 2009; Stack & Muir, 1990; 1992). Stack and Muir (1992) demonstrated that it is not only the presence of maternal touch that impacts infants' emotion regulation, but also the quality of that maternal touch. For example, there is evidence that maternal affectionate and nurturing touches are used by mothers to sooth and relax their infants (e.g., Arnold, 2002; Jean & Stack, 2009; Moreno et al., 2006). In addition, an increase in nurturing touch was documented when infants exhibited a medium-high level of distress during the SF period (Jean & Stack, 2009). In contrast, playful and stimulating touches were related to infants' smiling (Stack & Jean, 2011). Finally, an increase in infants' smiling and gazing at mothers' faces was associated with the use of mothers' stimulating and playful touch (Jean, 2006; Moreno, Posada, & Goldyn, 2006; Stack, LePage, Hains, & Muir, 1996).

Similarly, clear associations between infants' self-regulatory behaviors and infants' current emotional and attentional states have been documented (e.g., Braungart-

Rieker, Garwood, Powers, & Notaro, 1998; Weinberg & Tronick, 1996). For example, Weinberg and Tronick (1996) demonstrated that 6-month-old infants' gazing at mothers was associated with self-soothing through touch, while infants' anger was related to escape behaviors. In addition, Bridges, Grolnick, and Connell (1997) documented that infants who engaged in active exploration of a toy, or gazed away from their parents, displayed fewer negative emotions.

Although the aforementioned findings suggest that maternal touch and infants' self-regulatory behaviors are independently associated with infants' affect, no studies have attempted to understand how they may both be associated with infants' positive and negative affect. As a consequence, the present study had two primary objectives. First, differences in nurturing touch and infants' self-regulatory behaviors were examined across infants' distress level (i.e., low or medium-high distress level) displayed during the SF period (Malatesta et al., 1986; Muller-Nix et al., 2004). Consistent with previous literature (Jean & Stack, 2009; Moreno et al., 2006), and the findings from Study 1a, nurturing touch was specifically investigated with regard to infant distress. Based on existing evidence (; e.g., Feldman & Eidelman, 2007; Field, 1979; Malatesta et al., 1986; Minde, Perrotta & Marton, 1985; Muller-Nix, et al., 2004) only mothers of full-term infants were expected to use more nurturing touch when their infants displayed higher levels of distress). Pertaining to regulatory strategies, full-term and VLBW/PT infants exhibiting low levels of distress were expected to use higher levels of gaze aversion and self-comfort regulatory and exploratory behaviors while infants exhibiting higher levels of distress were expected to exhibit more escape behaviors (Braungart-Rieker et al., 1998; Braungart-Rieker & Stifter, 1996; Johnson, 1999; Stifter & Braungart, 1995).

Second, the association between maternal touch, infants' self-regulatory behaviors, and infants' smiling was investigated. In light of results from previous studies, playful touch was examined in relation to smiling (Jean, Moszkowski, Girouard, & Stack, 2008; Moreno et al., 2006; Weiss, Wilson, Hertenstein, & Campos, 2000). Together with playful touch, bidirectional exchanges, self-comfort regulatory and exploratory behaviors were expected to be positively associated with the amount of smiling during both Normal periods in full-term and VLBW/PT infants. For the SF period, given the expected positive association between smiling and playful touch during the Normal period, playful touch during the Normal period was expected to be positively associated with infants' smiling during the SF period. In contrast, self-comfort regulatory and exploratory behaviors, and gaze aversion in the SF period were expected to be negatively associated with smiling during the SF period.

Method

The participants, procedure, apparatus, and behavioral coding were the same as in Study 1a. As a result, only the description of infants' distress level was added in the behavioral coding section.

Behavioral Coding

Infants' distress level. Subsequent to viewing the SF period, the experimenter coded for infants' global distress level (Jean & Stack, 2009). While distress level was made up in part by infants' fretting, distress level and fretting were different. That is, both the duration of infants' fretting, negative vocalizations, and infants' motor behaviors (e.g., trying to get out of the chair, gesturing toward their mothers) were used to determine the level of infants' distress (low, medium or high; see Appendix E for brief

operational definitions).

Results

Infants' distress level, as well as percent durations for functions of maternal touch, infants' self-regulatory behaviors, and infants' affect and gaze at mothers' faces obtained in Study 1a were used in the following analyses (see Results section in Chapters 2 for results for functions of maternal touch, infants' self-regulatory behaviors, and infants' affect and gaze at mothers' faces). Descriptive statistics were conducted to assess for the presence of outliers, and to verify the normality of the distribution. When significant skewness or kurtosis was found, outliers were brought in according to the method described by Tabachnick and Fidell (1996), where the score is brought in to the next acceptable level and 1 is added to the score. As a result of bringing in outliers, there was no skewness or kurtosis in the data hence no transformations were required. When ANOVAs revealed significant interactions, Šidāk pairwise comparisons were used to isolate the source of the significance (Šidāk, 1967). Furthermore, for significant ANOVAs, partial eta-squared (η_p^2) are reported as a measure of effect size; a η_p^2 of .01, .06, and .14 indicate small, medium, or large effect sizes (Clark-Carter, 1997).

Objective 1: Influence of Infants' Distress Level on Maternal Functions of Touch and Infants' Self-Regulatory Behaviors

Given the low frequency of infants' distress, the medium and high levels of infants' distress were combined (low distress: full-term n = 29, VLBW/PT n = 28; medium-high distress: full-term n = 11, VLBW/PT n = 12). A Chi-Square Test confirmed that more infants exhibited low distress than medium-high level of distress, χ^2 (1, N = 80) = 14.50, $p < .001$, while no group differences were obtained between full-term and

VLBW/PT groups, $\chi^2(1, N = 80) = 0.00$, $p = 1.00$. A 2 x 2 x 2 (Period x Group x Infants' Distress) repeated measures ANOVA was performed to assess the differences in the amount of mothers' nurturing touch based on infants' distress level. A significant interaction, $F(1, 76) = 3.95$, $p < .05$, $\eta_p^2 = .05$, indicated that mothers of full-term infants used more nurturing touch in the Reunion Normal Period when their infants exhibited medium-high level of distress (low distress, $M = 4.49\%$, $SE = 1.35$, medium-high distress, $M = 11.44\%$, $SE = 2.19$) compared to the Normal period (low distress, $M = 4.14\%$, $SE = 0.81$, medium-high distress, $M = 4.32\%$, $SE = 1.32$). In contrast, mothers of VLBW/PT infants did not adjust their tactile behavior to their infants' distress level (Normal period: low distress, $M = 3.20\%$, $SE = 0.83$, medium-high distress, $M = 3.35\%$, $SE = 1.27$; Reunion Normal period: low distress, $M = 5.93\%$, $SE = 1.37$, medium-high distress, $M = 6.18\%$, $SE = 2.10$).

In order to assess the impact of infants' distress level on their self-regulatory behaviors a 6 x 2 x 2 x 2 (Self-Regulatory Behaviors x Period x Group x Infants' Distress) repeated measures ANOVA was conducted. A significant interaction, $F(10, 760) = 1.75$, $p = .06$, $\eta_p^2 = .03$, indicated that during the SF period, low distress infants tended to use more self-comfort exploratory behavior while medium-high distress infants tended to display more escape behavior. In the Reunion Normal period, low distress infants tended to display more gaze aversion than medium-high distress infants (see Table 1).

Objective 2: Association of Infants' Smiling and Maternal Functions of Touch and Infants' Self-Regulatory Behaviors

Hierarchical regression analyses were conducted to evaluate the contribution of

Table 1

Percent Duration of Infants' Self-Regulatory Behavior across Interaction Periods as a Function of Infants' Distress Level

Periods	Normal		Still-Face		Reunion Normal	
Distress Level	Low Distress	Medium-High Distress	Low Distress	Medium-High Distress	Low Distress	Medium-High Distress
Self-Comfort Regulatory	11.89[a]	9.59[a]	37.54[a]	39.23[a]	13.06[a]	15.08[a]
	(1.93)	(3.03)	(3.13)	(4.93)	(2.53)	(3.99)
Self-Comfort Exploratory	3.11[a]	1.44[a]	15.48[a]	5.79[b]	1.66[a]	1.12[a]
	(0.61)	(0.96)	(2.32)	(3.65)	(0.41)	(0.64)
Attention-Seeking	0.00[a]	0.00[a]	1.88[a]	3.21[a]	0.00[a]	0.00[a]
	(0.00)	(0.00)	(0.48)	(0.76)	(0.00)	(0.00)
Escape	0.18[a]	0.14[a]	0.77[a]	3.63[b]	0.28[a]	0.26[a]
	(0.09)	(0.14)	(0.36)	(0.56)	(0.11)	(0.18)
Gaze Aversion	35.60[a]	36.20[a]	36.03[a]	35.19[a]	29.60[a]	17.14[b]
	(3.14)	(4.95)	(3.04)	(4.79)	(2.56)	(4.03)
Bidirectional Exchanges	45.90	51.73[a]	0.00[a]	0.00[a]	53.41[a]	63.71[a]
	(3.18)	(5.01)	(0.00)	(0.00)	(3.34)	(5.25)

Note. Numbers in parenthesis are standard errors. Means in a row and in the same period that do not share the same superscript differ at $p < .05$.

playful touch, self-comfort regulatory and exploratory behaviors, and bidirectional exchanges to the prediction of full-term and VLBW/PT infants' smiling in the Normal and Reunion Normal periods. Given the relatively small sample size and the number of analyses that were planned, it was deemed necessary to reduce the number of variables to be included in the study. All analyses conducted included a minimum of 10 participants per predictor variable, which is within the recommended minimum required for a hierarchical regression analysis (Tabachnick & Fidell, 1996). As a result, only 4 predictors were selected. First, based on a documented association between playful touch and smiling (e.g., Jean, 2006; Moreno et al., 2006; Weiss et al., 2000), playful touch was selected as a predictor. Second, self-comfort regulatory and exploratory behaviors were selected because they represent regulatory behaviors that include infant touch and because they each showed a significant correlation with smiling (see Appendix G). Finally, bidirectional exchanges was included as a predictor for the regression assessing levels of smiling during the Normal and Reunion Normal periods since it is the only dyadic regulatory strategy. Given that there can be no bidirectional exchanges in the SF, for the regression assessing the level of smiling in the SF, gaze aversion was entered instead since it represents infants' attention toward mothers. For all regressions, playful touch was entered in the first step, self-comfort regulatory and self-comfort exploratory were entered in the second and third steps, while bidirectional exchanges was entered in the last step. The rationale for this order was that maternal predictors were entered first because the major focus of the dissertation was on maternal touch; infant predictors were entered second, and finally, the dyadic predictor was entered last.

As illustrated in Tables 2 and 3, for both groups, playful function of touch, self-comfort regulatory behavior, and bidirectional exchanges emerged as significant predictors of infants' smiling in the Normal period. These findings imply that when mothers provided high levels of playful touch and when full-term and VLBW/PT infants exhibited high levels of self-comfort regulatory behaviors and engaged in bidirectional exchanges with their mothers in the Normal period, infants were more likely to smile.

In the Reunion Normal period, playful touch emerged as a significant predictor of infants' smiling for both groups of infants while for VLBW/PT infants, bidirectional exchanges was also found to be a significant predictor. These findings imply that during the Reunion Normal period, when mothers of full-term infants provided high levels of playful touch infants were more likely to smile, while VLBW/PT infants were more likely to smile when their mothers provided high levels of playful touch and when they engaged in bidirectional exchanges with their mothers (see Tables 4 and 5).

One final hierarchical regression for each group was conducted to investigate whether playful touch in the Normal period, self-comfort regulatory and exploratory behavior, and gaze aversion during the SF period were associated with full-term and VLBW/PT infants' smiling in the SF period. Playful touch was entered in the first step, self-comfort regulatory and exploratory behaviors were entered in the second and third steps, and gaze aversion was entered in the last step. As shown in Table 6, for full-term dyads, playful touch remained a significant predictor until the last step, when self-comfort regulatory and exploratory behavior, as well as gaze aversion, emerged as significant predictors. For VLBW/PT dyads (Table 7), self-comfort regulatory and exploratory behavior, as well as gaze aversion, emerged as significant predictors in the

Table 2

Summary of Hierarchical Regression Analysis for Variables Predicting Full-Term Infants' Smiling in the Normal Period

Variables	β	sr^2	t	R^2_{ch}	F_{ch}
Step 1				0.43	29.16***
Playful	0.66	0.66	5.40***		
Step 2				0.08	5.71*
Playful	0.63	0.63	5.48***		
Self-Comforting Regulatory	0.28	0.28	2.39*		
Step 3				0.02	1.59
Playful	0.61	0.60	5.25***		
Self-Comforting Regulatory	0.28	0.28	2.45*		
Self-Comforting Exploratory	- 0.15	- 0.14	- 1.26		
Step 4				0.12	11.96***
Playful	0.46	0.42	4.19***		
Self-Comforting Regulatory	0.39	0.37	3.67***		
Self-Comforting Exploratory	- 0.11	- 0.10	- 0.10		
Bidirectional Exchanges	0.48	0.35	3.46***		
	R = .81		R^2 adj. = .61		F = 16.26 ***

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

Table 3

Summary of Hierarchical Regression Analysis for Variables Predicting VLBW/PT Infants' Smiling in the Normal Period

Variables	β	sr^2	t	R^2_{ch}	F_{ch}
Step 1				0.23	10.58**
Playful	0.48	0.48	3.25**		
Step 2				0.07	3.65
Playful	0.55	0.53	3.74***		
Self-Comforting Regulatory	0.28	0.27	1.91		
Step 3				0.001	0.03
Playful	0.56	0.50	3.45**		
Self-Comforting Regulatory	0.28	0.26	1.81		
Self-Comforting Exploratory	0.03	0.03	0.18		
Step 4				0.13	7.64**
Playful	0.40	0.34	2.53*		
Self-Comforting Regulatory	0.30	0.29	2.18*		
Self-Comforting Exploratory	0.05	0.04	0.34		
Bidirectional Exchanges	0.41	0.37	2.76**		
	R = .66		R^2 adj. = .37		F = 6.31***

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

Table 4

Summary of Hierarchical Regression Analysis for Variables Predicting Full-Term Infants' Smiling in the Reunion Normal Period

Variables	β	sr^2	t	R^2_{ch}	F_{ch}
Step 1				0.26	13.55***
Playful	0.51	0.51	3.68***		
Step 2				0.05	2.46
Playful	0.56	0.55	3.99***		
Self-Comforting Regulatory	-0.22	-0.21	-1.57		
Step 3				0.06	3.60
Playful	0.44	0.40	3.01**		
Self-Comforting Regulatory	-0.23	-0.22	-1.67		
Self-Comforting Exploratory	-0.28	-0.25	-1.90		
Step 4				0.04	2.14
Playful	0.41	0.36	2.79**		
Self-Comforting Regulatory	-0.03	-0.03	-0.13		
Self-Comforting Exploratory	-0.18	-0.18	-1.16		
Bidirectional Exchanges	0.29	0.29	1.46		
	R = .64		R^2 adj. = .34		F = 6.03 ***

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

Table 5

Summary of Hierarchical Regression Analysis for Variables Predicting VLBW/PT Infants' Smiling in the Reunion Normal Period

Variables	β	sr^2	t	R^2_{ch}	F_{ch}
Step 1				0.23	10.15**
Playful	0.47	0.47	3.19**		
Step 2				0.00	0.11
Playful	0.47	0.47	3.14**		
Self-Comforting Regulatory	-0.05	-0.05	-0.33		
Step 3				0.04	1.65
Playful	0.43	0.42	2.83**		
Self-Comforting Regulatory	-0.00	-0.00	-0.02		
Self-Comforting Exploratory	-0.20	-0.19	-1.29		
Step 4				0.15	7.99**
Playful	0.38	0.37	2.75**		
Self-Comforting Regulatory	0.04	0.04	0.32		
Self-Comforting Exploratory	-0.02	-0.16	-0.12		
Bidirectional Exchanges	0.44	0.38	2.83**		
	R = .64		R^2 adj. = .34		F = 5.89**

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

Table 6

Summary of Hierarchical Regression Analysis for Variables Predicting Full-Term Infants' Smiling in the Still-Face Period

Variables	β	sr^2	t	R^2_{ch}	F_{ch}
Step 1				0.14	6.17*
Playful (N)	0.37	0.37	2.48*		
Step 2				0.02	0.88
Playful (N)	0.42	0.40	2.64*		
Self-Comforting Regulatory (SF)	-0.15	-0.14	-0.94		
Step 3				0.01	0.54
Playful (N)	0.40	0.38	2.48*		
Self-Comforting Regulatory (SF)	-0.18	-0.17	-1.11		
Self-Comforting Exploratory (SF)	-0.12	-0.11	-0.73		
Step 4				0.10	4.63*
Playful (N)	0.29	0.26	1.80		
Self-Comforting Regulatory (SF)	-0.59	-0.35	-2.40*		
Self-Comforting Exploratory (SF)	-0.45	-0.30	-2.07*		
Gaze Aversion (SF)	-0.55	-0.31	-2.15*		
	R = .52		R^2 adj. = .19		F = 3.22*

*$p < .05$, **$p < .01$, ***$p < .001$
N = Normal Period, SF = Still-Face Period

Table 7

Summary of Hierarchical Regression Analysis for Variables Predicting VLBW/PT Infants' Smiling in the Still-Face Period

Variables	β	sr^2	t	R^2_{ch}	F_{ch}
Step 1				0.08	3.04
Playful (N)	0.28	0.28	1.74		
Step 2				0.02	0.82
Playful (N)	0.29	0.29	1.77		
Self-Comforting Regulatory (SF)	0.15	0.15	0.91		
Step 3				0.02	0.59
Playful (N)	0.25	0.23	1.42		
Self-Comforting Regulatory (SF)	0.13	0.13	0.78		
Self-Comforting Exploratory (SF)	-0.13	- 0.13	- 0.77		
Step 4				0.23	11.00**
Playful (N)	0.06	0.06	0.38		
Self-Comforting Regulatory (SF)	- 0.76	- 0.35	- 2.49*		
Self-Comforting Exploratory (SF)	-0.71	- 0.44	- 3.07**		
Gaze Aversion (SF)	- 1.08	- 0.48	- 3.32**		
	R = .59		R^2 adj. = .26		F = 3.22*

*$p < .05$, ** $p < .01$, *** $p < .001$
N = Normal Period, SF = Still-Face Period

last step. These findings suggest that infants exhibiting high levels of gaze aversion, self-comfort regulatory and exploratory behaviors, were less likely to smile during the SF period.

Discussion

The two main objectives of Study 1b were to examine: 1) how infants' distress level was associated with infants' regulatory behaviors during and following the SF period, and maternal touch during the Reunion Normal period, and 2) how maternal touch and infants' self-regulatory behavior were related to infants' smiling. While a number of the hypotheses were supported, some findings were contrary to the expectations.

The findings from this study contribute to understanding the influence of infants' distress level on the amount of maternal nurturing touch. Consistent with our hypothesis, mothers of full-term infants provided more nurturing touch when infants exhibited distress, while mothers of VLBW/PT infants did not change their tactile stimulation in response to infants' distress level. In line with these findings, Malatesta and colleagues (1986) documented that mothers of full-term infants are better at matching and responding to their infants' negative affect. One possible explanation for the lack of change in mothers of VLBW/PT infants is that VLBW/PT infants may have had difficulty clearly communicating their distress and desire for maternal regulatory support (Field, 1979; Malatesta et al., 1986; Segal et al., 1995). In addition, it is possible that when confronted with infants' negative affect mothers of VLBW/PT infants may use other regulatory strategies to respond to distress, such as talking, smiling or gazing at their infants. Consistent with this assumption, mothers of preterm infants are reported to

be more vocally responsive towards their infants (Greene, Fox & Lewis, 1983; Schumucker et al., 2005). Future work should address the specific ways (i.e., other modalities of communication) in which mothers of preterm infants, as well as mothers of full-term infants, react to their infants' distress in order to clarify the possible negative implications of VLBW/PT mothers' lack of apparent responsiveness to their infants' distress.

The results from the present study make a strong case for full-term and VLBW/PT infants' abilities to successfully regulate their affect and attention during brief moments of distress. Given the generally low occurrence of infants' distress and fretting during the SF period, it can be argued that most infants were able to self-regulate during brief periods that can be considered stressful for some infants (Mesman et al., 2009). Similar to previous studies, and consistent with the hypotheses, infants who were able to re-direct their attention away from the source of stress (i.e., their mothers), and use the opportunity to explore their environment did not demonstrate overt levels of distress (Gianino & Tronick, 1988; Rothbart et al., 1992; Stifter & Braungart, 1995; Toda & Fogel, 1993). However, since one limitation of the present study pertains to the fact that no physiological stress markers (e.g., heart rate, vagal tone, cortisol) were measured, it is impossible to know whether these infants did not experience any distress or if they had developed more sophisticated ways of regulating. Given that previous studies have documented an increase in heart rate and cortisol during the SF procedure (Feldman et al., 2010; Haley & Stansbury, 2003; Lewis & Ramsay, 2005), a simultaneous investigation of physiological markers in future studies would clarify this issue.

In contrast, medium-high level of distress was associated with increased use of escape as a means to self-regulate during the SF period. During the Reunion Normal period, infants displaying a medium-high level of distress exhibited a significantly lower level of gaze aversion and, although not significant, a higher level of bidirectional exchanges, thereby suggesting their desire for regulatory support from mothers (Conradt & Ablow, 2010; Gianino & Tronick, 1988). Consistent with this interpretation, Calkins, Hungerford, and Dedmon (2004) found that infants exhibiting high levels of irritability sought their mother's attention and regulation more during a frustrating period (i.e., arm restraint procedure) than during play, and used less self-distraction and exploration. Nevertheless, the nature of the present study precludes a disentangling of which behaviors (i.e., infants experiencing distress or self-regulatory behavior) occurred first. In particular, while it is possible that infants were mildly distressed because they were re-orienting their attention away from their mother, it is also possible that they were re-orienting away from their mothers because they were not distressed. Future research is needed to extricate these possibilities.

Contrary to expectation, infants' level of distress was not associated with an increase in infants' use of self-comfort regulatory behavior. Given the high prevalence of self-comfort regulatory behavior observed in Study 1a during the SF period as well as the regulatory role of infants' touch during the SF period (Moszkowski & Stack, 2007; Moszkowski, Stack, & Chiarella, 2009), one possibility is that this regulatory strategy is consistently used by infants throughout the SF procedure to self-regulate regardless of their distress level. Similarly, the frequent use of a specific self-regulatory strategy by infants does not always involve a change in infants' affect or emotion (Bridges, Denham,

& Ganiban, 2004). Consequently, infants might be using self-comfort regulatory behaviors to *maintain* their arousal at a specific level which could involve as much regulation as trying to *up-regulate* a distress state. Another possibility for the lack of association between self-comfort regulatory behaviors and distress level may be attributed to the coding of distress as a global category, which was coded once at the end of the period. Infants' self-comfort regulatory behaviors might be associated with the incidence of distress, or when infants first show signs of distress, but not throughout the entire period. Therefore, in future work it would be beneficial to assess infants` distress level using second-by-second or interval (i.e., 10 seconds interval) coding (Conradt & Ablow, 2010; Moore & Calkins, 2004; Weinberg & Tronick, 1994). In this way, an assessment of the variability in infants' distress level throughout the SF period would be possible, which in turn would permit moment-to-moment associations between infants' distress level and self-regulatory behaviors.

One unique contribution made by the current research was the examination of how both maternal touch and infants' self-regulatory behaviors were associated with infants' smiling. Consistent with hypotheses, playful touch, as well as infants' self-comfort regulatory behavior and bidirectional exchanges between the dyad, were found to predict infants' smiling during the Normal period for both groups of infants. The positive association between playful touch and infants' smiling adds to the growing body of evidence documenting infants' increased enjoyment following physical play that includes touch (Blehar, Lieberman, & Ainsworth, 1977; Moszkowski, Jean, & Stack, 2005; Stack & Jean, 2011). In addition, this finding underscores the positive nature of dyadic reciprocal exchanges for both full-term and VLBW/PT dyads (Cohn & Tronick, 1989;

Kaye & Fogel, 1980). Furthermore, the positive association between infants' self-comfort regulatory behavior and smiling speaks to the role of infants' touch in regulating positive emotions; infants might have used self-comfort regulatory behavior, such as mouthing, to regulate the intense arousal experience during the interaction or in contrast, self-comfort regulatory behavior, such as fingering, might have resulted in smiling (Moszkowski & Stack, 2007). Since the coding scheme in the present study regrouped different types of infants' touch within the self-comfort regulatory behavior category (e.g., mouthing, stroking, fingering), future research may include investigations of specific infant tactile behaviors used during these instances (Moszkowski & Stack, 2007).

In contrast to findings from the Normal period, during the Reunion Normal period, only playful touch was associated with increased smiling for both groups of infants; however, bidirectional exchanges were positively associated with smiling for VLBW/PT infants. One possible explanation for these findings is the higher, albeit not significant, level of bidirectional exchanges in VLBW/PT infant-mother dyads during the Reunion Normal period. Thus, together with findings from Study 1a and Montirosso and colleagues' (2010) findings, results seem to suggest that full-term infants exhibit a more independent style of interaction during the Reunion Normal period. Taken together, these results highlight the fact that maternal touch, in conjunction with infants' self-regulatory behaviors, appears to be associated with the elicitation and maintenance of infants' smiling.

Finally, consistent with the hypotheses, self-comfort regulatory and exploratory behaviors and gaze aversion were negatively associated with infants' smiling during the SF period. Similar to previous studies (e.g., Morales, et al., 2005; Moszkowski & Stack,

2007; Stifter & Braungart, 1995; Rothbart, Ziaie, & O'Boyle, 1992), these regulatory behaviors are likely used to self-sooth during a time of increased stress (SF) rather than being used to elicit or maintain infants' smiling. Contrary to the hypotheses, and contrary to previous work in our own laboratory (Jean, 2006), the positive influence of playful touch during the Normal period did not carry-over to the SF period for both groups (i.e., full-term and VLBW/PT) of dyads. Although playful touch emerged as a significant predictor for full-term dyads, once gaze aversion was taken into account, its positive influence diminished. This result indicates that *current* self-regulating abilities, such as gaze aversion, might be more powerful regulators than *prior* maternal touch. Given that past studies have demonstrated that earlier maternal behaviors (e.g., interactive behaviors, sensitivity, responsiveness, affect) influence infants' reactions to the SF (Carter, Mayes, & Pajer, 1990; Stoller & Field, 1982; Tarabulsy et al. 2003; Tronick, Ricks, & Cohn, 1982) future studies would benefit from further addressing the association between other functions of touch and infants' smiling and fretting levels during the SF period.

In summary, findings from Study 1b underscored the importance of measuring how infants' distress level influenced subsequent maternal nurturing touch and infants' self-regulatory behaviors. Examining infants' reactions to the SF period was found to be essential in better understanding the reasons mothers use touch and infants resort to specific self-regulatory behaviors. Inferring that all infants react the same way may result in invalid conclusions and a lack of generalizability. Since the number of infants experiencing distress was small, and since no group differences were noted, it can be argued that full-term and VLBW/PT infants were generally able to successfully regulate during a brief period of stress. Furthermore, our results indicated that both maternal touch

and infants' self-regulatory behavior contributed to the elicitation and maintenance of infants' smiling, thus demonstrating that they are both important in infants' emotion regulation. Taken together, results from the current study demonstrate mothers' abilities to attune their tactile behavior to their infants' affect for both full-term and VLBW/PT infants, and to full-term infants' distress level, thereby providing further support for mothers' sensitivity toward their infants' emotional displays. The findings also add to the growing body of literature underscoring the positive and normative nature of healthy VLBW/PT infant-mother interactions.

CHAPTER 4:

STUDY 2

Investigating Maternal Touch and Infants' Self-Regulatory Behaviors during a Modified Face-to-Face Still-Face with Touch Procedure

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Abstract

Maternal touch and infants' self-regulatory behaviors were examined during a modified Still-Face with Touch (SF+T) procedure. Mothers and their 5½-month-old infants participated in one period of Normal interaction followed by three SF+T periods. Maternal functions of touch, and infants' self-regulatory behavior, affect, attention, and distress level were evaluated. Contrary to a typical SF procedure, the amount of smiling remained high while fretting remained low. High levels of maternal touching and variations in the functions of maternal touch were observed across periods. Playful touch remained high while there was an increase in nurturing touch and a decrease in attention-getting touch from the Normal to all SF+T periods. Similar amounts of self-regulatory behaviors were observed across periods with the exception of a decrease in bidirectional exchanges during the SF+T periods. Across periods, maternal touch and infants' self-regulatory behaviors were found to be temporally organized with infants' affect and attention. Finally, during the first SF+ T period mothers provided more nurturing touch to infants who exhibited medium-high level of distress while no changes were observed in infants' self-regulatory behaviors. Examining how mothers use touch when other forms of communication are absent increased our understanding of the role of touch in infants' emotion regulation.

During the first year of life, mothers act as external sources of regulation for their infants by supporting and facilitating their nascent emotion regulation abilities (e.g., Fox & Calkins, 2003; Kopp, 1989; Poehlmann et al., 2011). Through their emotional expressions, infants communicate their regulatory needs and desires (Kopp, 1989; Weinberg & Tronick, 1994). In response, mothers modify their own behavior with the goal of regulating infants' positive and negative arousal (Cole, Martin, & Dennis, 2004; Gianino & Tronick, 1988; Tronick, 2005). As such, mothers contribute to infants' regulation through distal modalities, such as vocalizations, gaze, and facial expressions, as well as through proximal modalities, such as touch (Hertenstein, 2002; Stack & Jean, 2011).

Touch is one essential means through which mothers modulate their infants' behavior and emotions (Stack, 2010; Tronick, 1995). It is an integral part of mother-infant interchanges occurring between 65-99% of the time during face-to-face interactions (Hertenstein, 2002; Stack & Jean, 2011). The regulatory benefits of maternal touch for infants' emotional expressions and attention have been documented in the scientific literature (e.g., Jean & Stack, 2009; 2012; Peláez-Nogueras, Field, Hossain, & Pickens, 1996; Stack & Muir, 1990; 1992). For example, caregiver-infant interactions, which include tactile stimulation and physical contact, were shown to elicit the most smiling and positive responses in infants (Dickson, Walker, & Fogel, 1997; Fogel, Hsu, Shapiro, Nelson-Goens, & Secrist, 2006). In addition, the reinforcing nature of stroking and soothing tactile behavior on infants' smiling has been documented (Peláez-Nogueras et al., 1996; Perez & Gewirtz, 2004). Similarly, Tronick and Brown (cited in Tronick, 1995) reported that the lowest level of infant crying was observed in a touch-only

condition compared to a series of conditions which included other forms of soothing behaviors used by mothers.

One way through which the regulatory benefits of touch have been examined is through the use of a modified Still-Face (SF) procedure, during which mothers are allowed to touch their infants (SF+T; Stack & Muir, 1990). Typically, a SF procedure consists of two normal periods of social interaction between a caregiver and an infant separated by a SF period. During the SF period, mothers are instructed to gaze at their infants, while maintaining a neutral facial expression and refraining from vocalizing or touching their infants (Tronick, Als, Adamson, Wise, & Brazelton, 1978). There is consistent evidence that infants respond to the SF period by displaying a "signature" SF effect which consists of a decrease in positive affect, with an increase in gazing away from mothers, fretting, and neutral affect (see Adamson & Frick, 2003; Mesman, van Ijzendoorn, & Bakermans-Kranenburg, 2009). Furthermore, as a means to cope with the distress associated with the SF period, infants increase their use of self-regulatory behaviors, such as self-touch, exploration and gaze aversion (e.g., Manian & Bornstein, 2009; Moszkowski & Stack, 2007; Toda & Fogel, 1993; Weinberg & Tronick, 1996). Such responses are an indication that in the context of maternal emotional unresponsiveness, infants resort to using their own internal regulatory mechanisms (Braungart-Rieker, Garwood, Powers, & Natoro, 1998; Gianino & Tronick, 1988).

In contrast to the basic SF procedure, during a SF+T procedure mothers are allowed to touch their infants, thereby permitting the potential for regulatory support to their infant via tactile stimulation. Consequently, examining how mothers touch their infants when other forms of communication are absent provides important insight into

how mothers use touch, and its role in infants' emotion regulation. For example, using a SF+T procedure with mothers and their 3, 6, or 9 month-old infants, Stack and Muir (1990) demonstrated that by adding maternal touch to the SF period, the "signature" SF effect was significantly diminished. Specifically, higher levels of infants' positive affect and gazing in the direction of mothers were observed as well as a decrease in negative affect. The regulatory benefits of touch were further documented by Feldman, Singer, and Zagoory (2010) who examined the effects of maternal touch on 6-month-old infants' stress levels during a SF+T period. Maternal touch attenuated infants' physiological stress responses, specifically their cortisol levels and cardiac vagal tone. Furthermore, compared to the standard SF period, lower levels of gaze aversion, fussing, and crying, and higher levels of laughing and cooing were observed. Taken together, results from these studies underscore the unique and significant contribution of maternal touch to infants' regulation.

The regulatory benefits of maternal touch were also underscored through Stack and Muir's (1992) study. They demonstrated that active rather than passive touch was responsible for modulating the SF effect, providing evidence that it is not only the mere presence of touch that is important in infants' regulatory processes but its specific qualities. In addition, they demonstrated that it was not the visual stimulation of the hands that elicited the effects but the tactile components of the touch. Several researchers (e.g., Hertenstein, 2002; Stack, 2010; Stack & Jean, 2011; Tronick, 1995) have hypothesized that different forms of touch may convey distinct meanings to infants and may generate specific responses from them. To assess this hypothesis, Stack and colleagues used a modified SF+T procedure during which mothers were given instructions on which infants

behaviors to elicit using only touch (Arnold, 2002; Stack & LePage, 1996; Stack, LePage, Hains, & Muir, 1996). Findings indicated that, for example, in order to get their infants relaxed, mother used more stroking behaviors, while they used high levels of tickling and lifting in order to get their infants happy and excited.

Our understanding of the regulatory functions of specific tactile behaviors on infants' affect and attention was further delineated in an investigation of 5 ½ month-old-infants interacting with their mothers during a SF procedure (Jean, Girouard, & Stack, 2008; Jean & Stack, 2009). During the Normal periods, maternal touch served various functions ranging from playful and stimulating to nurturing and soothing. Furthermore, maternal touch was related to infants' affect: an increase in playful touch was associated with infants' smiling while an increase in nurturing touch occurred when infants exhibited distress. Consistent with these findings, Moreno, Posada, and Goldyn (2006) established that maternal affectionate and stimulating touch influenced the dyadic regulation process in both mothers and their 3½ month-old infants. Specifically, when mothers provided affectionate touch, infants became calmer and shifted their attention away from her. In contrast, when infants were touched in a stimulating and playful way, they exhibited increased focus on their mothers. Finally, Hertenstein and Campos (2001) evaluated the impact of maternal touch on infants' emotional expressions. When mothers tensed their fingers around their infants' abdomen, infants' displayed more negative affect and decreased their tactile exploration of a novel object. Together, results from these aforementioned studies suggest that specific maternal tactile behavior can directly influence infants' affect and attentional focus, thus serving various regulatory roles within mother-infant exchanges.

Although evidence indicates that maternal touch plays a role in infants' emotion regulation (Moreno, et al., 2006; Stack & Jean, 2011), to date there is a paucity of research examining the association between infants' self-regulatory behaviors (internal means of regulation) and maternal touch (external means of regulation). Understanding how both means of regulation contribute to infants' emotion regulation is pivotal for a thorough comprehension of infants' self-regulating abilities and to more fully ascertain the unique contribution of maternal touch. Previous investigations focusing on infants' self-regulating abilities have documented that infants rely on several regulatory strategies to effectively maintain or reduce their arousal (Bridges, Denham, & Ganiban, 2004; Kopp, 1989; Rothbart, Ziaie, & O'Boyle, 1992). For example, results from studies have demonstrated that across periods of the SF procedure, infants engage in a number of self-regulatory behaviors (e.g., gaze aversion, attention-seeking, exploration, self-soothing), but the durations of these behaviors change when the regulatory support of caregivers becomes unavailable during the SF period (Braungart-Rieker et al., 1998; Moszkowski & Stack, 2007; Weinberg & Tronick, 1996). In addition, evidence suggests a clear association between infants' self-regulatory strategies and infants' current emotional and attentional states. For example, Weinberg and Tronick (1996) demonstrated that 6-month-old infants' gazing at mothers was associated with self-soothing through touch while infants' anger was related to escape behaviors. Similarly, infants who displayed more negative affect showed less self-comforting and less orienting toward a parent or an object (Braungart-Rieker et al., 1998). In contrast, Bridges, Grolnick, and Connell (1997) documented that 12 ½- to 14-month-old-infants who engaged in an active exploration of

a toy, as well as those who spent less time focusing on their parents when unavailable, displayed less negative emotion.

Taken together, given that infants' emotion regulation involves both internal (self-regulatory behavior) and external (e.g, maternal touch) means of regulation, a detailed investigation of the association between maternal touch and infants' self-regulatory behaviors is warranted to address how touch contributes to infants' emotion regulation. Several questions remain unanswered. First, an investigation of how different functions of maternal touch and infants' self-regulatory behaviors are uniquely related is essential to clarify how different functions of touch may help support specific infants' regulatory behaviors. Second, clarifying how different functions of touch in collaboration with infants' self-regulatory behaviors are associated with infants' affective displays and attention is warranted. Third, an examination of the influence of infants' distress during on maternal touch and infants' self-regulatory behavior is also necessary. Finally, since it is believed that there is a relationship between maternal touch and infants' self-regulatory abilities, studying these behaviors in an experimental context during which mothers can only use touch to regulate their infant, such as the SF+T procedure, is imperative to obtain a clear understanding of this relationship.

The present study was designed to address the four aforementioned objectives by investigating the associations between maternal touch and infants' self-regulatory behavior in the regulation of infants' affect, attention, and distress level during a SF+T procedure. The first objective was to compare the overall amount of maternal touch and its specific functions during a Normal and three SF+T periods. Based on previous studies (Arnold, 2002; Moreno et al., 2006; Stack & LePage, 1996), an increase in the amount of

touch provided, specifically nurturing and playful functions of touch, was hypothesized to occur across the SF+T periods.

The second objective was to compare the types of infants' self-regulatory behaviors used across the Normal and SF+T periods. This comparison would permit an examination of how the presence of maternal touch during the SF period impacts on infants' self-regulatory behaviors. Previous studies have demonstrated that during a typical SF procedure, infants react by increasing their use of self-regulatory abilities (Manian & Bornstein, 2009; Weinberg & Tronick, 1996). Hence, an increase in self-comfort regulatory and exploratory, gaze aversion, and escape was expected across period. However, given the presence of maternal touch, the observed means were expected to be lower than are generally observed in a typical SF procedure. In addition, consequent to the change in maternal availability from the Normal to the SF+T periods, bidirectional exchanges were expected to decrease from the Normal to the SF+T periods.

The third objective consisted of analyzing how each maternal function of touch co-occurred with infants' affect, gaze, and self-regulatory behaviors and how infants' self-regulatory behaviors co-occurred with infants' affect and gaze. Examining two co-occurring behaviors, compared to only focusing on the separate discrete behaviors, was expected to clarify how these variables are organized during dyadic interaction. Co-occurrences between touch and infants' affect, gaze, and self-regulatory behaviors were expected to vary across the four interaction periods. Specifically, across all four periods, playful function of touch was hypothesized to co-occur with infants' smiling, gazing at mothers' face and bidirectional exchanges between the dyads. During the SF+T periods, nurturing function of touch was hypothesized to co-occur with infants' fretting and

neutral affect, gazing at mothers' faces, and with infants' self-comfort regulatory and exploratory behaviors. For infants' self-regulation, bidirectional exchanges were expected to co-occur with smiling and looking at mothers' faces during the Normal period. During the SF+T periods, self-comfort regulatory and exploratory behaviors, gaze aversion, and escape were expected to co-occur with fretting and neutral affect, thus indicating that infants were regulating their own negative emotions (Moszkowski, Stack, & Chiarella, 2009; Toda & Fogel, 1993). Finally, across all SF+T periods, bidirectional exchanges were expected to co-occur with gazing at mothers' hands.

Finally, the fourth objective pertained to observing the association between infants' distress level and maternal touch and infants' self-regulatory behaviors. Across periods, an increase in infants' distress was expected, however, since maternal touch was present throughout the SF +T periods the levels of infants' distress were expected to remain relatively low. Based on previous research (Jean & Stack, 2009; 2012), infants' distress level was expected to be positively associated with the amount of maternal nurturing function of touch and infants' escape behavior, and negatively associated with infants' self-comfort regulatory and exploratory behaviors, and gaze aversion (Braungart-Rieker & Stifter, 1996; Manian & Bornstein, 2009).

Method

Participants

Participants were recruited from a major University teaching hospital in the Montréal community (Québec, Canada). Mothers of healthy full-term infants, weighing at least 2,750 g (approximately 6.0 pounds) and born between 38 and 41 weeks of gestation were recruited. The current sample of twenty-four (12 males; 12 females) 5½ -

month-olds was obtained from an archival data set investigating maternal touch and gesture during face-to-face interaction (see Stack & Arnold, 1998). With regard to maternal touch, the present study expands the aim and focus of the previous research by systematically investigating the functions of maternal touch compared to its mere presence or absence. The mean age of the infants was 5 months and 14 days (range: 4.23-6.00, *SD* = 0.27) and the mothers' mean age was 30.16 (range: 24-37, *SD* = 3.95). Although the majority of mother-infant dyads were Caucasian (75%), the sample was also composed of infants who were African-Canadian (12.5%), Asian/Pacific Islander (4%), Middle Eastern (4%), and Hispanic (4%). Regarding mother's education, 23% of parents were classified as high school graduates without college education, 56% had some college education, and 21% held degrees from programs requiring 4 years of college or more.

Apparatus

In a testing room, separated by a one-way mirror from the observation room, infants were seated in an infant seat mounted and secured to a custom-made box (75 cm high x 46 cm wide x 51 cm long). Mothers were asked to sit facing their infant at a distance of approximately 70 cm. A rectangular mirror was strategically placed behind the infant in order to monitor and record mother's facial expressions. A view of the infant's face and body and the mother's hands was captured using a color video camera (Hitachi Solid Slate model VK-350) while another camera captured a frontal view of the infant's body and the mother's hands. The two camera images were transmitted through a split screen generator and recorded on a Sony 8 mm-video recorder located in the adjacent observation room.

Procedure

Mother-infant dyads participated in four 90-second interaction periods separated by 20-second transition periods. Dyads participated in a Normal (N) interaction period followed by three SF+T (first SF+T period: SF+T1, second SF+T period: SF+T2, and third and final SF+T period: SF+T3) periods. During the SF+T periods, mothers were asked to remain silent and gaze at their infants while maintaining a neutral face, however, they were permitted to touch their infants. After each period, the examiner re-entered the testing area for a 20-second interval in order to provide the instructions for the following period. Mothers were advised that if at any time during the experiment their infants fretted for more than 20 seconds or if they wished to terminate a period for any particular reason the session would be interrupted and re-started at a subsequent time (n = 0). Following the testing session, mothers completed a demographic questionnaire and answered questions regarding their infants' development. Subsequent to each testing, all video records were viewed by the experimenter to ensure that all mothers complied with the SF instructions.

Behavioral Measures and Coding

Each period was coded from the videorecords for infants' (1) smiling, (2) fretting, (3) gazing, (4) self-regulatory behavior and (5) distress level, and for (6) function of maternal touch.

Infants' affect and attention. Infants' smiling, fretting, neutral affect, and gazing were coded frame-by-frame. Infants' smiling was operationally defined as an upturned mouth (either open or closed). Fretting was coded when the infant was crying or when his/her mouth was turned down or curled. Neutral affect was coded when the infant's

mouth was flat (either slightly open or closed). Infants' gazing was recorded when infants looked at their mothers' (1) faces or (2) hands, and (3) when they looked away. These behaviors have been reliably coded this way in a number of studies (e.g., Stack & Arnold, 1998; Stack & LePage, 1996).

Infants' distress level. Subsequent to viewing the SF period, the experimenter coded for infants' distress level (Jean & Stack, 2009). While distress level was made up in part by infants' fretting, distress level and fretting were different. Both the duration of infants' fretting, negative vocalizations, and infants' motor behaviors (e.g., trying to get out of the chair, gesturing toward their mother) were used to determine the level of infants' distress (low, medium or high; see Table 1 for brief operational definitions).

Functions of maternal touch. The functions of maternal touch were coded using a modified version of the Functions of Touch Scale (FTS; Jean, Girouard & Stack, 2007; Jean & Stack, 2009; 2012). Specifically, the original coding scheme was applied to the SF+T periods by specifying how each function of touch would occur during a SF+T period. The FTS is an observational coding measure, which assesses the duration of nine functions of maternal touch. For each second of the interaction, one of the nine functions of touch was coded (see Table 2 for brief operational definitions).

Infants' self-regulatory behavior. Infants' self-regulatory behavior was coded using a modified version of the Infant Self-Regulatory Scheme (ISRS; Millman, Jean, & Stack, 2009; Baljak, Millman, Jean, & Stack, 2009, personal communication), which is based on Weinberg and Tronick's (1996) Infant Regulatory Scoring System (IRSS). The original IRSS codes for: infants' direction of gaze, vocalizations, gestures, self-comforting, distancing, and autonomic stress indicators. The IRSS was adapted to better

reflect some previous research findings on infants' touching (Moszkowski & Stack, 2007; Moszkowski, Stack, & Chiarella, 2009). Our revised version, the ISRS, is an observational coding scheme that evaluates the duration of six types of self-regulatory behavior that infants exhibit: self-comfort regulatory, self-comfort exploratory, attention-seeking, escape, gaze aversion, and bidirectional exchanges. One of our adaptations consisted of dividing the original self-comforting category into two categories that focused on different ways infants use touch to self-regulate (regulatory and exploratory). Furthermore, the bidirectional exchange category was added, which documents instances during which infants are relying on mothers' regulatory contributions by gazing and interacting with their mothers. For each second of the interaction, one of the six types of self-regulatory behavior was coded (see Table 3 for brief operational definitions).

Reliability. To establish inter-rater reliability, a trained second coder who was blind to the hypotheses of the study re-coded 20% of a random portion of the video records; the results were compared to the original coding. Kappa coefficients (Cohen, 1968) were used to assess the reliability of onset and offset times for each measure ($K >$ .84 for all measures). Percent agreement reliability (agreements divided by total agreements plus disagreements) was calculated for infants' distress (95.00%).

Results

The data obtained for infants' affect, gazing, self-regulatory behaviors, and maternal functions of touch were reduced to obtain the percent duration of behavior during each period. In addition, since the durations of harsh or negative, accidental, unspecified, and instrumental functions were absent or very low, they were removed from subsequent analyses leaving five functions of touch remaining. Descriptive statistics were

conducted to assess for the presence of outliers, and to verify the normality of the distribution. When significant skewness or kurtosis was found, outliers were brought in according to the method described by Tabachnick and Fidell (1989), where the score is brought in to the next acceptable level and 1 is added to the score. As a result of bringing in outliers, there was no skewness or kurtosis remaining in the data hence no transformations were required. When ANOVAs revealed significant interactions, Šidāk pairwise comparisons were used to isolate the source of the significance (Šidāk, 1967). Furthermore, for significant ANOVAs, partial eta-squared (η_p^2) are reported as a measure of effect size; a η_p^2 of .01, .06, and .14 indicate small, medium, or large effect sizes (Clark-Carter, 1997; Ferguson, 2009).

Preliminary Analyses

Infants' smiling, neutral affect and fretting were analyzed using 3 one-way repeated measures ANOVAs in order to assess the impact of the modified SF procedure. As reported in Table 4, the amount of infant smiling decreased, $F(3, 69) = 26.49$, $p < .001$, $\eta_p^2 = .54$, from the Normal period to the three SF+T periods, while the amount of infant fretting, $F(3, 69) = 6.23$, $p < .001$, $\eta_p^2 = .21$, and neutral affect, $F(3, 69) = 19.68$, $p < .001$, $\eta_p^2 = .46$, increased across periods. A 3 x 4 (Gaze x Period) repeated measures ANOVA was conducted to evaluate the quality of infants' gazing across period. As reported in Table 4, the quality of infant gaze changed across period, $F(3, 138) = 6.29$, $p < .001$, $\eta_p^2 = .22$. Specifically, while the duration of gaze away remained constant across period, the amount of gazing at mothers' hands increased from the Normal period to the other SF+T periods. In contrast, the amount of gazing at mothers' faces decreased from the Normal period to the other SF+T periods.

Objective 1: Comparison of the Overall Amount and Functions of Maternal Touch across Interaction Periods

Overall touch. The overall amount of touch occurring in each period was obtained by regrouping the functions of touch from the FTS in order to form one total touch category. A one-way repeated measure ANOVA indicated that compared to the Normal periods (M = 82.08%, SE = 4.79) there was an increase in the amount of touch in SF+T1 (M = 95.1%1, SE = 1.46) and SF+T2 (M = 95.23%, SE = 1.26). No significant differences were observed for the SF+T3 period (M = 91.02%, SE = 3.22; $F(3,69) = 6.32$, $p < .001$, $\eta_p^2 = .22$) compared to other periods.

Functions of touch. A 5 x 4 (Function of Touch x Period) repeated measures ANOVA revealed a significant main effect for the Function of Touch, $F(4, 92) = 34.22$, $p < .001$, $\eta_p^2 = .60$, indicating that mothers' touch served various functions. Mothers spent the most time using playful, followed by nurturing and active accompaniment, passive accompaniment, and attention getting functions of touch (Table 5). A significant interaction between Function of Touch and Period, $F(12, 276) = 4.27$, $p < .001$, $\eta_p^2 = .16$, indicated that while playful function of touch touch remained high across all periods, there was an increase in nurturing function of touch from the Normal period to all SF+T periods, and a decrease in attention-getting from the Normal period compared to all SF+T periods.

Objective 2: Comparison of Infants' Self-Regulatory Behaviors across Interaction Periods

To examine the types of self-regulatory behavior used by infants across interaction periods, a 6 x 4 (Self-Regulatory Behavior x Period) repeated measures

ANOVA was conducted. A main effect of Self-Regulatory Behavior, $F(5, 115) = 49.25$, $p < .001$, $\eta_p^2 = .67$, indicated that infants spent the most time engaged with their mothers in bidirectional exchanges, followed by gaze aversion and self-comfort regulatory behavior followed by self-comfort exploratory behavior and escape, and finally attention-seeking (See Table 6). A significant interaction between Self-Regulatory Behavior and Period, $F(15, 345) = 3.96$, $p < .001$, $\eta_p^2 = .15$, revealed that there was more bidirectional exchanges in the Normal period as compared to all SF+T periods. Furthermore, there was a decrease in self-comfort exploratory behavior from SF+T1 and SF+T2 to SF+T3.

Objective 3: Examination of the Co-occurrence between Functions of Maternal Touch, Infant Self-Regulatory Behaviors and Infants' Affect and Gaze across Interaction Periods

To address objective 3, analyses were conducted to determine: (1) significantly co-occurring pairs between touch and infants' self-regulation across interaction periods, (2) significantly co-occurring pairs between touch and infants' affect and gaze across interaction periods, and (3) significantly co-occurring pairs between infants' self-regulatory abilities and infants' affect and gaze across interaction periods. Wilcoxon signed-ranks test were conducted to identify significantly co-occuring behavior pairs that occurred to a degree significantly greater than expected by chance (Fogel & Hannan, 1985; Legerstee, Corter, & Kienapple, 1990; Moszkowski, Stack & Chiarella, 2009). Specifically, to determine which behavior pairs were significant across each interaction period, the degree to which particular behavior pairs were observed to occur (i.e., observed/actual co-occurrence values) was compared with the expected degree to which these two behaviors were expected to co-occur based on chance alone (i.e., expected co-

occurrence values). Expected co-occurrence values were determined by calculating the joint probability of the two behavior categories of interest (i.e., multiplying the proportional session durations of the two behaviors). The actual and expected co-occurrence values were then compared using Wilcoxon signed-ranks tests and behavior pairs were considered to be significantly co-occurring if the actual co-occurrence values were significantly greater than the expected co-occurrence values.

Functions of maternal touch. The co-occurrence analyses between functions of maternal touch and infants' self-regulatory behaviors indicated that during the Normal period, playful function of touch significantly co-occurred with bidirectional exchanges. No other significant co-occurrences were noted between functions of maternal touch and infants' self-regulatory behaviors. The co-occurrence analysis between functions of maternal touch and infants' affect and attention revealed the following significant co-occurrences: for smiling, only playful function of touch significantly co-occurred with smiling in the Normal and SF+T1 period. Neutral affect significantly co-occurred with playful function of touch in the SF+T2 period, with attention-getting function of touch in the Normal and SF+T2 periods, with active accompaniment function of touch in the Normal, SF+T1, and SF+T2 periods, and with nurturing function of touch in SF+T1 and SF+T2 periods. For infants' attention, only nurturing function of touch co-occurred significantly with looking away in the Normal period, while it co-occurred significantly with gazing at mothers in the SF+T2 and SF+T3 periods.

Infants' self-regulatory behaviors. The co-occurrence analyses between infants' self-regulatory behaviors and infants' affect and attention indicated that in the Normal and SF+T1 periods, bidirectional exchanges significantly co-occurred with smiling.

Neutral affect co-occurred with self-comfort regulatory behaviors in the Normal and SF+T2 periods, with self-comfort exploratory behaviors in the Normal, SF+T1, and SF+T2 periods, with gaze aversion in the Normal period, and with escape in the SF+T3 periods. For infants' attention, bidirectional exchanges significantly co-occurred with gazing at mothers' hands across all periods and with gazing at mothers' face only in the Normal period. Gazing away from mother significantly co-occurred with self-comfort exploratory and gaze aversion in all four periods, and with escape in SF+T3 period.

Objective 4: Examination of how Maternal Functions of Touch and Infants' Self-Regulatory Behaviors Varied as a Function of Infants' Distress Level

An analysis of the number of infants demonstrating varying levels of distress determined that during the Normal period 4.20% (n = 1) of infants experienced medium-high level of distress, 8.30% (n = 2) in the SF+T1, 25.00% (n = 6) in the SF+T2, and 29.20% (n = 7) in the SF+T3 period. A one-way ANOVA, $F(3, 69) = 2.96$, $p < .05$, $\eta_p^2 = .11$, revealed that there was a significant increase in infants' distress from the Normal period to SF+T2 and SF+T3, and from SF+T1 to SF+T3.

Functions of maternal touch and infants' distress level. To examine how functions of maternal touch varied as a function of infants' distress level, a 5 x 2 (Function of Touch x Distress Level) ANOVA was conducted for each period. Infants' distress level was found to influence the amount of nurturing function of touch provided to infants in the SF+T1 period, $F(4, 88) = 4.56$, $p < .001$, $\eta_p^2 = .17$. When infants were displaying medium-high level of distress mothers provided more nurturing function of touch (Table 7). No significant differences were obtained for the Normal period, $F(4, 88) = 0.16$, $p = .96$, $\eta_p^2 = .00$, the SF+T2 period, $F(4, 88) = 0.71$, $p = .58$, $\eta_p^2 = .03$, and the

SF+T3 period, $F(4,88) = 0.37$, $p = .83$, $\eta_p^2 = .02$.

Infants' self-regulatory behaviors and infants' distress level. To examine how infants' self-regulatory behaviors varied with infants' distress level, four 6 x 2 (Self-Regulatory Abilities x Distress Level) ANOVAs were conducted. For all four periods, there was no significant difference between type of self-regulatory behaviors and infants' distress; that is, type of self-regulatory behaviors did not differ as a function of infants' distress in any of the periods (Normal, $F(5, 110) = 0.76$, $\eta_p^2 = .03$, $p = .58$; SF+T1 period, $F(5, 110) = 0.52$, $p = .76$, $\eta_p^2 = .02$, SF+T2, $F(5, 110) = 1.52$, $\eta_p^2 = .07$, $p = .19$, and the SF+T3 period, $F(5, 110) = 0.89$, $\eta_p^2 = .04$, $p = .49$; Table 8).

Discussion

The current study sought to further our understanding of the contribution of maternal touch to infants' emotion regulation. Specifically, using an experimental protocol consisting of a Normal period and three consecutive SF+T periods, the functions of maternal touch and infants' self-regulatory behaviors were uniquely investigated. In addition, co-occurrences between functions of maternal touch, infants' self-regulatory behaviors, affect, and attention were examined as a means to describe how these behaviors are temporally organized. Finally, infants' negative reactions to the SF+T periods (i.e., distress level) were evaluated in relation to changes in maternal functions of touch and infants' self-regulatory behaviors.

Before addressing the specific objectives of the study, infants' reactions to the SF+T procedure were documented by analyzing infants' affect, attention, and distress level across periods. As expected based on the robust SF literature (see Adamson & Frick, 2003; Mesman et al., 2009), infants' smiling decreased from the Normal period to

the SF+T periods while the amount of fretting and neutral affect increased across the SF+T periods. Contrary to the "signature" SF effect (Adamson & Frick, 2003; Mesman et al., 2009), however smiling remained fairly high and fretting relatively low. These observed means for infants' affect and gaze are consistent with those reported in Stack and Muir's (1990) original SF+T paper documenting a modulation of the SF effect through touch**.** The presence of maternal touch affected the quality of infants' gaze. As such, consistent with what has been reported with the SF+T procedure (Feldman et al., 2010; Stack & Muir, 1990; 1992), gazing at mothers' faces decreased from the Normal to the SF+T periods, while gazing at mothers' hands increased. Following mothers' lack of emotional responsiveness during SF periods, infants may visually disengage from their mothers' faces by refocusing on their active hands (Peláez-Nogueras et al., 1996; Stack & Arnold, 1998; Stack & Muir, 1992). Interestingly, contrary to what is observed during a typical SF period (Jean & Stack, 2009; Manian & Bornstein, 2009), the amount of gaze away from mother remains constant and low across periods, thus implying that through her touch alone, mothers are able to capture infants' attention throughout the interactions at least for brief periods of time. Furthermore, since gazing away from a source of stress (i.e. the mother during a typical SF period) is thought to be a powerful self-regulatory behavior (Johnson, Posner, & Rothbart, 1991; Rothbart, Zaiae, & O'Boyle, 1992), it can be argued that infants did not experience the same amount of stress that is generally observed in a typical SF procedure. Finally, there was an increase in the number of infants experiencing distress across period, which culminated in about 30% of infants experiencing a heightened state of arousal in the last period (SF+T3). This observed percentage is consistent with those observed during a typical SF period (Jean & Stack,

2009; 2012), suggesting that for these infants, maternal touch might not be sufficient in regulating infants' distress at least overtime. Moreover, it may suggest that infants might have habituated to the presence of maternal touch, therefore its positive influence may have diminished. In summary, our findings pertaining to infants' reactions to the SF+T procedure suggest that through the regulatory support of maternal touch, infants were able to successfully regulate their affect at least for brief periods of time.

The main goal of the current study was to provide further support for the pivotal role of maternal touch in infants' emotion regulation. As a result, the regulatory support of maternal touch was isolated from other maternal regulatory behaviors by using three consecutive SF+T periods. Consistent with Stack and Muir's (1990) original findings, the overall amount of touch increased from the Normal to the SF periods. Although this is likely an artifact of the specific instructions given to mothers, the high levels of touch observed and maintained across period combined with mothers' ability to seemingly adjust their touch to compensate for their inability to use other modalities of communication reflect the pervasiveness and sophistication of touch as a powerful means of non-verbal communication within the dyad (Feldman et al., 2010; Hertenstein, 2002; Stack & Jean, 2011; Tronick, 1995).

Consistent with the existing literature on maternal touch, touch was found to serve various functions such as playful, nurturing, and attention-getting (Ferber, Feldman, & Makhoul, 2008; Jean & Stack, 2009; Weiss, Wilson, St. John Seed, & Paul, 2001). Yet, results from the present study expand on previous work by showing that these specific functions can be accomplished through touch alone. Mothers were found to adjust their tactile behaviors by providing more attention-getting touch at the beginning of the study

and, as expected based on previous work (Jean & Stack, 2009; Moreno et al., 2006), more nurturing function of touch during the SF+T periods. In addition, an increase in nurturing function of touch was documented when infants initially exhibited distress in the SF+T1 period. Although the level of playful function of touch remained high across periods, it did not increase over time, suggesting that mothers might be using playful function of touch to maintain infants' positive affect and attention throughout the procedure.

A second goal of this study was to examine changes in infants' self-regulating behaviors across Normal and SF+T periods with the objective of clarifying how the presence of maternal touch was related to infants' reliance on their own internal self-regulatory behaviors. In line with previous findings from the SF literature (Mayes & Carter, 1990; Millman et al., 2009; Toda & Fogel, 1993; Weinberg & Tronick, 1996) and from work specifically aimed at examining infants' regulation during periods of stress (Calkins, Dedmon, Gill, Lomax, & Johnson, 2002; Diener, Mangelsdorf, McHale, & Frosch, 2002), infants were expected to increase their use of self-comfort regulatory and exploratory behaviors, escape, and gaze aversion and decrease their bidirectional exchanges during the SF+T periods compared to the Normal period. Findings confirmed the expected decrease in bidirectionality from the Normal to the SF+T periods. Given the disruption in the social engagement from Normal to SF periods as well as mothers' facial and vocal unresponsiveness, it may have proved to be challenging for the dyad to engage and maintain a high state of shared attention and mutual exchange typical of bidirectional exchanges. However, there were some bidirectional exchanges during the SF+T periods, indicating that by using only touch, mothers were able to engage their infants in reciprocal and shared exchanges.

An increase in the use of self-exploratory behavior during the first SF+T period partially supports our hypothesis. Following the end of the Normal period, this initial increase may reflect infants' ability to explore their environment when the level of fretting and distress is relatively low. Yet, with an increase in their fretting and distress level over time, infants may rely on other modalities of regulation. Support for this contention comes from evidence suggesting that distraction and exploration is effective in low-distress situations while other forms of regulation, such as self-soothing and gaze aversion may be preferred during times of higher distress (Staples, 2010; Stifter & Braungart, 1995). Contrary to our hypothesis, no changes in the amount of self-comfort regulatory behavior, gaze aversion, and escape were observed. The lack of significant change in the amount of self-comfort regulatory behavior, gaze aversion, and escape across periods as well as infants' distress is an indication that contrary to a typical SF period (Weinberg & Tronick, 1996), the regulatory support provided by mothers through touch may have been sufficient to deal with the perturbed periods. Thus, maternal touch may have acted as a primary regulatory source.

One of the major objectives of the current study was to investigate the association between touch and self-regulatory abilities. Although separate investigations seem to suggest a strong link between touch and infants' self-regulatory behaviors (Feldman et al., 2010; Millman, et al., 2009; Moszkowski & Stack, 2007), contrary to expectations strong support for this contention was not obtained from the co-occurrence analyses in the present study. Nonetheless, playful function of touch was found to co-occur with bidirectional exchanges during Normal periods. Consistent with previous work (e.g., Jean & Stack, 2009; 2012; Moreno et al., 2006), this result suggests that when mothers are

providing playful function of touch during a Normal period of face-to-face interaction, infants and mothers are in a state of shared attention and mutual exchange. The unexpected lack of association between maternal touch and infants' self-regulation during the SF+T periods may reflect the complexity of the regulatory process in infants. One explanation is that maternal touch and infants' self-regulatory behavior may not co-occur as expected because they do not occur at the same time in the regulation process (Bridges et al., 2004). In addition, infants' use of different coping strategies does not always translate into an immediate change in their affective displays. Furthermore, regulation can also include maintenance of specific affect (e.g., smiling or neutral affect), which does not result in any observable changes (Bridges et al., 2004). Since mothers are thought to be responding to a change in infants' emotional expression (Braungart-Rieker et al., 1998; Conradt & Ablow, 2010; Gianino & Tronick, 1988; Kopp, 1989), infants' and mothers' regulatory behaviors may not occur at the same time. The analyses are further complicated by possible individual differences in the lag between use of self-regulatory behavior and a resulting change in infants' affective displays (Bridges et al., 2004). Consequently, the association between maternal touch and infants' self-regulatory behavior may be better captured using other statistical techniques, such as sequential analysis or temporal contingency assessment.

Our understanding of the regulatory roles of maternal touch and infants' self-regulatory behavior was also informed by examining how they are both temporally organized with infants' affect and attention through co-occurrence analysis (Fogel & Garvey, 2007; Weinberg & Tronick, 1994). Overall, the findings support our hypothesis indicating that maternal touch and infants' self-regulatory behavior were organized with

infants' affect and attention, thus suggesting specific patterns of dyadic regulation (Arnold, 2002; Moszkowski et al., 2009; Symons & Moran, 1987; Toda & Fogel, 1993). In addition, these co-occurring pairs varied across periods, underscoring the adaptable and changing nature of infants' regulation.

Specific findings deserve particular attention. First, consistent with existing literature (Dickson et al., 1997; Stack & Jean, 2011), during the first two periods (Normal and SF+T1) infants smiled when being playfully touched by their mothers. In contrast, during the SF+T2 period, infants displayed neutral affect when mothers used playful function of touch thus suggesting that with the observed increase in infants' fretting and distress level over time, the positive influence of playful function of touch on infants' affect may be less evident. Second, the changes in the co-occurrences observed between nurturing function of touch and gazing away in the Normal period and nurturing function of touch and gazing at mother in the last two periods allude to infants' desire for regulatory support when they are experiencing increased fretting and distress. Contrary to our hypothesis, nurturing function of touch did not co-occur with infants' fretting. Given the low level of fretting observed across period, this result is not surprising. In addition, this finding is consistent with Crockenberg and Leerkes' finding (2004) where maternal tactile soothing behavior did not co-occur with an increase in infants' distress.

Finally, pertinent findings emerged from the co-occurrence analysis between infants' self-regulatory behavior and affect and gaze. The co-occurences between self-comforting regulatory and exploratory behaviors across interaction periods imply that infants are possibly using these regulatory strategies to maintain a state of neutrality as opposed to generating positive affect or regulating negative affect. In contrast, when

engaged in bidirectional exchanges with their mothers during the Normal and SF+T1 periods, infants smiled. Furthermore, the observed change in the co-occurrence between bidirectional exchanges and gazing at mothers' faces during the Normal period and gazing at mothers' hands during the SF+T periods suggest that through touch alone, mothers were able to maintain a state of shared attention and mutual exchanges at least for brief periods. Finally, throughout the procedure, self-comfort exploratory and regulatory and escape behaviors momentarily co-occurred with gazing away from mothers. Given that infants' gaze, or attention control, is part of the regulatory repertoire of infants (Rothbart, Posner, & Boylan, 1990; Rothbart et al., 1992), these results suggest that infants may be turning away from the source of stress (i.e., mother) in order to regulate through their other regulation strategies (Crockenberg & Leerkes, 2004).

Our findings also advance the current literature on the SF effect by examining the unique contribution of maternal touch in infants' emotion regulation and reactions to the SF procedure. Prior studies have attempted to examine the contribution of other means of maternal communication (e.g., facial expression, voice, gaze, touch) by modifying the SF procedure (e.g., Delgado, Messinger, & Yale, 2002; D'Entremont & Muir, 1997; Legerstee & Markova, 2007; Stack & Muir, 1990; 1992; Striano, 2004). Thus far, only maternal touch has been shown to significantly diminish the signature "SF effect".

Although the unique procedure of the SF+T periods offered several advantages and the inclusion of a Normal period served as a baseline for comparison, the inclusion of two additional control groups (one group participating in Normal periods of interaction and another participating in typical SF periods as opposed to the SF+T period) would have strengthened our results. However, only the SF+T periods could specifically be used

to address the regulatory roles of maternal touch when other forms of maternal communication are unavailable. In addition, a larger sample size would have permitted more advanced statistical analysis. Furthermore, since the quality of maternal touch and self-regulatory behaviors have been shown to change across context (e.g., Braugart-Rieker & Stifter, 1996; Jean, Stack, & Fogel, 2009; Polan & Ward, 1994), future research would benefit from investigating the relationship between touch and infants' self-regulatory abilities in challenging (arm restraint, inoculation, physical separation) vs non challenging (feeding, caregiving, free play) contexts. Finally, the inclusion of physiological markers of distress (e.g., heart rate, vagal tone, cortisol) would have allowed us to identify infants that might be experiencing distress without any overt emotional signs of distress (Dennis, Buss, & Hastings, 2012). Since previous studies have documented increased cortisol and heart rate during the SF procedure (Feldman et al., 2010; Haley & Stansbury, 2003; Lewis & Ramsay, 2005), a simultaneous investigation of physiological markers would be beneficial.

Taken together, the present research makes a strong case for the regulatory role of maternal touch. Examining how mothers use touch across three consecutive SF+T periods when other forms of communication are absent contributes to our knowledge pertaining to the reasons that mothers use touch and its role in infants' emotion regulation over time. Touch was revealed to serve various functions. Furthermore, findings from infants' affect and attention provide support for the positive nature of these touch-only interactions. Although the amount of touch provided to infants remained high across periods, consistent with past research findings (Feldman et al., 2010; Ferber et al., 2008; Hertenstein, 2002; Stack & LePage, 1996) mothers sensitively adjusted their tactile

behaviors to the constraints of the interactions from the Normal to the SF+T periods. Since mothers provided regulatory support through touch during the SF+T periods, no major changes were observed across period for infants' self-regulatory behaviors. In combination with the low distress level observed in the first two SF+T periods, results imply that through touch alone mothers are able to regulate the changes in their infants' affect. In addition, by clarifying the association between touch, infants' affect, attention, and self-regulatory behavior we were able to explain how maternal touch supported specific infants' regulatory behaviors. Furthermore, the sophistication of infants' regulatory mechanisms were highlighted by the results from the co-occurrence analyses and suggest that infants' self-regulation does not occur in isolation but in organized patterns of infant and mother behaviors (Moszkowski et al., 2009; Symon & Morans, 1987; Toda & Fogel, 1993).

In summary, findings from our study add to the growing body of literature suggesting that mothers' touch attenuates infants' reactions to stress (Feldman et al., 2010; Peláez-Nogueras et al., 1996; Stack & Muir, 1990). Furthermore, our results underscore the prevalence and considerable breadth of maternal touch and its unique role in communication during dyadic interactions. Finally, the results extend our knowledge of infants' emotional and behavioral regulation by underscoring the central roles that both mothers and infants play. The current findings have implications for the development of touch-related prevention and intervention programs whereby touch could potentially have a direct influence on the development of self-regulation abilities in at-risk children (i.e., infants of depressed mothers, deaf mothers or infants, premature infants, etc.).

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Table 1

Brief Operational Definitions for Infants' Distress Level during the Still-Face Period

Low Distress	Infant is displaying mostly positive or neutral vocalizations with rare bouts of fretting or crying. Infant is sitting calmly in the seat.
Medium Distress	Infant has short bouts of fretting or crying (between 25% - 50% of the period), or does not begin fretting/crying until the end of the period. Infant may squirm in the seat at times and may gesture to his/her mother in order to attract her attention.
High Distress	Infant is fretting or crying (usually the infant is quite loud) for an extended amount of time (more than half of the period). Infant is also showing discontent by squirming and trying to get out of the seat and gesturing toward his/her mother to attract her attention.

Table 2

Brief Operational Definitions for the Functions of Touch Scale (FTS; Jean, Girouard, & Stack; 2007; Jean & Stack, 2009, 2012)

Passive Accompaniment	Touch serves as an accompaniment to another modality of communication. The focus is not on touch. The tactile behavior of the mother is generally passive (e.g., not a lot of movements and practically static.). During a SF+T period code when mother is providing passive and static touch.
Active Accompaniment	Touch serves as an accompaniment to another modality of communication. The focus is not on touch. The tactile behavior of the mother is active. The mother is typically lifting, moving, grabbing, or squeezing her infant's limbs. During a SF+T period code when there is no game or playful aspect to the mother's behavior.
Nurturing	Touch is very soothing, and slow. The mother is typically kissing, stroking, or massaging her infant in an attempt to demonstrate affection to her infant or regulate her infant's negative affect. The mother is generally speaking in a soft tone of voice, and/or she is acknowledging her infant's emotion or behavior (e.g., "you are crying", "that was hard for you").
Playful	Touch is very active, playful, dynamic, repetitive and fast paced. The mother tends to tickle, shake, squeeze, lift, move, extend, or flex the infant's limb. Typically, the goal is to make the infant smile and laugh. It is not only the presence of active types of touch that is important, but there is a playful aspect to the touching event that is clearly evident. Touching is often accompanied by the maternal singing, game playing, making noises, or motherese. Of note during a SF+T period, no other behaviors is accompanying mothers' touch, therefore in order to be coded as playful the playful and game-aspect to the touching event needs to be evident (often repetitive movement, fast pasted, and of longer duration).
Attention-Getting	Touch serves to get the infant's attention. The mother is typically tapping, patting, squeezing, pinching, or stroking the infant. Touching is accompanied by similar maternal attention-getting strategies in other modalities, such as calling the name of her infant, making noises with her mouth to get her infant's attention, or snapping her finger while touching her infant.
Accidental	Maternal tactile behavior is very brief, unintentional and fortuitous.
Utilitarian	Touch is used to accomplish a specific instrumental task such as removing the infant's hands from his/her mouth, or fixing the infant's clothes.
Harsh or Negative	Maternal touch serves to control the infant's behavior. It is typically intrusive and performed in a negative manner.
Unspecified Function	No apparent function of maternal touch. No other maternal behaviors are present.

Table 3

Brief Operational Definitions for Infant Self-Regulation Scheme (ISRS; Millman, Jean, & Stack; 2007; Baljak, et al., personal communication)

Self-Comfort Regulatory	Infant is using touch as a way to self-regulate. Infant's gaze must be directed away from self or objects. Examples: mouthing of self or object, self-grasp, pulling clothes.
Self-Comfort Exploratory	Infant is touching him/herself or an object and his/her gaze must be directed toward the self or object of interest. Examples: using touch to explore his/her chair, playing with the chair's belt.
Attention-Seeking	Infant is trying to get his/her mother's attention during situations when the mother is not interacting with the infant, such as during the Still-Face, or when she is gazing away. Examples: infant is vocalizing in an exaggerated manner, smiling, reaching, or making motor movements toward mother.
Escape	Infant is attempting to get out of the chair. Examples: twisting, crying, and trying to get out of the chair.
Gaze Aversion	Infant is not looking at his/her mother. Infant is not interested in interacting with the mother and/or has his/her attention elsewhere.
Bidirectional Exchanges	Infant is regulating by being engaged in an interaction with his/her mother. Infant must be engaged in the interaction by reciprocating or simply gazing at mother's face, body, or hands. The dyad is typically in a state of joint-attention. Bidirectional exchanges are possible during a SF+T period as the mother is allowed to engage in an interaction with her infant though touch. Examples: infant and mother are playing peek-a-boo, mother is cooing and infant is smiling, mother remains silent and is waving her hands in front of infant's face.

Table 4

Mean Percent Duration of Infant Affect and Gaze as a Function of Interaction Periods

Period	Normal	SF+T1	SF+T2	SF+T3
Smiling	37.32[a]	12.73[b]	9.99[b]	10.83[b]
	(19.60)	(11.58)	(11.60)	(10.98)
Fretting	0.32[a]	0.32[a]	1.95[ab]	4.34[b]
	(0.88)	(1.09)	(3.56)	(6.65)
Neutral	61.57[a]	86.20[b]	86.57[b]	83.43[b]
	(19.89)	(11.27)	(13.66)	(14.01)
Gaze at Mothers' Hand	24.12[a]	43.66[b]	40.69[b]	48.57[b]
	(14.62)	(23.46)	(25.07)	(24.89)
Gaze at Mothers' Face	39.82[a]	17.26[b]	17.45[b]	13.19[b]
	(22.08)	(13.70)	(14.23)	(10.69)
Gaze Aversion	36.07[a]	37.41[a]	41.85[a]	36.81[a]
	(19.08)	(22.03)	(25.32)	(22.67)

Note. Numbers in parenthesis are standard deviations. Means in the same row that do not share the same subscripts differ at $p < .05$ in the Pairwise Comparisons.

Table 5

Mean Percent Duration of Maternal Function of Touch as a Function of Interaction Periods

Period	All Periods	Normal	SF+T1	SF+T2	SF+T3
Passive Accompaniment	7.22[a]	11.34[a]	7.31[a]	5.68[a]	4.53[a]
	(5.19)	(12.88)	(9.33)	(8.74)	(7.38)
Active Accompaniment	12.44[b]	11.48[a]	15.01[a]	11.38[a]	11.80[a]
	(6.71)	(11.53)	(12.38)	(10.00)	(9.94)
Nurturing	19.59[b]	4.34[a]	24.07[b]	25.65[b]	24.31[b]
	(13.91)	(5.88)	(20.74)	(21.18)	(17.86)
Playful	44.05[c]	47.22[a]	41.44[a]	40.97[a]	46.57[a]
	(23.66)	(26.67)	(29.15)	(31.37)	(29.12)
Attention-Getting	1.04[d]	3.38[a]	0.19[b]	0.60[ab]	0.00[b]
	(5.09)	(5.06)	(0.70)	(1.25)	(0.00)

Note. Numbers in parenthesis are standard deviations. Means in the All Periods column that do not share the same subscripts differ at $p < .05$ in the Pairwise Comparisons. Means for the Normal and SF+T periods in the same row that do not share the same subscripts differ at $p < .05$ in the Pairwise Comparisons.

Table 6

Mean Percent Duration of Infant Self-Regulatory Behaviors as a Function of Interaction Periods

Period	All Periods	Normal	SF+T1	SF+T2	SF+T3
Self-Comforting Regulatory	18.03[a]	17.50[a]	16.16[a]	18.70[a]	19.77[a]
	(14.10)	(16.46)	(17.64)	(19.26)	(21.80)
Self-Comforting Exploratory	5.25[b]	3.23[a]	8.47[a]	7.40[ab]	1.89[b]
	(6.27)	(4.60)	(11.59)	(11.59)	(2.73)
Attention-Seeking	0.06[c]	0.00[a]	0.00[a]	0.23[a]	0.00[a]
	(0.14)	(0.00)	(0.00)	(0.65)	(0.00)
Escape	1.19[bc]	0.83[a]	1.44[a]	1.23[a]	1.25[a]
	(2.35)	(4.08)	(5.92)	(3.84)	(2.89)
Gaze Aversion	22.21[a]	18.19[a]	22.08[a]	22.59[a]	25.97[a]
	(8.81)	(14.74)	(13.26)	(13.45)	(14.24)
Bidirectional Exchanges	40.10[d]	56.76[a]	35.88[b]	33.94[b]	37.41[b]
	(12.39)	(20.68)	(25.14)	(26.72)	(23.98)

Note. Numbers in parenthesis are standard deviations. Means in the All Periods column that do not share the same subscripts differ at $p < .05$ in the Pairwise Comparisons. Means for the Normal and SF+T periods in the same row that do not share the same subscripts differ at $p < .05$ in the Pairwise Comparisons.

Table 7

Mean Percent Duration of Maternal Function of Touch as a Function of Interaction Periods and Infants' Distress Level

Period	Normal		SF+T1		SF+T2		SF+T3	
Distress Level	Low	Med-High	Low	Med-High	Low	Med-High	Low	Med-High
Passive Accompaniment	11.44[a]	8.89[a]	7.57[a]	4.44[a]	4.99[a]	7.76[a]	3.53[a]	6.97[a]
	(13.15)	---	(9.72)	(1.57)	(7.95)	(11.38)	(6.23)	(9.79)
Active Accompaniment	11.88[a]	2.22[a]	14.74[a]	18.89[a]	13.31[a]	5.56[a]	12.80[a]	9.37[a]
	(11.61)	---	(12.52)	(14.14)	(10.51)	(5.44)	(10.29)	(9.34)
Nurturing	4.53[a]	0.00[a]	20.30[a]	65.56[b]	22.35[a]	35.56[a]	21.96[a]	30.00[a]
	(24.07)	---	(16.20)	(25.14)	(19.48)	(24.82)	(14.88)	(5.93)
Playful	47.97[a]	30.00[a]	44.19[a]	11.11[a]	39.26[a]	46.11[a]	47.65[a]	43.97[a]
	(27.01)	---	(28.77)	(12.57)	(29.28)	(39.62)	(26.00)	(37.89)
Attention-Getting	3.53[a]	0.00[a]	0.20[a]	0.00[a]	0.67[a]	0.37[a]	0.00[a]	0.00[a]
	(5.12)	---	(0.74)	(0.00)	(1.36)	(0.91)	(0.00)	(0.00)

Note. Numbers in parenthesis are standard deviations. Means in the same period and same row that do not share the same subscripts differ at $p < .05$ in the Pairwise Comparisons.

Table 8

Mean Percent Duration of Infant Self-Regulatory Behavior as a Function of Interaction Periods and Infants' Distress Level

Period	Normal		SF+T1		SF+T2		SF+T3	
Distress Level	Low	Med-High	Low	Med-High	Low	Med-High	Low	Med-High
Self-Comfort Regulatory	17.77[a]	11.11[a]	15.95[a]	18.33[a]	16.97[a]	21.89[a]	18.56[a]	22.70[a]
	(16.77)	---	(17.56)	(25.93)	(21.39)	(10.37)	(19.56)	(28.00)
Self-Comfort Exploratory	3.32[a]	1.11[a]	9.24[a]	0.00[a]	6.11[a]	11.29[a]	2.27[a]	0.95[a]
	(4.68)	---	(11.82)	(0.00)	(9.48)	(16.96)	(3.09)	(1.35)
Attention-Seeking	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.19[a]	0.37[a]	0.00[a]	0.00[a]
	(0.00)	---	(0.00)	(0.00)	(0.57)	(0.91)	(0.00)	(0.00)
Escape	0.63[a]	20.00[a]	0.25[a]	14.40[a]	0.80[a]	2.60[a]	1.50[a]	0.00[a]
	(0.00)	---	(0.97)	(20.43)	(2.69)	(6.35)	(3.29)	(0.00)
Gaze Aversion	18.84[a]	0.00[a]	21.31[a]	30.56[a]	21.48[a]	25.93[a]	23.66[a]	31.59[a]
	(14.72)	---	(11.65)	(32.21)	(15.20)	(5.43)	(12.57)	(17.43)
Bidirectional Exchanges	56.42[a]	64.44[a]	36.11[a]	33.33[a]	38.64[a]	19.81[a]	40.92[a]	28.89[a]
	(21.07)	---	(25.85)	(21.99)	(28.97)	(10.53)	(25.81)	(17.54)

Note. Numbers in parenthesis are standard deviations. Means in the same period and same row that do not share the same subscripts differ at $p < .05$ in the Pairwise Comparisons.

CHAPTER 5:

GENERAL DISCUSSION

Overview

The present dissertation was designed to examine the contributions of maternal touch and infants' self-regulatory abilities on infants' affect and attention during two modified series of mother-infant interactions, a Still-Face (SF) paradigm (Tronick et al., 1978) and a modified SF+ Touch (SF+T) paradigm (Stack & Muir, 1990; 1992). Although maternal touch and infants' self-regulatory abilities have been studied separately, the studies that make up the dissertation fill an important void in the literature by examining both internal (self-regulatory behaviors) and external (maternal touch) means of regulation in 5 ½ month-old infants.

The objectives of Study 1 were to: 1) investigate maternal functions of touch and infants' self-regulatory behaviors in full-term and VLBW/PT infant-mother dyads during a SF procedure, and 2) examine the relationship between maternal touch and infants' self-regulatory behaviors. The findings support previous studies suggesting that touch is a pervasive mode of dyadic communication and regulation (Feldman, 2011; Hertenstein, 2002; Stack & Jean, 2011). Furthermore, a rich description of the functions of touch used by mothers was obtained and functions of touch were found to vary across interaction periods. Specifically, more attention-getting function of touch was observed at the beginning of the procedure while more playful and nurturing functions of touch were observed during the Reunion Normal period. Moreover, mothers of VLBW/PT infants used a more stimulating (i.e., playful functions of touch) approach while interacting with their infants. Moreover, findings indicated that 5 ½ month-old full-term and VLBW/PT

infants possess a wide range of regulatory behaviors, which varied across the periods of the SF procedure. Specifically, similar to prior research findings (Braungart-Rieker & Stifter, 1996; Moszkowski & Stack, 2007; Toda & Fogel, 1993), infants' increased reliance on their own self-regulatory behaviors during the SF period was illustrated by an increase in self-touch, exploration, and gazing away. Findings also indicated that full-term infants may present with more independent regulatory abilities. Finally, results highlighted an important first step in revealing how the presence and quality of maternal touch were associated with infants' self-regulatory behaviors, providing evidence for the regulatory roles of maternal touch. Results from Study 1 make an important contribution by operationally defining and documenting both the functions of maternal touch and infants' self-regulatory behaviors during mother-infant interactions. In addition, this study extends our knowledge on the implications of prematurity for both maternal and infant regulatory behaviors, and provides a baseline of 5 ½ month-old VLBW/PT infants' reactions to the SF period.

Building on Study 1, Study 1b was designed to address several issues that deserved further investigation. The objectives were to examine: 1) how, in collaboration, functions of maternal touch and infants' self-regulatory behaviors were associated with infants' smiling, and 2) how infants' distress during the SF period was associated with the amount of nurturing touch used by mothers and the duration of infants' self-regulatory behaviors during the Reunion Normal period. Findings indicated that maternal touch and infants' self-regulatory behaviors were associated with infants' smiling, thus suggesting that they both play a role in infants' emotion regulation. Moreover, infants' use of specific self-regulatory behaviors and the amount of maternal nurturing function of

touch in full-term dyads were related to infants' level of distress. Results from Study 1b extend prior work by demonstrating the importance of both maternal touch and infants' self-regulatory behaviors to infants' regulation. In addition, findings provide further support for the importance of assessing infants' distress level during the SF period.

Finally, Study 2 was designed to investigate the regulatory contributions of maternal touch to infants' emotion regulation by examining how mothers regulate infants' affect and attention through touch alone. Using a SF+T procedure (Normal period followed by three SF+T periods), the specific objectives were to examine: 1) the functions of maternal touch, 2) infants' self-regulatory behaviors, 3) the co-occurrences between each maternal function of touch and infants' affect, gaze, and self-regulatory behaviors, and the co-occurrences between infants' self-regulatory behaviors and infants' affect and gaze, and 4) how infants' distress was associated with maternal functions of touch and infants' self-regulatory behaviors. Results from this study indicate that the presence of maternal touch mitigated infants' reactions to the SF and their reliance on their own self-regulatory behaviors, thereby corroborating our previous findings (Jean & Stack, 2012; Stack & Jean, 2011) that maternal touch may act as an important regulatory source. Our understanding of the regulatory roles of maternal touch and infants' self-regulatory behavior was informed by findings from the co-occurrence analyses documenting that they are both organized with infants' affect and attention. Furthermore, these behavioral pairs (e.g., playful function of touch and smiling, nurturing function of touch and neutral affect) varied across interaction periods thus suggesting distinct patterns of dyadic regulation. Our findings advance the literature on the SF by understanding the important contributions of maternal touch: the unique experimental

design of this study provided important insight into the functions maternal touch serve when other forms of communication are unavailable.

In the following sections, findings from the two studies are reviewed in light of their consistency as well as novel contributions to the existing literature and field. Specifically, four main themes will be addressed: 1) infants' responses to the SF and SF+T procedure, 2) contributions of infants and mothers to infants' emotion regulation, 3) the impact of infants' prematurity on maternal touch and infants' self-regulation, and 4) the applied implications of our findings.

Infants' Reactions to the SF and SF+T procedure

The results from the present studies confirm and expand upon theory and research in the area of infants' responses to the SF paradigm. In particular, to our knowledge this is the first study that compares 5 ½ month-old full-term and VLBW/PT infants' responses to the SF procedure. As a result, a baseline of VLBW/PT infants' reactions to the SF was obtained, thus adding to existing research on the implications of prematurity for infants' social-emotional competence by underscoring the positive and normative nature of healthy VLBW/PT infant-mother interactions. The stability and changes observed in infants' affect, gaze, and distress level across the periods of the SF are consistent with existing literature (Adamson & Frick, 2003; Mesman, et al., 2009) and provide further support for the existence of a signature SF effect in full-term and VLBW/PT infants. This pattern was also observed in Study 2, with full-term infants, during the SF+T periods (but to a lesser degree), thus further demonstrating that maternal touch can mitigate the effects of the SF period

Taken together, infants' reactions to the SF and the SF+T procedures suggest that full-term and VLBW/PT infants were generally able to regulate their negative affect for a brief period of time. Nevertheless, a number of infants experienced medium-high level of distress during the SF and the SF+T period. Therefore, findings from the present studies also underscore the importance of measuring infants' distress level, a global measure assessing infants' reactions to the SF period. The justification for measuring infants' distress level in addition to infants' affect and attention has been documented in several studies which have shown that infants' distress level influences infants' ability to self-regulate and maternal regulatory behaviors (e.g., Calkins et al., 2004; Jean & Stack, 2009; Mayes et al., 1991; Staples, 2010). Although the analysis of infants' distress level provided interesting information, the measure of infants' distress used in the present dissertation is not without its limitations. First, our measurement was derived from one global assessment based on infants' overall affect, bodily movements, and verbalizations conducted at the end of the SF period. It would have been beneficial to assess infants' distress level using second-by-second or interval (i.e., 10-second intervals) coding (Conradt & Ablow, 2010; Moore & Calkins, 2004; Weinberg & Tronick, 1994). Similar to the work by Ekas, Haltigan, and Messinger (2012), by measuring distress throughout the procedure, the variability in infants' distress level during the SF period could have been documented. Consequently, it would have been possible to identify potential precursors to an increase or decrease in infants' distress level thus providing insight into what may have prompted infants' distress. Second, although observational measures are considered integral to infancy research (Cummings, Davies, & Campbell, 2000), the inclusion of a physiological-biological indicator of infants' distress such as vagal tone or

cortisol level would have complimented our assessment while at the same time permitting the identification of infants who were experiencing distress but were not exhibiting overt signs. Given more advanced regulatory skills, some infants might be physiologically experiencing distress while being able to regulate its overt expression. Similar to the affective and behavior based signature SF effect displayed by infants (Adamson & Frick, 2003; Mesman et al. 2008), evidence exists for a physiological signature SF effect which is characterized by a decrease in vagal tone and an increase in cortisol during the SF period (Feldman et al. 2010; Haley & Stansbury, 2003; Moore & Calkins, 2004; Moore et al., 2009).

In addition to an enriched measurement of infants' distress level, future studies are also warranted to elucidate factors influencing infants' reactions to the SF period, as well as studies investigating the temporal changes in infants' affect and attention within the SF period. For example, Ekas and colleagues (2012) studied changes in infants' affect and attention during the SF period and found evidence for a *dynamic* still-face effect. That is, as time progressed about half to two-thirds of all infants decreased their smiling and gazing at their parents while increasing their negative expressions. Although most infants exhibited this pattern of response, individual differences were noted and thus imply that the SF effect does not reflect every infant's reaction. Future research is therefore warranted in order to identify individual patterns of responses to the SF procedure. The existence of different patterns of responses to the SF period was highlighted through the work of Papoušek and colleagues (see Papoušek, 2007) with 2-6 month-old infants during a SF procedure. Based on infants' affect and gaze, five reaction patterns to the SF procedure could be identified ranging from high levels of smiling and

gazing during the SF period to high levels of dysregulation throughout the period. Results underscored the implications of infants' self-regulatory competencies and quality of mother-infant communication prior to the SF period as determinants to infants' individual responses to the SF period.

Together, findings from infants' reactions to the SF and SF+T procedure underscore infants' sensitivity toward their caregivers' responsiveness and their understanding of the rules of reciprocity in dyadic interactions. Understanding infants' reactions to maternal emotional unavailability was an essential step in investigating how infants and mothers regulate infants' emotions during these challenging periods of interaction.

Infants' Emotion Regulation: Contribution of Infants and Mothers

The overarching goal of the current dissertation was to further elucidate the contributions of maternal touch to infants' emotion regulation. As such, both infants' internal (self-regulatory behaviors) and external (maternal functions of touch) means of regulation were examined. To our knowledge, this is the first study that conjointly investigated infants' self-regulatory behaviors and maternal functions of touch in a sample of 5 ½ month-old infants.

Infants' Self-Regulation. Findings from the current dissertation add to the existing body of knowledge by systematically documenting the strategies used by infants to regulate across two experimental contexts: a typical SF procedure and a modified SF+T procedure. Findings from Study 1 are consistent with the literature (e.g., Braungart-Rieker et al., 1998; Lowe et al., 2012; Moszkowski & Stack, 2007; Weinberg & Tronick, 1996) and provide support for the notion that the robust signature SF effect

reported in the scientific literature should also be characterized by infants' increased reliance on their own self-regulatory mechanisms during the SF. However, findings add to current knowledge by conjointly documenting that both both full-term and VLBW/PT infants were able to resort to their own regulatory abilities to cope with the SF period. In Study 2, when mothers provided touch to their infants during the SF periods, no major changes in self-regulatory behaviors were observed apart from a decrease in bidirectional exchanges. Results from Study 2 extend prior literature by specifically documenting the mitigating effect of maternal touch on infants' self-regulatory behaviors, in addition to their effect on affect and attention.

Across both studies, four self-regulatory strategies were particularly noteworthy: self-comfort regulatory and exploratory behaviors, gaze aversion, and bidirectional exchanges. These self-regulatory behaviors can be clustered into three essential regulatory mechanisms: self-touch, attentional control, and engagement with mothers. The observed increase during the SF period (Study 1) in the amount of self-comfort regulatory behaviors, such as sucking on finger or hands, as well as its prevalence through all periods of Study 2 emphasize the importance of self-touch as means of soothing. In addition, the pivotal role for infant touch is further underscored by infants' use of self-comfort exploratory strategies in both studies. Thus, infants might be using touch as a means to provide positive and soothing stimulation when mothers are unavailable or alternatively, this touch might allow them to re-direct their attention away from the source of stress (i.e., mothers' unavailability) onto proximal objects (Gianino & Tronick, 1988; Rothbart et al., 1992; Tronick, 1989). In conjunction with existing literature, the current findings add to the growing body of evidence underscoring the

importance and pervasiveness of infants' touch (e.g., Moszkowski & Stack, 2007; Toda & Fogel, 1993).

Findings also emphasized the significance of attentional control as a regulatory behavior through the documented prevalence of self-comfort exploratory behaviors and gaze aversion. Our findings are in line with existing literature documenting the importance of infants' gaze control, or attentional deployment, in regulation (Kopp, 2002; Rothbart et al., 1992). The ability to visually disengage from a source of distress and re-orient attention toward something else, such as the caregiver, is a powerful regulatory tool acquired with age (Posner & Rothbart, 2007) that can reduce physical arousal and negative emotions (Fox & Calkins, 2003; Stifter & Braungart, 1995). In both studies, infants were able to deploy their attention to either explore their environment or disengage from a source of stress (i.e., mothers' unavailability).

Finally, bidirectional exchanges were revealed to be a frequent strategy across studies. One of the strengths of the present dissertation is the inclusion of this dyadic coding category, which is rooted in tenets of dynamic system theories (Fogel, 1993; Fogel & Garvey, 2007.) Specifically, dynamic system theories underscore the importance of perceiving the separate components of mother-infant interaction as an integrated entity in order to adequately understand dyadic communicative and regulatory patterns (Fogel & Garvey, 2007). As such, Tronick (2005) proposed the concept of "dyadic expansion" which stipulates that the dyadic behaviors are greater than the sum of each individual's behaviors (Moore, et al., 2012). By taking into consideration mothers' and infants' behavior into its coding, the bidirectional exchanges category documents how conjointly mothers and infants are co-regulating infants' affect and attention. Findings from the

current dissertation documented high levels of of bidirectional exchanges across both Normal periods of the SF and across SF+T periods demonstrating not only its prevalence but also the dyads' ability to remain in bidirectional exchanges when mothers were still-faced and relying on only their touch.

Results from the present studies also extend scientific knowledge through the examination of the relationship between self-regulatory strategies and infants' affective expressions and attention. Consistent with previous research (Calkins et al., 2002; Diener et al., 1002; Moszkowski & Stack, 2007; Moszkowski, Stack & Chiarella, 2009; Weinberg & Tronick, 1994), results from Study 1b revealed that the strategies employed by infants to regulate are related to their affective or attentional states. Moreover, findings from co-occurrence analyses (Study 2) corroborated existing literature (Moszkowski & Stack, 2007; Weinberg & Tronick, 1994) showing a temporal organization between infants' self-regulatory behaviors and infants' affect and attention across different interaction contexts (e.g., Normal vs SF+T periods). Despite taking an important step in demonstrating the association between self-regulatory behaviors and affect and attention, more research is needed to elucidate how and when each regulatory strategy is used. One avenue would be to use sequential analysis (Bakeman & Quera, 2011) to identify infant and maternal behaviors that occur prior to and following the use of a specific self-regulatory strategy; this would provide important information on the antecedents and functions of such regulatory strategies.

Another strength of the current studies resides in the fact that they were designed to investigate distinct regulatory behaviors as opposed to relying on a general index of regulation. As suggested by Gross (1998) *more* regulation does not always equate to

better regulation. For example, an infant may over-regulate a positive emotion to the point of inhibiting any excitement. Alternatively, one strategy might be used repeatedly without success. As such, one limitation of the current studies pertains to the lack of a direct assessment of the effectiveness of infants' self-regulating behaviors. In order to do so, Bridges et al. (2004) stipulated that a direct observation of the use of one strategy and the analysis of subsequent change in infants' affect and attention is necessary. One would also assume that a change in infants' affect or attention would need to be immediate (Bridges et al., 2004). Yet, individual differences exist in the time lag between regulation and the impact on infants' behavior. In addition, infants often exhibit several regulatory behaviors at the same, therefore rendering it difficult to identify which regulatory behavior is responsible for an observable change. Finally, regulation does not always involve a change in infants' affect or emotion. The maintenance of an emotional expression at a specific level could involve as much regulation as trying to up-regulate a negative emotion.

Future work is needed to advance our understanding of infants' emotion regulation and clarify the aforementioned issues. Although longitudinal studies have documented changes in infants' self-regulatory abilities over time (e.g., Braungart-Rieker & Stifter, 1996; Mangelsdorf, Shapiro & Marzolf, 1995), additional studies are needed to investigate the consistency and evolution of infants' regulatory repertoire. With major developments occurring in infants' cognitive, social, emotional, and motor skills during the first year of life, investigating how infants' regulatory abilities parallel infants' developmental progression is also warranted to better understand the emergence and development of such essential skills and the impact on longer-term functioning. Finally,

although the studies in this dissertation investigated self-regulatory behaviors across interaction contexts, there is a need to examine how and where infants rely on their own regulatory means during other contexts of interaction (e.g., arm-restraint, food and gift delay, floor play), which might be more or less challenging and potentially different.

Together, results from both studies provide important knowledge on infants' abilities to easily adapt their regulatory behaviors to the changes in interaction contexts as well as changes in their own affect and attention, underscoring the diversity in infants' self-regulatory strategies at such a young age. In addition, findings further document infants' sensitivity toward their social partner (in this case their mothers) and their roles in their own regulation.

Contributions of Maternal Touch to Infants' Emotion Regulation. The importance of maternal touch to infants' emotion regulation was further clarified by results from the current dissertation. Thus far, most studies pertaining to maternal touch have focused on high-risk dyads (i.e., preterm infants, infants of depressed or anxious mothers, medically fragile infants) while neglecting to study typically developing infants (Hertenstein, 2002; Stack & Jean, 2011). In addition, although the positive influence of maternal touch has been well documented for preterm infants (e.g., Field, 2011; Vickers et al., 2004) most investigations have focused on the impact of touch for medically fragile preterm infants or have focused on the neonatal period. Consequently, the present studies add to existing findings by documenting normative or typical touching in a sample of 5 ½ month-old full-term and a sample of healthy VLBW/PT infants. This step was essential in order to appreciate the roles played by maternal touch for infants whose socio-emotional development may not be at risk (Hertenstein, 2002; Stack & Jean, 2011). Knowledge of

typical patterns of maternal touch has the potential to assist in early identification of problematic patterns in dyads for whom early touch intervention programs may be beneficial.

Throughout the current studies, the prevalence of maternal touch during mother-infant interactions was documented; thereby supporting the cumulating evidence that touch is an important channel of communication between members of the dyad (e.g., Ferber et al., 2008; Jean & Stack, 2009; Moreno et al., 2006; Stack & Jean, 2011). The stability in the duration of maternal touch across Normal periods (Study 1) and the observed increase in duration during the SF+T periods (Study 2) provide evidence that the perturbation caused by mothers' still-faces did not negatively influence the amount of touch provided to infants. Nevertheless, findings from the current studies indicate that the qualitative properties of maternal touch, in this case the *functions*, were affected by the SF periods. Consequently, the importance of examining the quality of maternal touch as opposed to only focusing on its mere presence or absence was underscored (Ferber, et al., 2008; Moreno et al., 2006; Stack & Muir, 1990).

Although a limited number of prior studies (Jean, Stack, & Fogel, 2009; Polan & Ward, 1994) have documented a variation in the *types* of touch used by mothers across context, the current findings contribute new insights into the importance of measuring *functions* of maternal touch across different interaction contexts. Results from both studies lend support for the contention that maternal touch can play different roles in infants' emotion regulation and mother-infant communication (Stack & Jean, 2011; Tronick, 1995). Moreover, results from Study 2 expand on previous knowledge by showing that these functions can be accomplished through touch alone. Together, the

results obtained in both studies provide evidence that an integrated approach to the measurement of touch (i.e., Function of Touch Scale) adequately portrays subtle changes in maternal touch.

In both studies, variations in maternal tactile behavior were illustrated mainly through three functions of touch: attention-getting, nurturing, and playful functions. First, consistent with previous studies, touch was employed by mothers as a strategy to sustain or recapture infants' declining attention throughout both studies (e.g., Arnold, 2002; Jean & Stack, 2009; Symons & Moran, 1987). With the emergence of joint attention and interest in visually exploring the environment (Legerstee, 2009), the ability to recapture infants' attention becomes especially important and relevant to infants' developmental maturation. Second, the soothing and calming nature of maternal touch reflected in the greater use of nurturing touch following the SF period (Study 1) and throughout the SF+T periods (Study 2), is consistent with previous research (Arnold, 2002; Ferber et al., 2008; Moreno et al., 2006). Thirdly, the stimulating role of maternal touch was made evident by the prevalence of playful touch during both the SF and SF+T procedures. In Study 1, the increase in playful touch following the resumption of normal interaction during the Reunion Normal period suggests that mothers are using playful tactile behavior, as well as other modalities of communication, as a mean to re-engage their infants. In Study 2, playful touch was used consistently across periods thereby suggesting that mothers resort to playful tactile stimulation to maintain infants' positive affect and attention. Importantly, during the SF+T periods, mothers were able to playfully engage their infants using only touch. Together, findings illustrate how mothers adjust their tactile behaviors during or following a period of maternal emotional unresponsiveness, as

well as to their infants' affect and gaze. By creating more calming, stimulating, and engaging interactions through their touch, mothers are facilitating the engagement and co-regulatory processes.

The current dissertation adds to the existing literature by examining maternal touch in the context of other maternal behaviors and by taking into account infants' behavior as opposed to studying touch in isolation. As pointed out by Stack (2001) and Hertenstein (2002), touch occurs within a dynamic bidirectional communication system between infants and caregivers: it is impossible to touch without being touched at the same time (Montagu, 1986). Therefore, it is essential to investigate its bidirectional influence by demonstrating that touch affects infants' affect and attention, and in return, infants' affect and attention affects maternal touch. Evidence for the association between maternal touch and infants' affect and attention was obtained. For example, in Study 1b, mothers of full-term infants used more nurturing touch in the Reunion Normal period when their infants exhibited medium-high level of distress. Similarly, an increase in nurturing touch was noted in Study 2 when infants began to experience distress. In addition, findings from Study 2 revealed a temporal organization between maternal touch and infants' affect (co-occurrence), that was found to vary across periods. The specific co-occurrence between playful function of touch and smiling during the Normal period of interaction is consistent with the results from Study 1b documenting a positive association between playful function of touch and infant smiling. These findings add to the growing body of evidence demonstrating infants' positive reactions to physical stimulation (Blehar et al., 1977; Dickson, Walker & Fogel, 1997; Stack & Jean, 2011; Stack, LePage, Hains, & Muir, 2006).

Finally, the current dissertation moves the area of emotion regulation and maternal touch forward by conjointly investigating maternal functions of touch and infants' self-regulatory behaviors. Prior studies have documented that touch facilitates emotion regulation (e.g., Feldman et al. 2010; Moszkowski & Stack, 2007; Stack & Muir, 1990; 1992). Yet, to date, no studies have directly measured the association between touch and infants' self-regulatory behaviors. Findings from Study 1b documented how both maternal touch and infants' self-regulatory behaviors contributed to the elicitation and maintenance of infants' smiling, thus demonstrating that they are both important in infants' emotion regulation. Furthermore, the co-occurrence analyses between function of touch and infants' self-regulatory behaviors demonstrated an organized pattern of mother-infant regulatory behaviors. Together, results provide further support for the contention that infants' regulation is simultaneously accomplished through internal and external means, one of which being maternal touch.

Without taking away from the important contributions of the present dissertation in providing a significant step toward elucidating the different functions of touch and their respective roles in infants' emotion regulation, it is nonetheless important to recognize that it was not possible to determine with absolute certainty what functions mothers' touch was serving at a particular point in time. Mothers' intentions were not directly assessed. Nevertheless, our findings are based on a well-operationalized and systematic coding scheme aimed at capturing the functions of maternal touch. In order to clarify this issue, future work could directly assess mothers' intention while using a specific function of touch. For example, mothers might be asked to clarify the reasons that propelled them to use a specific function at a given time while either watching a

videorecord of their interaction or stopping them intermittently while the interaction is occurring. Alternatively, similar to the work by Stack and colleagues (Stack & Arnold, 1998; Stack et al., 2006), specific instructions might be given to mothers at the beginning of each period to elicit a specific function of touch (e.g., get your infants excited and stimulated) or to use a specific function of touch and then measure the infants' behavior.

New insights on the role of maternal touch in infants' regulation were obtained from the results of the present studies, however, in order to fully comprehend the role of maternal touch in infants' emotion regulation future research is warranted in several areas. For example, future studies should examine how a change in maternal function of touch precedes or follows a change in infants' affect and/or attention, and precedes or follows the use of a specific self-regulatory behavior. This approach would help unravel the roles of maternal touch in infants' self-regulation. In addition, longitudinal studies are needed to document how maternal touch evolves with infants' age and development, and with their growing self-regulatory abilities. Thus far, some research has documented longitudinal changes in maternal tactile behaviors (Crnic et al., 1983; Ferber et al., 2008; Jean, Stack, & Fogel, 2009), however, no studies have investigated how maternal touch evolves with changes in infants' self-regulatory abilities. Finally, current findings would be strengthened by observing maternal touch across other social contexts such as feeding, floor play, bathing or caretaking.

Taken together, findings from Studies 1 and 2 demonstrate mothers' abilities to attune their tactile behavior to their infants' affect and level of distress, thereby providing further support for mothers' sensitivity toward their infants' emotional displays, while at the same time validating the importance of measuring the functions of maternal touch. In

addition, findings confirmed the existence of a reciprocal influence between infants' affect and mothers' touch. By observing that a change in infants' affect leads to a contingent change in their mothers' regulatory behaviors, infants may discover that they have control over the interaction, leading in turn to an increased sense of self-efficacy and self-awareness (Bigelow, 2001; Gable & Isabella, 1992; Gergely & Watson, 1996; 1999; Stack, LePage, Hains, & Muirs, 1996).

Infants' Birth Status and the Quality of Maternal Functions of Touch and Infants' Self-Regulatory Behaviors

In general, the comparison of maternal functions of touch and infants' self-regulatory behaviors across full-term and VLBW/PT infant-mother dyads revealed few differences across group. Consistent with the existing literature on preterm infants (Hsu & Jeng, 2008; Montirosso et al., 2010; Segal et al., 1995), VLBW/PT infants did not differ from full-term infants on measures of arousal and attention during the SF procedure. Although they presented with similar patterns of self-regulatory behaviors relative to full-term infants, the findings suggest that they sought the regulatory support of their mothers more than full-term infants during the Reunion Normal period. Consistent with Montirosso and colleagues (2010), this finding seems to suggest that when mothers are available, VLBW/PT infants rely on their mothers' regulatory contribution as opposed to relying on their own independent regulatory skills. Together, findings from the current dissertation support evidence suggesting healthy VLBW/PT infants' abilities to form social expectations, their sensitivity to their mothers' behaviors, and their abilities to successfully cope with stress, thus demonstrating an emotional maturity level expected for their age (Melinder et al., 2010; Montirosso et al., 2010).

In line with previous studies (Arnold, 2002; Korja et al., 2008; Montirosso et al., 2010), mothers of VLBW/PT infants were as sensitive to their infants' needs as mothers of full-term infants when their general level of sensitivity (e.g., EA scales) was assessed. They exhibited a similar pattern of touching with the exception of an increased reliance on playful function of touch; this illustrates their stimulating, albeit positive, style of interaction (Crnic et al., 1983). Contrary to mothers of full-term infants, no increase in the amount of nurturing function of touch was noted when infants exhibited distress suggesting that mothers of VLBW/PT infants may not be responding to their infants' distress or alternatively, they may respond through other regulatory strategies (e.g., talking, smiling, or gazing) to their infants' requests for regulatory support. This issue warrants clarification given that, as outlined by the Mutual Regulation Model (Gianino & Tronick, 1988; Tronick, 2005), an effective and contingent response to infants' distress can lead to more effective self-regulating abilities while maternal unresponsiveness to distress can negatively impact infants' regulating abilities and overall sense of efficacy (Braungart-Rieker et al., 2001; Conradt & Ablow, 2010; Gable & Isabella, 1992; Tronick et al., 1978).

Although it would be tempting to conclude that VLBW/PT infant-mother dyads do not differ from full-term infants-mother dyads in their ability to regulate the intensity of infants' affective response, future research is needed in order to adequately support this conclusion. The present study was composed of healthy infants who met rigorous inclusion/exclusion health criteria who were investigated at 5½ months of corrected age. Most studies noting significant differences between full-term and preterm infants' self-regulatory behaviors (e.g., Feldman, 2009; Korja et al., 2008; Wolf et al., 2002) and with

mother-infant interaction quality (e.g., Forcada-Guex et al., 2011; Korja et al., 2008; Muller-Nix et al., 2004) were conducted with preterm infants suffering from medical complications or chronic health conditions. Therefore, it would be beneficial to investigate different samples of preterm infants such as healthy preterm infants and those having undergone medical complications and chronic health conditions. Interestingly, Forcada-Guex and colleagues (Forcada-Guex et al., 2006; Forcada-Guex et al., 2011) identified two dyadic patterns of interaction in mother and preterm infants; a protective pattern (e.g., cooperative pattern) defined by sensitive, cooperative and responsive partners, and an at-risk pattern (e.g., controlling pattern) consisting of a controlling mother and a compliant infant. According to them, the negative outcomes associated with prematurity are typically related to the controlling pattern of interaction. Consequently, choosing dyads based on these characteristics could provide a better understanding of preterm infants' self-regulating abilities. In addition, given that evidence suggests that deficits in socio-emotional development have generally dissipated in the second half of the first year for healthy preterm infants (Brachfeld, Goldberg, & Sloman, 1980; Forcada-Guex et al., 2006), longitudinal investigations are required to better understand the normative as well as atypical development of self-regulation.

Theoretical Implications

Findings from the present studies confirm and expand upon theory and research in the area of mother-infant interaction, infants' reactions to the SF period, and models of regulation (Fogel, 1993; Fogel & Garvey, 2007; Gianino & Tronick, 1988; Tronick & Beeghly, 2011). In particular, by demonstrating that mothers are active participants in the regulation of their infants' affect and attention, the results support current theories such as

dynamic systems theories (Fogel, 1993; Fogel & Garvey, 2007) and the Mutual Regulation Model (Gianino & Tronick, 1988; Tronick & Beeghly, 2011; Tronick & Weinberg, 1997). Consistent with dynamic system theories, mothers and infants were found to adjust their affect and behaviors during the interaction periods and in accordance with their interactive partners' affect and behaviors. In addition, the importance of assessing dyadic behaviors as stipulated by dynamic system theories compared to to separate components for each individual interacting was underscored through the use of the bidirectional exchange categories. Changes in bidirectional exchanges in Study 1a and Study 2 documented how both mothers and infants were co-regulating infants' affect and attention. In addition, findings from the present studies are in line with the Transactional Model (Sameroff, 2009; Sameroff & Chandler, 1975), underscoring how mothers' implications can support, or undermine, the development of infants' socio-emotional development and how infants' risk status (e.g., birth status) can influence the quality of mother-infant interactions. Findings from both studies demonstrated how maternal touch influenced infants' socio-emotional development by supporting infants' nascent self-regulatory abilities and affect. In addition, findings from Study 1a support the contention that infants' risk status can impact maternal behaviors and infants' self-regulatory development.

The observed infants' negative reaction to the SF period is consistent with several explanations of the SF phenomenon. Infants' observed response to the SF period is thought to be due to a violation of the social expectancies infants have regarding their dyadic adult partner (Adamson & Frick, 2003; Mesman et al., 2009; Shapiro et al., 1998; Tronick et al., 1978). In addition, infants' inability to engage in reciprocal social

interaction with their mothers (Field, 1994), as well as the lack of regulatory support provided by mothers during this period where they are physically present but emotionally unavailable (Field, 1994; Stack & Muir, 1990) are believed to be responsible for an increase in infants' negative arousal. These explanations are further reinforced by findings from Study 2 demonstrating that mothers' responsiveness through touch alone can mitigate the negative effects of the SF period, at least for brief periods of time.

Finally, findings from this series of studies are consistent with models of regulation. In line with the tenets of the Mutual Regulation Model (Gianino & Tronick, 1988; Tronick & Beeghly, 2011; Tronick & Weinberg, 1997) which stipulaties that infants are forced to rely on their own resources when mothers are not available, an increase in self-regulatory behaviors was observed during the SF period in Study 1a. In Study 2, given that mothers were available through their touch, no such findings were obtained. In addition, findings provide further support for functionalist theories of emotion (Barrett & Campos, 1987; Campos, Mumme, Kermonian, & Campos, 2008), emphasizing the importance of emotions in motivating an individual to maintain or change his or her behavior. In this case, infants' negative reactions to the SF period (Study 1a) might have motivated them to adjust their behaviors and rely on their own self-regulatory behaviors. In contrast during Study 2, both infants' affect and self-regulatory behaviors remained fairly stable across periods. Finally, our findings are consistent with Rothbart and Derryberry's (1981) theory of reactivity and self-regulation, which stipulates that when infants' expectancies are violated (i.e., Still-Face), it results in an emotional reaction (reactivity). In order to deal with this heightened level of arousal, infants resort to their own regulatory abilities in a attempt to modulate this increase in

emotional arousal (self-regulation). In Study 1a, infants reacted to the SF period by increasing their use of self-comfort regulatory and exploratory behaviors, attention-seeking, escape, and gaze aversion. In contrast in Study 2, mothers' use of touch during the SF+T period might not have violated infants' expectancies to the same extent than during a typical SF period. Thus, infants might not have experienced the same level of negative arousal. The general stability in use of self-regulatory abilities observed throughout the SF+T periods support this hypothesis.

Applied Implications

In addition to providing further support for theory and existing models of mother-infant interaction and infants' regulation, results from the present studies also have significant applied implications. More specifically, results from these studies can inform clinical intervention programs aimed at reducing the negative effects associated with prematurity, as well as overall clinical intervention programs aimed at promoting successful socio-emotional development in typically developing infants. In this regard, results from the dissertation studies inform intervention program in at least three ways.

First, current findings add to the growing body of literature documenting beneficial effects of maternal touch for preterm dyads (e.g., Feldman et al., 2002; Field, Hernandez-Rief, & Freedman, 2004; Underdown, Barlow, Chung, Stewart-Brown, 2009). Thus far, early touch interventions program have shown positive effects for infants' developmental outcomes, socio-emotional development, as well as the quality of the mother-infant relationship (e.g., Bigelow & Power, 2012; Feldman, et al., 2002; Field et al., 2004; Meijssen et al., 2010; Neu & Robinson, 2010; Spittle, Orton, Doyle & Boyd, 2007). Findings from the current studies contribute to existing knowledge by

demonstrating that maternal touch can also influence and support 5 1/2-month-old full-term and VLBW/PT infants' regulatory abilities. Therefore, early touch intervention programs can be implemented for infants at-risk of developing emotion regulation difficulties (i.e., infants born prematurely, infants of depressed, anxious, or adolescent mothers).

Second, since maternal touch was shown to be related to infants' affect and expression in the current studies, this information may be beneficial for the implementation of preventative programs aimed at teaching parents how to interpret infants' behavioral cues, and in response providing the appropriate tactile stimulation. Although previous interventions aimed at enhancing infant social competence and promoting maternal sensitivity and responsiveness have shown promising results (e.g., Meijssen et al., 2010; Melnyk et al., 2001; Spiker, Fergusson & Brooks-Gunn, 2008; Spittle et al., 2010), these preventative programs rarely include touch. Therefore, results from the current studies illustrate the importance and pertinence of adding a touch component. Teaching parents how to also be responsive through their tactile behavior may result in an increase in caregiver's sense of competence as a parent, and an overall improvement in the quality of mother-infant interactions.

Finally, the documentation of infants' responses to the SF procedure in both full-term and premature infants, in conjunction with existing literature (Mesman et al., 2009), can serve as a baseline comparison to measure infants' socio-emotional competencies. As such, how infants react to the SF period and how parents respond in return, might be an early indicator that can be used for detection of future socio-emotional difficulties. For example, infants at-risk for autism (i.e., siblings of infants diagnosed with autism) were

shown to be less upset by the SF procedure (Yirmiya et al., 2006). Similarly, knowledge of the development of emotion regulation abilities in normal and low-risk preterm infants has the potential to assist in early identification of infants who demonstrate maladaptive patterns of emotion regulation.

Conclusions

The overarching objective of the current research was to examine the regulatory roles of maternal touch in the context of infants' self-regulation. This examination was carried out over a series of two studies, addressing the same fundamental questions, through different experimental procedures (SF procedure vs SF+T procedure), varied statistical analyses and on different samples (full-term vs VLBW/PT infants). A number of important conclusions can be drawn from the current dissertation with implications for our understanding of a) the role(s) of mothers in developing infants' emotion regulation, b) infants' socio-emotional development, c) and the impact of prematurity.

Results from both studies demonstrated that infants are sensitive to perturbations in the quality of their interactions with their mothers. Similar to existing literature (Conradt & Ablow, 2010) both mothers and infants were found to play a pivotal role in how infants handled the SF procedure. Specifically, mothers adjusted their tactile behaviors while infants responded by changing their affect and gaze, but also through changes in their self-regulatory behaviors. In addition, the current research contributed to our understanding of the influence of prematurity on infants' socio-emotional development and the quality of the mother-infant interaction. Our findings also documented the positive and normative nature of healthy VLBW/PT infant-mother interactions.

In summary, findings from both studies highlight the roles of maternal touch as a regulatory strategy and underscore mothers' ability to use only one modality of communication, touch, to regulate their infants' affect and attention, at least for brief periods of time. Results extend our knowledge of infants' emotional and behavioral regulation by documenting the central roles that both mothers and infants play. Finally, findings emphasize the bidirectional nature of mother-infant social interactions and highlight the flexibility of the dyad, wherein each partner adjusts and modifies their behaviors to meet the contextual demands, as well as partners' needs and expectations. Taken together, the current research sheds light on the use of touch during SF procedures and makes a substantive contribution to the growing body of literature on the role(s) of maternal touching during mother-infant interactions. Finally, the importance of maternal touch as a modality of regulation and communication during early infants' socio-emotional development is underscored.

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APPENDIX A

CONSENT FORM STUDY 1 A-B

Consent Form

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 INFORMATION QUESTIONNAIRE FOR STUDY 1 A-B

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

FUNCTION OF TOUCH SCALE (FTS)

FUNCTION OF TOUCH SCALE (FTS)

AMÉLIE JEAN, NADINE GIROUARD, & DALE STACK (2007)

The Function of Touch Scale (FTS) was designed to measure the functions or roles of maternal touch during mother-infant face-to-face interaction. The coding is based on the qualitative and quantitative aspects of maternal touch as well as contextual information such as maternal affect and content of verbalization, and infants' affect and attention.

CODING OF THE FTS

The function of maternal touch is coded when the mother is touching her infant. If the infant initiated the tactile contact and the mother remained passive, then mother's touch is not coded. The FTS is coded for every second of the interaction. Given that the coding of the FTS takes into consideration contextual information such as maternal affect and content of verbalization, and infants' behaviors and affects, the volume of the rig should be turned on.

If the mother is not touching her infant for more than 3 seconds, then the touching event is stopped.

HINTS

- If mothers is singing a song as part of game or playing a touching game with the infant, the entire song/game is part of one touching sequence. However, if there is a significant pause and the mother is changing game, beginning a new song, or restarting the same song, a new touching event is coded

CATEGORY FOR FUNCTIONS OF MATERNAL TOUCH

1. Passive accompaniment
2. Active accompaniment
3. Nurturing
4. Playful
5. Attention-Getting
6. Accidental
7. Utilitarian
8. Harsh
9. Unspecified function of touch

1. Passive accompaniment

- Touch serves as an accompaniment to another modality of communication. The focus is not on the touch, but on the other modalities.
- The tactile behavior of the mother is *passive*, or used in order to provide support (holding) to the infant. Generally, there is not a lot of movement, but some brief, slow active movement might be present.
- The mother is generally speaking to the infant or she is letting the infant lead the interaction (i.e. respecting what the infant is doing). For example, the infant might be looking around the room and the mother is passively touching his legs.

- The mother might also be singing (which is normally coded in a playful context of touch), however her touching behavior is passive as opposed to active.
- During a Still-Face + Touch period code when the touch is passive and static.

2. Active accompaniment

- Touch serves as an accompaniment to another modality of communication. The focus is not on the touch, but on the other modalities.
- The tactile behavior of the mother is *active*.
- The mother is generally speaking to the infant. Compared to playful function of touch, there is *no game aspect* for this function.
- If during a touching event, there might be some passive and active accompaniment touch. If there is more active touch, code it as active accompaniment
- During a Still-Face + Touch period, code when touch is active and there is no game or playful aspect to the mother's behavior.

3. Nurturing

- The tactile behavior of the mother is soothing and done in a slow manner.
- The mother is typically kissing, and rubbing her infants in an attempt to demonstrate affection of her infant or regulate infant's negative affect.
- The mother is generally speaking in a low tone voice, and/or she is acknowledging her infant's emotion or behavior (e.g., "you are crying", "that was hard for you")
- If the child is sitting on the mother, the mother is rocking or slowly shaking her child using her own body
- The mother might be patting and stroking her infant's body

4. Playful

- The touch need to be *active* and *playful*
    - *If the mother is singing and she is using passive/static touch it should be coded as passive accompaniment*
- Often fast pace (intense) and repetitive
- The goal is to make the infant smile and laugh
- Often accompanied by mother singing, game playing, making some noises, motherese (not normal conversation style)
    - Part of a game or rhythmic vocalization
    - During a Still-Face + Touch period; no other behaviors is accompanying mothers' touch, therefore in order to be coded as playful the playful and game-aspect to the touching event needs to be evident (often repetitive movement, fast pasted, and of longer duration).
- It is not only the presence of active touch, but there is *a playful aspect to touching event that is clearly evident.*
- Active and fast tickling is often coded here
- In the lap position, mother might be actively rocking her infant in a playful manner

5. Attention-Getting

- Touch that is use in order to get baby's attention
    - Mother is using touch to get infant attention, *she is not only naming the infant's name* while passively touching the infant
- Mother is looking at the infant, and trying to gain attention
- Often accompanied by similar maternal getting strategies, such as calling the infant's name, making noises with her mouth to get baby's attention, or snapping her finger.

6. Accidental

- Unintentional touch
- Fortuitous physical contact
- *Very brief*

- No specific maternal behavior accompanied this context of touch

7. Utilitarian

- Touch that is use in order to accomplish a specific instrumental task such as removing infant's hands from his/her mouth, or fixing the infant's clothes.
    - Using touch to remove hands from mouth
    - "*Donnes les main a maman* (while grabbing)"
- She might be talking to the infant, describing what she is doing to him
    - fix baby clothes, wipe baby's face, change baby's postur
- Can be coded for more than the "other" type of touch of the CITS, for example grabbing can be in this category
- In the lap context, mother is changing her infant posture from one posture to another

8. Harsh, negative touch

- Maternal touch serves to control the infant's behavior. It is typically intrusive and performed in a negative manner
- There might be some harsher talking toward the infant

9. Unspecified function

- No apparent function of maternal touch. No other maternal behaviors are present.
- Different from accidental and accompaniment
    - The difference with active accompaniment is that here the focus is on touch
- The mother seem to be touching for touching

APPENDIX D

INFANT SELF-REGULATION SCHEME (ISRS)

INFANT SELF-REGULATION SCHEME (ISRS)

TARA MILLMAN, AMÉLIE JEAN, & DALE STACK (2007)

The Infant Self-Regulation Scheme (ISRS) was designed to measure types of infant self-regulatory behaviors during mother-infant face-to-face interaction. It measures quantitative and qualitative changes in regulatory behavior as a function of different contexts. It is based on Weinberg and Tronick's (1996) Infant Regulatory Scoring System (IRSS).

*N.B. All indications with an * consist of modifications to the original Infant Self-Regulation Scheme (Baljak, Millman, Jean, & Stack, 2009)*

CODING OF THE ISRS

All codes except for *Bidirectional Exchange* involve behavior that is **initiated by the infant**. One type of self-regulatory behavior is coded for each second of the interaction. Codes do not need to fully include all examples of listed behavior – one is sufficient. Each code must last for at least half a second. For example, the behavior must be present from 0:00:04:00 to at least 0:00:04:15 for it to be coded. If two behaviors co-occur, code the behavior that has a longer duration during the 1-second interval. If they have equal durations, refer to hierarchy below.

CATEGORIES OF TYPES OF SELF-REGULATION BEHAVIOR

1. Self-Comfort – Regulatory
2. Self-Comfort – Exploratory
3. Escape
4. Attention-Seeking
5. Gaze Aversion
6. Bidirectional Exchange
7. No Code

Hierarchy

When two behaviors are present during the same time interval, the behavior higher on this list will predominate.

1. Self-Comfort – Regulatory

The infant's torso is relaxed during these behaviors. Except for any mouthing behavior, the infant's gaze must be directed **away** from self or the item (e.g., looking elsewhere while pulling feet; looking at mother or around the room while pulling clothes). These behaviors may be accompanied by positive, negative, or neutral vocalizations.

Examples of possible behaviors include:

- *Skin-to-Mouth or Object-to-Mouth Contact:* Mouthing limbs (ex. hands, feet, thumb); sucking clothes or strap; reaching for and bringing mother's hand into mouth. Do not code if the mother places their own finger in the infant's mouth
- *Tapping/Touching/Pulling/Grasping/Rubbing:* May occur on any body part (ex. face, hands, feet, torso) or object (ex. chair, clothes). Infant's hand must curl around the body part or object, and not

simply be resting on it. Do not code if pulling on chair as a support when twisting with the intention of looking behind the chair.
- *Self-Clasp*: Hands together or hugging body.
- *Rocking*: Involving torso, rhythmically, from back and forth or side to side.

2. Self- Comfort – Exploratory

The infant is using other objects upon which to focus their attention in order to avert their gaze from their mother, either due to disinterest or distress. The infant may also be using the object to self-soothe. The infant's gaze must be directed **toward** the self or the item of interest. These behaviors may be accompanied by positive, negative, or neutral vocalizations.

Examples of possible behaviors include:
- *Tapping/Touching/Pulling/Grasping/Rubbing:* May occur on any body part (ex. hands, feet, torso) or object (ex. shoelaces, chair, clothes). Infant's hand must curl around the body part or object, and not simply be resting on it.

3. Attention- Seeking

The infant is trying to get his/her mother's attention during situations when the mother is not interacting with the infant, such as during the Still-Face or a Still-Face with Touch, or when she is gazing away from the interaction. The mother must *not be engaged* in the interaction with the infant for this behavior to be coded. These behaviors may be accompanied by positive, negative, or neutral vocalizations.

Examples of possible behaviors include:
- *Reaching:* The infant extends his/her arms towards the mother, with or without physical contact.
- *Touch*: The infant's hands are in physical contact with the mother's body, including clothing, hair, or jewellery.
- *Lean forward:* The infant is leaning forward in their chair in the direction of the mother. The belt of the chair is pulled taut against the clothing of the infant.
- *Motor movements:* Involving jerky limb movements, such as banging arms, wiggling legs, and shaking head back and forth frequently.
- *Exaggerated vocalization:* Very loud and persistent vocalizations by the infant while looking at their mother, who is not engaged in the interaction.
- **Note**: for ***Attention-Seeking*** to be coded, **during the Still-Face or Still-Face + Touch*:** the infant must have eye contact with mother → if no eye contact, code as ***Escape***. **During the Normal and Reunion Normal :** if eye-contact with mother, code ***Bidirectional Exchange***.

4. Escape

The infant is attempting to increase the perceptual or physical distance between itself and their mother, or is trying to get out of their chair. These behaviors must be accompanied by negative or neutral vocalizations. The infant's gaze is directed at or away from their mother, although more commonly away, with an upward focus of the eyes.

Examples of possible behaviors include:
- *Turning/Twisting*: Some rotation must be seen in the shoulders and torso of infant. The infant's arms are normally raised above the head. The behavior occurs with a high intensity, and the infant is visibly distressed and restless. Do not code if infant is trying to get a better look at something behind the chair (code ***Gaze Aversion*** for this).
- *Arch*: The infant's shoulders are pushed against the chair and their torso is thrust upwards.

5. Gaze Aversion

There is no eye-contact between the infant and the mother. The infant is not interested in interacting with the mother and/or has their attention elsewhere. The infant may be looking around the room or at the camera. During the **Still-Face or Still-Face + Touch ***, code a ***Gaze Aversion*** even if the infant is looking at mother's clothes – anywhere but at her eyes.

N. B. The infant must not be actively touching themselves or an object while gaze averting – if they are, this is coded as ***Self-Comfort – Regulatory***. If the infant is looking into the mirror at either their mother or an object and will not look at their mother despite her repeated attempts to get the infant's attention by calling their name, code this as ***Gaze Aversion***. However, if the infant has eye-contact with their mother through the mirror, code as ***Self-Comfort – Regulatory.***

6. Bidirectional Exchange

The dyad must have eye-contact with each other. The infant must be engaged in the interaction by reciprocating or by simply gazing at mother's face, neck, shirt, or hands. Code ***Bidirectional Exchange*** for **joint attention** –i.e., both mother and infant are looking at the infant's toes. **Either mother or infant may initiate the behavior**. Infant may be looking at mother in the mirror, but for bidirectional exchange to be coded ***both*** mother and infant must be looking in the mirror, and interacting through the mirror –i.e., the mother is ***not*** trying to get their infant's attention away from the mirror. Positive, negative, or neutral vocalizations may accompany this behavior. ***Bidirectional Exchange*** is **not possible during the Still-Face**, as the mother is not allowed to engage in an interaction with their infant, though they are instructed to maintain eye-contact. However, ***Bidirectional Exchange*** is possible during the **Still-Face + Touch *** period as the mother is allowed to engage in an interaction with their infant through touch **ONLY** (the use of other modalities are not permitted throughout the Still-Face + Touch period).

Example of possible behaviors include:

- Mother extends fingers towards infant, and infant grasps them in response; mother coos and infant smiles (or frets) while maintaining eye contact.
- During the **Still-Face + Touch *** period: code **Bidirectional Exchange** if child is looking at mothers' hands while mother is either actively touching the child or using her hands to engage the infant in an interaction –i.e. waving hands in front of infant to get his/her attention.

- **Note**: If the mother initiates behavior, but the infant is engaged in self-regulatory behavior, such as pulling clothes while looking at mother, code this as ***Self-Comfort - Regulatory***. If the infant is looking away from the mother and the mother is the one initiating the interaction, code as ***Gaze Aversion.*** If the infant is looking away, and touches mother in response to a mother-initiated behavior, continue to code as ***Gaze Aversion.***

7. No Code

This is coded if no regulation behavior is exhibited; if the infant's behavior does not fit with above codes; or if the infant's face or movements are not visible. Also includes when the infant is simply gazing at their mother with no visible (or very low frequency, ex. a simple kick) motor movements **during the Still-Face period or Still-Face + Touch period *.**

APPENDIX E

OPERATIONAL DEFINITIONS FOR INFANTS' DISTRESS LEVEL

OPERATIONAL DEFINITIONS FOR INFANTS' DISTRESS LEVEL

AMÉLIE JEAN & DALE STACK (2009)

Low Distress	Infant is displaying mostly positive or neutral vocalizations with rare bouts of fretting or crying. Infant is sitting calmly in the seat.
Medium Distress	Infant has short bouts of fretting or crying (between 25% - 50% of the period), or does not begin fretting/crying until the end of the period. Infant may squirm in the seat at times and may gesture to his/her mother in order to attract her attention.
High Distress	Infant is fretting or crying (usually the infant is quite loud) for an extended amount of time (more than half of the period). Infant is also showing discontent by squirming and trying to get out of the seat and gesturing toward his/her mother to attract her attention.

APPENDIX F

ANOVA SUMMARY TABLES FOR STUDY 1 A-B

Table F1

Analysis of Variance for Duration of Infants' Smiling across Group and Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	1.86	0.02	0.18
Error	75	(882.76)		
	Within Subjects			
Period (P)	2	85.92***	0.53	0.00
Error	150	(238.12)		
P x G	2	2.16	0.03	

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table F2

Analysis of Variance for Duration of Infants' Fretting across Group and Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	0.11	0.002	0.74
Error	75	(13.46)		
	Within Subjects			
Period (P)	2	3.66*	0.05	0.03
Error	150	(10.75)		
P x G	2	3.58	0.05	0.03

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table F3

Analysis of Variance for Duration of Infants' Gaze across Group and Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	0.79	0.01	0.38
Error	75	(711.54)		
	Within Subjects			
Period (P)	2	156.42***	0.68	0.00
Error	150	(268.31)		
P x G	2	1.64	0.02	0.20

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table F4

Means and Standard Deviations for the Percent Duration of Infants' Smiling, Fretting, and Gazing at Mothers' Faces across Interaction Periods and Group

Group	FULL-TERM						VLBW/PT					
	Normal		SF		Reunion Normal		Normal		SF		Reunion Normal	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Smiling	44.69	24.36	12.03	14.15	44.38	23.39	34.92	21.69	12.38	14.89	37.77	26.20
Fretting	0.62	2.06	2.44	4.23	0.94	2.60	0.24	0.94	0.98	2.42	2.29	5.74
Gazing at Mother	57.88	26.21	18.66	15.35	66.98	21.88	51.66	19.51	21.05	15.30	61.43	21.62

Table F5

Analysis of Variance for Maternal Sensitivity across Group and Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	0.86	0.01	0.36
Error	78	(1.97)		
	Within Subjects			
Period (P)	1	0.33	0.00	0.57
Error	78	(0.23)		
P x G	1	0.54	0.01	0.46

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table F6

Analysis of Variance for Maternal Touch across Group and Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	0.09	0.00	0.76
Error	78	(470.34)		
	Within Subjects			
Period (P)	1	1.28	0.02	0.26
Error	78	(260.69)		
P x G	1	0.34	0.004	0.56

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table F7

Analysis of Variance for Functions of Maternal Touch across Group and Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	1.35	0.02	0.25
Error	78	(85.61)		
	Within Subjects			
Period (P)	1	1.129	0.01	0.29
Error	78	(45.68)		
P x G	1	0.87	0.01	0.35
Touch (T)	5	97.42***	0.56	0.001
Error	390	(223.49)		
T x G	5	2.57 **	0.03	0.03
P x T	5	4.28***	0.05	0.001
Error	390	(92.18)		
P x T x G	5	0.14	0.002	0.98

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table F8

Means and Standard Deviation for the Percent Duration of Touch and Function of Maternal Touch across Interaction Periods and Group

Groups Period	FULL-TERM				VLBW/PT			
	Normal		Reunion Normal		Normal		Reunion Normal	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall Touch	81.10	19.53	82.52	19.53	80.67	20.20	85.03	17.06
Function of Touch								
Passive Accompaniment	16.42	13.77	14.98	12.23	16.58	15.43	16.29	12.57
Active Accompaniment	20.46	12.08	18.79	15.02	17.55	15.02	14.96	11.88
Nurturing	4.19	4.84	6.40	7.85	3.24	3.71	6.00	7.14
Playful	26.06	18.41	31.29	19.35	33.22	23.00	39.44	19.95
Attention-Getting	6.67	7.80	2.88	4.44	3.95	5.01	2.72	3.62
Utilitarian	1.46	2.38	1.23	1.61	2.42	3.98	2.77	3.47
Harsh/Negative	0.03	0.16	0.00	0.00	0.00	0.00	0.02	0.13
Accidental	0.00	0.00	1.67	0.42	0.03	0.16	0.03	0.16
Unspecified Function	2.51	3.33	4.13	4.60	0.78	1.41	0.65	1.29

Table F9

Analysis of Variance for Maternal Touch across Group, Interaction Periods, and Infants' Distress Level

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	0.41	0.01	0.53
Infants' Distress (D)	1	0.17	0.00	0.68
G x D	1	0.78	0.01	0.38
Error	76	(476.65)		
	Within Subjects			
Period (P)	1	1.10	0.01	0.28
Error	76	(267.52)		
P x G	1	0.25	0.00	0.62
P x D	1	0.01	0.00	0.93
P x D x G	1	0.00	0.00	0.97

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table F10

Analysis of Variance for Nurturing Function of Touch across Group, Interaction Periods, and Infants' Distress Level

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	1.38	0.02	0.24
Infants' Distress (D)	1	2.38	0.03	0.13
D x G	1	1.89	0.02	0.17
Error	76	(48.89)		
	Within Subjects			
Period (P)	1	15.11***	0.17	0.000
Error	76	(22.99)		
P x G	1	0.33	0.00	0.57
P x D	1	4.21*	0.05	0.04
P x G x D	1	3.95*	0.05	0.05

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table F11

Means and Standard Deviations for the Percent Duration of Touch and Function of Maternal Touch as across Interaction Periods, Group, and Infants' Distress Level

Groups	FULL-TERM								VLBW/PT							
Infants' Distress Level	Low Distress (n = 29)				Medium-High Distress (n = 11)				Low Distress (n = 28)				Medium-High Distress (n = 12)			
Period	Normal		Reunion Normal		Normal		Reunion Normal		Normal		Reunion Normal		Normal		Reunion Normal	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall Touch	81.70	19.56	82.90	18.15	79.55	20.31	81.50	23.72	79.23	21.43	83.51	16.76	84.03	17.40	88.60	17.98
Function of Touch																
Passive Accompaniment	17.60	13.29	17.13	12.69	13.30	16.42	9.32	9.14	17.89	17.19	17.14	13.79	13.54	10.24	14.31	9.32
Active Accompaniment	18.80	11.83	16.26	11.74	24.82	12.19	25.45	20.65	15.48	15.69	14.43	10.63	22.36	12.65	16.19	14.84
Nurturing	4.14	5.20	4.49	5.06	4.32	3.94	11.44	11.41	3.20	3.58	5.92	6.47	3.35	4.17	6.18	8.85
Playful	27.87	18.36	33.02	16.94	21.21	18.49	26.74	24.98	31.31	22.43	31.20	17.11	37.71	24.69	44.65	25.51
Attention-Getting	6.62	7.93	3.60	4.92	6.82	7.87	0.98	1.89	4.19	4.98	3.61	4.42	3.38	5.26	0.79	1.60
Utilitarian	1.26	2.08	1.12	1.61	1.97	3.08	1.52	1.66	2.56	4.30	2.83	3.66	2.08	3.27	2.64	3.13
Harsh/Negative	0.03	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.16	0.00	0.00	0.00	0.00
Accidental	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.50	0.03	0.19	0.03	0.18	0.00	0.00	0.00	0.00
Unspecified Function	2.82	3.25	4.59	4.86	1.69	3.57	2.89	3.73	1.05	1.60	0.80	1.48	0.14	0.32	0.28	0.54

Table F12

Analysis of Variance for Functions of Infants' Self-Regulatory Behaviors across Group, Interaction Periods and Infants' Distress Level

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Group (G)	1	1.16	0.02	0.28
Infants' Distress (D)	1	0.49	0.01	0.49
G x D	1	0.52	0.01	0.46
Error	76	(15.72)		
Within Subjects				
Period (P)	2	16.66***	0.18	0.000
Error	152	(15.49)		
P x G	2	0.15	0.01	0.87
P x D	2	2.15	0.03	0.12
P x D x G	2	0.56	0.01	0.57
Self-Regulation (S)	5	118.42***	0.61	0.000
Error	380	(413.25)		
S x G	5	0.70	0.01	0.62
S x D	5	1.15	0.02	0.19
S x G x D	5	1.84	0.02	0.10
S x P	10	82.20***	0.52	0.000
Error	760	(205.29)		
S x P x G	10	1.92*	0.03	0.04
S x P x D	10	1.75^t	0.03	0.06
S x P x G x D	10	1.49	0.02	0.14

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$, $^t < .10$

Table F13

Means and Standard Deviations for the Percent Duration of Infants' Self-Regulatory Behaviors across Group and Interaction Periods

Group	**FULL-TERM**						**VLBW/PT**					
Period	Normal		SF		Reunion Normal		Normal		SF		Reunion Normal	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Self-Comfort Regulatory	12.55	15.10	37.45	23.57	19.40	24.83	9.99	13.70	38.83	23.91	7.85	9.89
Self-Comfort Exploratory	2.69	4.39	14.87	18.74	1.50	3.08	2.58	4.81	10.45	16.85	1.49	3.00
Attention-Seeking	0.00	0.00	2.72	4.10	0.00	0.00	0.00	0.00	1.79	3.15	0.00	0.00
Escape	0.25	0.89	1.58	3.08	0.21	0.62	0.08	0.41	1.59	2.85	0.34	1.03
Gaze Aversion	32.44	23.81	33.67	22.88	23.85	18.88	38.79	24.43	37.71	23.05	28.19	20.89
Bidirectional Exchanges	48.65	24.58	0.00	0.00	52.15	27.27	46.72	23.78	0.00	0.00	60.70	23.33

Table F14

Means and Standard Deviations for the Percent Duration of Infants' Self-Regulatory Behaviors across Interaction Periods, Group, and Infants' Distress Level

Distress Level	**Low Distress**						**Medium-High Distress**					
Period	Normal		SF		Reunion Normal		Normal		SF		Reunion Normal	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
						FULL-TERM						
Self-Comfort Regulatory	13.82	15.43	39.62	25.77	18.42	21.28	9.17	14.35	31.74	16.09	21.97	33.56
Self-Comfort Exploratory	3.25	4.61	17.41	21.08	1.57	2.98	1.23	3.55	8.18	7.61	1.33	3.46
Attention-Seeking	0.00	0.00	2.47	3.71	0.00	0.00	0.00	0.00	3.42	5.14	0.00	0.00
Escape	0.35	1.03	0.76	2.18	0.17	0.56	0.00	0.00	3.74	4.08	0.30	0.77
Gaze Aversion	28.76	21.50	31.72	23.53	27.33	20.09	42.12	27.83	38.79	21.26	14.70	11.50
Bidirectional Exchanges	49.45	21.23	0.00	0.00	50.34	23.35	46.52	32.98	0.00	0.00	56.51	36.67
						VLBW/PT						
Self-Comfort Regulatory	9.97	14.35	35.45	23.14	7.71	10.76	10.00	11.57	46.74	24.80	8.19	7.91
Self-Comfort Exploratory	2.99	5.02	13.48	19.07	1.74	3.23	1.64	4.35	3.40	6.10	0.90	2.40
Attention-Seeking	0.00	0.00	1.28	2.50	0.39	1.13	0.00	0.00	2.99	4.18	0.22	0.77
Escape	0.00	0.00	0.77	1.90	31.88	22.79	0.28	0.74	3.51	3.77	19.58	12.56
Gaze Aversion	42.44	24.31	40.32	24.45	29.56	21.39	30.28	23.51	31.60	18.95	17.25	12.05
Bidirectional Exchanges	42.35	23.79	0.00	0.00	56.34	24.83	56.94	21.30	0.00	0.00	70.91	15.93

Table F15

Summary of Chi-Square Analysis for Overall Maternal Touch across Infants' Distress Level and Group

		Groups	
	Distress Level	Full-Term	VLBW/PT
	Low Distress	29	28
	High Distress	11	12
Chi-Square	14.45	0.00	
Significance	0.000	1.00	

APPENDIX G

CORRELATION TABLE STUDY 1B

Table G1

Correlations between Functions of Maternal Touch, Infants' Self-Regulatory Behaviors, and Infants' Affect

	Fullterm						VLBW/PT					
	Smiling			Fretting			Smiling			Fretting		
	N	SF	RN	N	SF	RN	N	SF	RN	N	SF	RN
Maternal Function of Touch												
Passive Accompaniment	-.31 *		.09	-.04		-.21	-.03		-.21	.09		.38 *
Active Accompaniment	-.08		-.09	-.09		.17	-.33 *		-.03	.11		.41 *
Nurturing	-.11		-.18	.36 *		.52 ***	.18		.01	.24		.34 *
Playful	.66 ***		.51 ***	-.24		-.17	.48 **		.48 **	-.18		-.42 **
Attention-Getting	-.30 t		.03	-.10		-.01	-.43		-.34 *	-.14		.02
Utilitarian	.29 t		-.17	.27 t		.22	-.22 **		-.13	.38 *		-.05
Infant's Self-Regulating Behavior												
Self-Comfort Regulatory	.34 *	-.03	-.11	-.03	.08	-.06	.15	.14	-.06	-.08	.08	-.18
Self-Comfort Exploratory	-.24 *	-.15	-.44 **	.04	-.17	-.12	-.14	-.23	-.29 t	.21	-.17	-.12
Attention-Seeking	---	.51 ***	---	---	.06	---	---	.34 *	---	---	.06	---
Escape	-.36	.04	-.04	.67 ***	.40 *	-.04	-.07	.35 *	-.30 t	.05	.40 *	.43 **
Gaze Aversion	-.56 ***	-.13	-.10	.28 t	-.04	-.14	-.50 **	-.25	-.42	-.13	-.04	.12
Bi-Directional Exchange	.51 ***	---	.41 **	-.26	---	.20	.51 ***	---	.52	.12	---	-.05

Note. N = Normal Period, SF = Still-Face Period, RN = Reunion Normal Period.

$t < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

APPENDIX H

CONSENT FORM FOR STUDY 2

Consent Form

This study is designed to look at infants' responses to touch and to study the different types of touching used by caregivers and their role in social interchange. I understand that my baby and I will participate in a study lasting approximately 60 minutes. 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 play with my baby as I normally would at home. There will be brief breaks separating the interaction periods. Under no circumstances will any manipulation be harmful to my baby. 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 of 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.

In the event that I have any unanswered concerns or complaints about this study, I may express these to Dr. Dale Stack (848-7565) of the Psychology Department at Concordia University. In addition, the patient representative of the Jewish General Hospital is Roslyn Davidson (340-8222, local 5833).

Thank you for your cooperation.

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

Signature: _____ Date:_____

Witness: _____ Date: _____

APPENDIX I

DEMOGRAPHIC INFORMATION QUESTIONNAIRE FOR STUDY 2

Demographic Information

Order :

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

Infant's Name : _____
D.O.B. :_____ E.D.O.B. :_____ Âge : _____
Mother's Name : _____ Âge : _____
Language Spoken : _____
Father's Name : _____ Âge : _____
Language Spoken : _____
Phone #: _____
Address: _____
_____

Sex: _____ Birth Weight: _____ Length of Labour: ___
Pregnancy Complications and Delivery Status: _____
_____

Medical History:_____
_____

Breast fed:_____ Bottle fed:_____

Sibling:	Age:	Sex
_____	_____	_____
_____	_____	_____
_____	_____	_____

Father's Occupation: _____ Education: _____
Mother'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	¾	½	¼	< ¼
Father :	all day	¾	½	¼	< ¼

Caretaking history (# of caretakers, day/homecare, hours) : _____
_____

Previous tactile games : _____
Amount relative to auditory & visual games : _____
Comments :_____
_____

APPENDIX J

ANOVA SUMMARY TABLES FOR STUDY 2

Table J1

Analysis of Variance for Duration of Infants' Smiling as a Function of Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Within Subjects			
Period	3	26.49***	0.54	0.001
Error	69	(155.82)		

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J2

Analysis of Variance for Duration of Infants' Fretting as a Function of Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Within Subjects			
Period	3	6.23***	0.21	0.001
Error	69	(13.97)		

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J3

Analysis of Variance for Duration of Infants' Neutral Affect as a Function of Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Within Subjects			
Period	3	19.68***	0.46	0.001
Error	69	(175.53)		

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J4

Analysis of Variance for Duration of Infants' Gaze as a Function of Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Within Subjects			
Period (P)	3	1.00	0.04	0.40
Error	69	(6.52)		
Gaze (G)	2	9.28***	0.29	0.001
Error	46	(967.86)		
P x G	6	6.29***	0.22	0.001
Error	138	(505.69)		

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J5

Means and Standard Deviations for the Percent Duration of Infants' Affect and Gaze as a Function of Interaction Periods

Period	Normal	SF+T1	SF+T2	SF+T3
Smiling	37.32 (19.60)	12.73 (11.58)	9.99 (11.60)	10.83 (10.98)
Fretting	0.32 (0.88)	0.32 (1.09)	1.95 (3.56)	4.34 (6.65)
Neutral	61.57 (19.89)	86.20 (11.27)	86.57 (13.66)	83.43 (14.01)
Gaze at Mother's Hands	24.12 (14.62)	43.66 (23.46)	40.69 (25.07)	48.57 (24.89)
Gaze at Mother's Face	39.82 (22.08)	17.26 (13.70)	17.45 (14.23)	13.19 (10.69)
Gaze Aversion	36.07 (19.08)	37.41 (22.03)	41.85 (25.32)	36.81 (22.67)

Table J6

Analysis of Variance for Maternal Touch as a Function of Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Within Subjects			
Period	3	6.32***	0.22	0.001
Error	69	(144.49)		

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J7

Means and Standard Deviations for the Percent Duration of Overall Maternal Touch as a Function of Interaction Periods

Period	Normal	SF+T1	SF+T2	SF+T3
Touch	82.08 (23.45)	95.11 (7.15)	95.23 (6.16)	91.02 (15.77)

Table J8

Analysis of Variance for Functions of Maternal Touch as a Function of Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Within Subjects			
Period (P)	3	2.86*	0.11	0.04
Error	69	(36.75)		
Touch (T)	4	34.22***	0.60	0.001
Error	92	(778.27)		
T x P	12	4.27 ***	0.16	0.001
Error	276	(175.61)		

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J9

Means and Standard Deviations for the Percent Duration of Functions of Maternal Touch as a Function of Interaction Periods

Period	Normal	SF+T1	SF+T2	SF+T3
Passive Accompaniment	11.34 (12.88)	7.31 (9.33)	5.68 (8.74)	4.53 (7.39)
Active Accompaniment	11.48 (11.53)	15.01 (12.38)	11.38 (10.00)	11.80 (9.94)
Nurturing	4.34 (5.88)	24.07 (20.74)	25.65 (21.18)	24.31 (17.86)
Playful	47.22 (26.67)	41.44 (29.15)	40.97 (31.37)	46.57 (29.12)
Attention-Getting	3.38 (5.06)	0.19 (0.70)	0.60 (1.25)	0.00 (0.00)

Table J10

Analysis of Variance for Infants' Self-Regulatory Behaviors as a Function of Interaction Periods

Source	*df*	*F*	η_p^2	*p*
	Within Subjects			
Period (P)	3	5.77***	0.20	0.001
Error	69	(24.48)		
Self-Regulation (S)	5	49.25***	0.68	0.001
Error	115	(485.40)		
P x S	15	3.96***	0.15	0.001
Error	345	(156.92)		

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$, $^t < .10$

Table J11

Means and Standard Deviations for the Percent Duration of Infants' Self-Regulatory Behaviors as a Function of Interaction Periods

Period	Normal	SF+T1	SF+T2	SF+T3
Self-Comfort Regulatory	17.50 (16.46)	16.16 (17.64)	18.70 (19.26)	19.77 (21.80)
Self-Comfort Exploratory	3.23 (4.60)	8.47 (11.59)	7.40 (11.59)	1.89 (2.74)
Attention-Seeking	0.00 (0.00)	0.00 (0.00)	0.23 (0.65)	0.00 (0.00)
Escape	0.83 (4.08)	1.44 (5.92)	1.23 (3.84)	1.25 (2.89)
Gaze Aversion	18.19 (14.74)	22.08 (13.26)	22.59 (13.45)	25.97 (14.24)
Bidirectional Exchanges	56.76 (20.68)	35.88 (25.14)	33.94 (26.72)	37.41 (23.98)

Table J12

Analysis of Variance Infants' Distress

Source	*df*	*F*	η_p^2	*p*
	Within Subjects			
Infants' Distress	3	2.96*	0.11	0.04
Error	69	(1219.81)		

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J13

Means and Standard Deviations for the Percent Duration of Infants' Distress as a Function of Interaction Periods

Period	Normal	SF+T1	SF+T2	SF+T3
Distress	4.17 (20.42)	8.33 (28.23)	25.00 (44.23)	29.17 (46.43)

Table J14

Analysis of Variance for Infants' Distress Level across Functions of Maternal Touch during the Normal Period

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Distress (D)	1	2.94	0.11	0.10
Error	22	(95.35)		
	Within Subjects			
Touch (T)	4	3.65**	0.14	0.01
Error	88	(250.98)		
D x T	4	0.16	0.01	0.96

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J15

Analysis of Variance for Infants' Distress Level across Functions of Maternal Touch during the SF+T1 Period

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Distress (D)	1	0.96	0.04	0.34
Error	22	(64.54)		
	Within Subjects			
Touch (T)	4	6.85***	0.24	0.001
Error	88	(315.39)		
D x T	4	4.56**	0.17	0.01

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J16

Analysis of Variance for Infants' Distress Level across Functions of Maternal Touch during the SF+T2 Period

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Distress (D)	1	2.57	0.10	0.12
Error	22	(76.34)		
	Within Subjects			
Touch (T)	4	14.45***	0.40	0.001
Error	88	(387.03)		
D x T	4	0.71	0.03	0.59

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J17

Analysis of Variance for Infants' Distress Level across Functions of Maternal Touch during the SF+T3 Period

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Distress (D)	1	0.35	0.02	0.56
Error	22	(54.21)		
	Within Subjects			
Touch (T)	4	20.86***	0.49	0.001
Error	88	(325.85)		
D x T	4	0.37	0.02	0.83

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J18

Means and Standard Deviations for the Percent Duration of Function of Maternal Touch as a Function of Interaction Periods and Infants' Distress Level

Period	Normal				SF+T1				SF+T2				SF+T3			
Distress Level	Low Distress (n = 23)		Med-High Distress (n = 1)		Low Distress (n = 22)		Med-High Distress (n = 2)		Low Distress (n = 18)		Med-High Distress (n = 6)		Low Distress (n = 17)		Med-High Distress (n = 7)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Passive Accompaniment	11.44	13.15	8.89	---	7.57	9.72	4.44	1.57	4.99	7.95	7.76	11.38	3.53	6.23	6.97	9.79
Active Accompaniment	11.88	11.61	2.22	---	14.74	12.52	18.89	14.14	13.31	10.51	5.56	5.44	12.80	10.29	9.37	9.34
Nurturing	4.53	5.93	0.00	---	20.30	16.20	65.56	25.14	22.35	19.48	35.56	24.82	21.96	14.88	30.00	24.07
Playful	47.97	27.01	30.00	---	44.19	28.77	11.11	12.57	39.26	29.28	46.11	39.62	47.65	26.00	43.97	37.89
Attention-Getting	3.53	5.12	0.00	---	0.20	0.74	0.00	0.00	0.67	1.36	0.37	0.91	0.00	0.00	0.00	0.00

Table J19

Analysis of Variance Infants' Distress Level across Infants' Self-Regulatory Behaviors during the Normal Period

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Distress (D)	1	0.19	0.01	0.67
Error	22	(11.09)		
	Within Subjects			
Self-Regulation (S)	5	9.98***	0.31	0.001
Error	110	(190.60)		
D x S	5	0.76	0.03	0.58

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J20

Analysis of Variance Infants' Distress Level across Infants' Self-Regulatory Behaviors during the SF+T1 Period

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Distress (D)	1	0.85	0.04	0.37
Error	22	(68.19)		
	Within Subjects			
Self-Regulation (S)	5	5.32***	0.20	0.001
Error	110	(249.30)		
D x S	5	0.52	0.02	0.76

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J21

Analysis of Variance Infants' Distress Level across Infants' Self-Regulatory Behaviors during the SF+T2 Period

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Distress (D)	1	0.00	0.00	0.97
Error	22	(46.17)		
	Within Subjects			
Self-Regulation (S)	5	9.87***	0.31	0.001
Error	110	(268.15)		
D x S	5	1.52	0.07	0.19

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J22

Analysis of Variance Infants' Distress Level across Infants' Self-Regulatory Behaviors during the SF+T3 Period

Source	*df*	*F*	η_p^2	*p*
	Between Subjects			
Infants' Distress (D)	1	0.17	0.01	0.69
Error	22	(23.02)		
	Within Subjects			
Self-Regulation (S)	5	18.73***	0.46	0.001
Error	110	(250.43)		
D x S	5	0.90	0.04	0.49

Note. Values enclosed in parentheses represent mean square errors.
*$p < .05$, ** $p < .01$, *** $p < .001$

Table J23

Means and Standard Deviations for the Percent Duration of Infants' Self-Regulatory Behaviors as a Function of Interaction Periods and Infants' Distress Level

Period	Normal				SF+T1				SF+T2				SF+T3			
Distress Level	Low Distress (n = 23)		Med-High Distress (n = 1)		Low Distress (n = 22)		Med-High Distress (n = 2)		Low Distress (n = 18)		Med-High Distress (n = 6)		Low Distress (n = 17)		Med-High Distress (n = 7)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Self-Comfort Regulatory	17.77	16.77	11.11	---	15.95	17.56	18.33	25.93	16.97	21.39	23.89	10.37	18.56	19.59	22.70	28.00
Self-Comfort Exploratory	3.32	4.68	1.11	---	9.24	11.82	0.00	0.00	6.11	9.48	11.29	16.96	2.27	3.09	0.95	1.35
Attention-Seeking	0.00	0.00	0.00	---	0.00	0.00	0.00	0.00	0.19	0.57	0.37	0.91	0.00	0.00	0.00	0.00
Escape	0.00	0.00	20.00	---	0.25	0.97	14.4	20.43	0.80	2.69	2.60	6.35	1.50	3.29	0.63	1.68
Gaze Aversion	18.84	14.72	3.33	---	21.31	11.65	30.56	32.21	21.48	15.20	25.93	5.43	23.66	12.57	31.59	17.43
Bidirectional Exchanges	56.42	21.07	64.44	---	36.11	25.85	33.33	21.99	38.64	28.97	19.81	10.53	40.92	25.81	28.89	17.54

APPENDIX K

CO-OCCURRENCE ANALYSIS FOR STUDY 2

Table K1

Co-occurrences between Functions of Maternal Touch and Infants' Self-Regulatory Behaviors across Interaction Periods

Behavioral Pair	Normal	SF+T1	SF+T2	SF+T3
Passive Accompaniment				
Self-Comfort Regulatory	9/9	2/13*	5/7	5/7
Self-Comfort Exploratory	2/7	0/0	4/6	1/0
Attention-Seeking	0/0	2/0	1/0	0/0
Escape	1/0	7/10	1/1	0/2
Gaze Aversion	8/9	9/9	6/8	3/10
Bidirectional Exchanges	7/11	4/9	5/9	6/6
Active Accompaniment				
Self-Comfort Regulatory	4/17*	2/17**	4/12	3/14
Self-Comfort Exploratory	2/11	3/11	3/8	3/8
Attention-Seeking	0/0	0/0	0/1	0/0
Escape	1/0	1/1	0/2	2/2
Gaze Aversion	7/13	12/10	9/10	11/10
Bidirectional Exchanges	24/3	10/13	9/10	11/10
Nurturing				
Self-Comfort Regulatory	7/8	9/9	9/9	9/11
Self-Comfort Exploratory	2/5	4/9	6/8	4/6
Attention-Seeking	0/0	0/0	1/2	0/0
Escape	0/0	1/1	2/0	3/2
Gaze Aversion	7/7	9/12	9/12	11/12
Bidirectional Exchanges	5/10*	13/8	6/15	7/14
Playful				
Self-Comfort Regulatory	7/16	8/8	8/8	7/11
Self-Comfort Exploratory	1/13**	5/7	5/8	2/8*
Attention-Seeking	0/0	0/0	0/2	0/0
Escape	0/1	1/1	0/2	1/4
Gaze Aversion	9/13	6/13	9/11	10/11
Bidirectional Exchanges	19/4**	12/8	14/6	15/7
Attention-Getting				
Self-Comfort Regulatory	1/10*	0/2	1/3	0/0
Self-Comfort Exploratory	4/5	1/0	1/3	0/0
Attention-Seeking	0/0	0/0	0/1	0/0
Escape	0/0	0/1	0/0	0/0
Gaze Aversion	7/4	0/2	0/5*	0/0
Bidirectional Exchanges	4/7	0/2	4/1	0/0

Note. For each behavioral pair, the numerator represents the number of infants for whom the actual probability of co-occurrence was greater than expected by chance; the denominator represents the number of infants for whom the expected probability of co-occurrence was greater than the actual (act. > exp. / exp. > act.). Not included in this table is the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence. The values in the numerator and denominator, combined with the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence add up to the total number of infants in the sample (i.e. 24). *$p < .05$, ** $p < .01$, *** $p < .001$.

Table K2

Co-occurrences between Maternal Functions of Touch and Infants' Affect across Interaction Periods

Behavioral Pair	Normal	SF+T1	SF+T2	SF+T3
Passive Accompaniment				
Smiling	6/12	1/14*	3/12	1/10*
Fretting	2/1	1/1	3/10	2/3
Neutral	0/18***	0/18***	0/4	0/13***
Active Accompaniment				
Smiling	5/16*	6/14	4/13*	6/12
Fretting	1/1	0/2	2/14*	3/6
Neutral	16/5*	15/6*	19/0***	13/6
Nurturing				
Smiling	4/11*	5/14*	3/18***	5/13
Fretting	1/0	0/2	2/16*	3/7
Neutral	10/5	15/5*	21/0***	13/7
Playful				
Smiling	17/5***	12/5**	5/19*	9/9
Fretting	0/3	2/0	0/17***	3/5
Neutral	5/17**	4/14**	20/0***	10/9
Attention-Getting				
Smiling	2/9*	0/2	0/20***	0/0
Fretting	0/1	0/0	0/3	0/0
Neutral	9/2*	2/0	5/0*	0/0

Note. For each behavioral pair, the numerator represents the number of infants for whom the actual probability of co-occurrence was greater than expected by chance; the denominator represents the number of infants for whom the expected probability of co-occurrence was greater than the actual (act. > exp. / exp. > act.). Not included in this table is the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence. The values in the numerator and denominator, combined with the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence add up to the total number of infants in the sample (i.e. 24). *$p < .05$, ** $p < .01$, *** $p < .001$.

Table K3

Co-occurrences between Infants' Self-Regulatory Behaviors and Infants' Affect across Interaction Periods

Behavioral Pair	Normal	SF+T1	SF+T2	SF+T3
Self-Comfort Regulatory				
Smiling	6/17*	7/12	0/16***	7/10
Fretting	0/3	0/1	1/7*	1/7*
Neutral	17/6*	12/7	18/1***	12/6
Self-Comfort Exploratory				
Smiling	1/13**	0/14***	1/11*	2/9
Fretting	0/2	0/1	1/3	0/3
Neutral	13/1**	14/0***	12/2*	9/2
Attention-Seeking				
Smiling	0/0	0/0	0/1	0/0
Fretting	0/1	0/1	2/3	0/3
Neutral	0/23***	0/23***	0/24***	0/24***
Escape				
Smiling	0/1	0/1	0/2	0/4
Fretting	1/0	1/0	3/0	2/1
Neutral	0/1	2/0	1/2	5/0*
Gaze Aversion				
Smiling	6/17**	9/11	11/8	6/13
Fretting	1/2	0/2	3/5	7/3
Neutral	17/6**	12/9	9/13	12/9
Bidirectional Exchanges				
Smiling	21/3***	24/0***	6/18	13/11
Fretting	1/2	6/15	11/8	2/17*
Neutral	3/21***	2/0	1/7*	2/7

Note. For each behavioral pair, the numerator represents the number of infants for whom the actual probability of co-occurrence was greater than expected by chance; the denominator represents the number of infants for whom the expected probability of co-occurrence was greater than the actual (act. > exp. / exp. > act.). Not included in this table is the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence. The values in the numerator and denominator, combined with the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence add up to the total number of infants in the sample (i.e. 24). *$p < .05$, ** $p < .01$, *** $p < .001$.

Table K4

Co-occurrences between Maternal Functions of Touch and Infants' Gaze across Interaction Periods

Behavioral Pair	Normal	SF+T1	SF+T2	SF+T3
Passive Accompaniment				
Hand	3/15*	9/9	8/6	7/6
Mother	11/7	5/12	5/9	4/9
Away	10/8	8/10	7/7	4/9
Active Accompaniment				
Hand	9/12	11/12	9/9	13/7
Mother	5/16*	8/14	7/10	7/13
Away	12/9	11/11	7/12	7/14
Nurturing				
Hand	4/11	9/12	7/14	9/14
Mother	4/15**	10/10	12/6*	13/4**
Away	9/6*	12/9	12/9	13/10
Playful				
Hand	15/8	12/8	13/7	14/6
Mother	15/8	9/10	9/9	10/11
Away	6/17*	7/12	9/11	11/11
Attention-Getting				
Hand	4/7	0/2	3/2	0/0
Mother	1/10*	0/2	1/2	0/0
Away	7/3	2/0	1/4	0/0

Note. For each behavioral pair, the numerator represents the number of infants for whom the actual probability of co-occurrence was greater than expected by chance; the denominator represents the number of infants for whom the expected probability of co-occurrence was greater than the actual (act. > exp. / exp. > act.). Not included in this table is the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence. The values in the numerator and denominator, combined with the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence add up to the total number of infants in the sample (i.e. 24). *$p < .05$, ** $p < .01$, *** $p < .001$.

Table K5

Co-occurrences between Infants' Self-Regulatory Behaviors and Infants' Gaze across Interaction Periods

Behavioral Pair	Normal	SF+T1	SF+T2	SF+T3
Self-Comfort Regulatory				
Hand	3/20**	5/15**	4/16**	8/12
Mother	10/13	11/9	12/6	7/13
Away	14/8	11/8	14/6*	11/9
Self-Comfort Exploratory				
Hand	3/11*	3/11	5/10	1/10**
Mother	1/13**	2/12*	0/13***	2/9
Away	13/1**	10/4*	11/4**	10/1**
Attention-Seeking				
Hand	0/0	0/0	0/3	0/0
Mother	0/0	0/0	2/1	0/0
Away	0/0	0/0	2/1	0/0
Escape				
Hand	0/1	0/2	1/2	0/5*
Mother	0/1	0/1	1/2	0/5*
Away	0/1	2/0	3/0	5/0*
Gaze Aversion				
Hand	7/16	3/20***	3/20***	4/20***
Mother	1/22***	2/20***	1/21***	0/23***
Away	22/1***	20/3***	21/3***	22/2***
Bidirectional Exchanges				
Hand	18/5**	22/2***	24/0***	23/0***
Mother	21/3***	2/21***	1/21***	1/21***
Away	0/24***	3/20***	0/24***	1/22***

Note. For each behavioral pair, the numerator represents the number of infants for whom the actual probability of co-occurrence was greater than expected by chance; the denominator represents the number of infants for whom the expected probability of co-occurrence was greater than the actual (act. > exp. / exp. > act.). Not included in this table is the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence. The values in the numerator and denominator, combined with the number of infants for whom the actual probability of co-occurrence was equal to the expected probability of co-occurrence add up to the total number of infants in the sample (i.e. 24). *$p < .05$, ** $p < .01$, *** $p < .001$.