Mutual Touch during Mother-Infant Face-to-Face Still-Face Interactions: Influences of Interaction Period and Infant Birth Status

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complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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ABSTRACT

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Irene Mantis

Contact behaviours such as touch, have been shown to be influential channels of nonverbal communication between mothers and infants. While existing research has examined the communicative roles of maternal or infant touch in isolation, mutual touch, whereby touching behaviours occur simultaneously between mothers and their infants, has yet to be examined. The present study was designed to investigate mutual touch during face-to-face interactions between mothers and their 5 ½ -month-old full-term (n = 40), very low birth weight/preterm (VLBW/preterm; n = 40) infants, and infants at psychosocial risk (n = 41).

Objectives were to examine: (1) how the quantitative and qualitative aspects of touch employed by mothers and their infants varied across the normal periods of the still-face (SF) procedure and how these were associated with risk status, and (2) the association between co-touch and the quality of the mother-child relationship.

Mutual touch was systematically coded using the Co-Touch Scale (Mantis, Ng, Stack, 2010). Interactions were found to largely consist of mutual contact and mutual touch, highlighting that active co-touching is pervasive during mother-infant interactions. Consistent with the literature, while the SF period did not negatively affect the amount of mutual touch engaged in for mothers and their full-term infants and mothers and their infants at psychosocial risk, it did for mothers and their VLBW/preterm infants. Together, results illuminate how both mothers and infants participate in shaping and co-regulating their

interactions through the use of touch and underscore the contribution of examining the impact of birth status on mutual touch.

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Table of Contents

List of Figures

List of Tables

Mutual Touch during Mother-Infant Face-to-Face Still-Face Interactions: Influences of Interaction Period and Infant Birth Status

Early parent-infant interactions are central to infants' socio-emotional, regulatory, and communicative development. The parent-infant relationship is the first relationship to develop for the infant. During the first year of life, parent-infant interactions and dyadic communication are prominent. Through frequent early exchanges, the foundation for young infants' growth and development in emotional organization, attention regulation, and communicative skills emerges (Emde & Sameroff, l989; Shonkoff & Phillips, 2000). Among other skills, infants acquire knowledge of the basic rules of social engagement and form social expectations (Kaye, 1982; Landry, Smith, & Swank, 2006; McElwain & Booth-LaForce, 2006), which provide a working framework for future interactions and relationships (Mercer, 2006).

Mother-infant face-to-face interactions provide meaningful insight into the dynamics of the mother-child relationship. They have been widely used to study the development of infants' social and emotional capacities, and their responses to stress (Field, Vega-Lahr, Scafidi, & Goldstein, 1986; Kaye, 1982). The Still-Face procedure (SF; Tronick, Als, Adamson, Wise, & Brazelton, 1978), an adaptation of the face-to-face interaction procedure, is a popular and valid paradigm to study mother-infant exchanges. During the SF procedure, mother-infant interactions are separated into three brief periods (normal, SF, and reunion-normal periods; 120 sec). During the normal and reunion-normal periods, mothers interact normally, typically providing vocal, visual, and tactile stimulation to their infants. In the SF period, mothers assume a neutral, unresponsive "still face" and provide neither vocal nor tactile stimulation to their infants. Studies have shown that infants are negatively affected by

their mothers' sudden emotional unavailability and unresponsiveness during the SF period. Infants typically decrease gazing and smiling at their mothers (Gusella, Muir, & Tronick, 1988; Mayes & Cater, 1990), increase neutral to negative affect, and vocalize more often (Ellsworth, Muir, & Hains, 1993; Stack & Muir, 1990). Such a "still face effect" has been replicated numerous times and in various ways (Adamson & Frick, 2003, Gusella et al., 1988, Tronick, Ricks, & Cohn, 1982). By exhibiting changes in their behaviours during the SF period, infants reveal themselves to be active participants during mother-infant interactions, and show their sensitivity to changes in their mothers' behaviour (Stack & LePage, 1996; Tronick, 2003; Tronick et al., 1978; Weinberg & Tronick, 1996).

During early mother-infant interactions, non-verbal communication is paramount given that infants are largely prelinguistic during the first year of life. Nonetheless, past studies examining social interactions during early development (e.g., first year of life) have primarily focused on the examination of the distal behavioural indices of gaze and affect, while neglecting to investigate the specific contribution of contact behaviours such as touch during these interactions. Yet, caregivers commonly employ touch during face-to-face interactions and play, along with their vocal and facial expressions (Stack, 2010). Although still in its early stage, significant advancements have contributed to our understanding of tactile stimulation as an integral component of the mother-infant communicative system (Stack, 2010; Stack & Jean, 2011). Within mother-infant interactions, touch has been shown to be an influential channel through which mothers and their infants convey emotion and affection, and establish a strong connection (Stack, 2010). Maternal physical contact is fundamental for attachment and secure positive attachment is promoted by maternal affection and closeness (Ainsworth, Blehar, Waters, & Wall, 1978). In addition, touch aids in the

reduction of infants' distress (Jean & Stack, 2009; Stack & Muir, 1992) and facilitates emotion regulation (Hertenstein & Campos, 2001; Weiss, Wilson, Hertenstein, & Campos, 2000). Emotion regulation involves the ability to control one's internal states and also one's behaviors according to a situation (Derryberry & Rothbart, 1988). With time, infants learn strategies such as turning their head away from a source of distress, in order to help regulate their internal states (Grou-Louis, Zhen, Miller, & Anderson, 2012; Tronick, 1989).

Maternal touch is pervasive during interactions, occurring between 55% and 81% of the time during brief interaction periods (e.g., Field, 1984; Stack & Muir, 1990; Symons & Moran, 1987). A number of studies have documented the use of different types of touch by mothers such as stroking, rubbing, tapping and tickling and some studies have documented the functions of touch such as nurturing, playful, and attention-getting, to name a few (Jean & Stack, 2009; Stack, 2010). Maternal touch has been found to soothe, arouse, and elicit specific infant behaviours during face-to-face interactions (Stack, 2004), indicating that mothers may use touch in order to serve different functions during such interactions with their infants (Beebe, 2006; Jean & Stack, 2009; Stack, 2010). Results from studies have also shown that mothers modify their patterns of touch according to verbal instructions (e.g., Stack & LePage, 1996; Stack, 2001). That is, when mothers were instructed to use touch in order to maximize infant smiling during the SF procedure, more dynamic types of touch, such as stroking and tickling, were used (Stack & LePage, 1996). These findings suggest that mothers are communicating with their infants through the use of touch (Stack, 2004), which aids in modulating and regulating infants' emotion displays (Hertenstein, 2002).

Much of the research that has examined touch during mother-infant face-to-face interactions has focused on *maternal* tactile behaviours, but touch is also an important

modality of communication for *infants*. In a study by Moszkowski and Stack (2007), infant touch was found to occur 85% of the time during brief interaction periods. Furthermore, results from the limited number of studies investigating infant touch have revealed that infant touch varies with maternal emotional availability. Specifically, it has been shown that infants use touch to communicate their emotional states and seek attention during face-to-face interactions, as well as to regulate their emotions during the SF period (i.e., when their mothers are unavailable; Moszkowski, Stack, & Chiarella, 2009). Similar to mothers, infants use various types of touch. Specifically, infants use more active types of touch (e.g., stroking, grabbing, patting, pulling) relative to passive touch (e.g., static) during the SF period compared to the normal periods of the SF procedure (Moszkowski & Stack, 2007). Together, research has demonstrated that infants are active and competent participants during their early social encounters (e.g., Adamson & Frick, 2003; Cohn, 2003; Moszkowski & Stack, 2007), and that mother-infant interactions are a 2-way process involving influences from both interactive partners.

While existing research has focused on examining the important communicative role of *maternal* touch *or* of *infant* touch from a more unidirectional perspective and has looked at touch in the context of other behaviors, the investigation of *mutual* touch, whereby *both* mothers and infants are active agents in shaping their interactions, has been largely overlooked. According to the dynamic systems perspective, mother-infant interactions form a mutually regulated bi-directional system (Fogel & Garvey, 2007). Synchronized engagement is a mutual goal during these interactions and the dyad works to repair the interactive sequence during periods of desynchronized interaction (Gianino & Tronick, 1988). Thus, not only are mothers and infants responsive to each other's behaviours and affective displays, but

they both actively contribute to shaping their interactions. Complementary to this perspective, the transactional model highlights that while mother-infant interactions can be a context for fostering healthy development, they can also be a context through which risk can be transferred (Sameroff, 2009). Thus, co-regulation may be impaired, particularly in at-risk dyads, leading to maladaptive development, behavioural problems, and poor socio-emotional competence (Crockenberg & Leerkes, 2005). Examining touch through a reciprocal, bi-directional process, could add to our understanding of the communicative properties underlying non-verbal communication during mother-infant interactions.

Despite an abundance of studies involving interactions of mothers and their infants, research on touch is sparse, and particularly within at-risk dyads. In the present study, two types of risk were examined (infants born prematurely and infants at high psychosocial risk). In very low birth weight preterm infants (VLBW/preterm), several factors (e.g., restricted opportunities for physical contact following birth, modified experiences with touch early in life, maternal stress) may alter their abilities to process and/or reciprocate tactile-gestural stimulation in the same way as normal birth weight full-term infants. Similarly, interactions may also be altered during interactions between mothers and their infants at high psychosocial risk due to disadvantage and problematic patterns of social behaviour and peer relations in their mothers' childhood histories.

A number of investigations have documented differences in the communicative styles between preterm infant-mother dyads and full-term mother-infant dyads. While premature infants have been described as less alert, attentive, active and responsive than full-term infants, mothers of infants born prematurely have been described as more active, stimulating, intrusive and at the same time more distant in mother-child interactions, than mothers of full-

term infants (e.g., Chapiesky & Evankovich, 1997; Goldberg & Di Vitto, 1995; Wijnroks, 1999; Barnard, Bee, & Hammond, 1984; Brown & Bakeman, 1980; Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983; Field, 1979; Minde, Perrotta, & Marton, 1985). In addition, previous literature has suggested that preterm infants have less efficient self-regulatory strategies than full-term infants, as infants born prematurely demonstrate greater reactivity and sensitivity to distress, lower thresholds for displaying reactions to negative stimuli, and increased difficulty soothing and regulating negative arousal (Als, Duffy, & McAnulty, 1988; Field, 1982; Lester, Boukydis, & LaGasse, 1996).

Preterm infants place different demands on their caregivers, which may lead to fewer positive early interactions with their mothers, compared to full-term infants (Holditch-Davis & Thoman, 1988; Segal et al., 1995). As a result, the development of sensitive and co-regulated interactions that are typical in mother-infant dyads and are characterized by an intimate interchange, is often hindered in preterm infant-mother interactions. Nonverbal behavior is important as the sequelae associated with preterm birth have been found to interfere with infants' abilities to engage in sustained social interactions and to provide clear nonverbal signals to their caregivers (Crnic et al., 1983). Touch may be serving different needs or be especially important in preterm infant-mother dyads and may be used in different ways compared to full-term dyads.

Similarly, touch may be working differently during interactions between mothers and their infants at high psychosocial risk. Problematic behavioural styles during childhood have been shown to impact the conditions under which parents raise their offspring, and these conditions affect their ability to nurture their children's development and growth (Stack, Serbin, Mantis, & Kingdon, 2012; Stack et al., 2012). Problem behaviour in childhood (such

as aggression and social withdrawal) is linked to a sequence of problematic events and conditions that contribute to late disadvantaged child-rearing conditions (e.g., low education, early parenthood, single parenthood, family poverty) in parenthood. These conditions then place subsequent generations at risk for a wide variety of developmental, social, academic, economic, and health problems.

In terms of parent-child interactions, mothers with childhood histories of aggression and social withdrawal have been shown to demonstrate negative parenting (e.g., failing to provide stimulating and well structured home environments (Saltaris et al., 2004) during interactions with their children (Serbin et al., 1998; Wiefel et al., 2005). Further, maternal childhood histories of risk have been found to predict negative emotional availability (higher levels of hostility) during mother-child interactions at preschool age (Stack et al., 2012). Emotional availability is a relational construct that reflects the ability of mothers and infants to regulate their interactions (Emde, 1980, 2000), taking into account the behaviour of both partners (Biringen, 2000). Findings from several studies underscore the importance of optimal emotional availability for infants' social and emotional competence during normal and perturbed interactions (Bornstein, Gini, Suwalsky, Putnick, & Haynes, 2006; Bornstein et al., 2006). Several studies have considered how family psychosocial risk may be associated with emotional availablity across age (Cicchetti & Toth, 2009; Stack et al., 2012). Results from one such study revealed that mothers with childhood histories of aggression and social withdrawal showed poorer relationship quality (i.e., higher levels of maternal hostility) during mother-child interactions. For example, mothers with higher levels of social withdrawal during childhood had preschoolers who were less appropriately responsive to and involving of their mothers during interactions (Stack et al., 2012). On the positive side,

higher levels of appropriate maternal structuring during infancy predicted child responsiveness during preschool age whereas higher levels of maternal sensitivity and structuring predicted child involvement (Stack et al., 2012). Finally, more maternal social support and better home environment, combined with lower stress, predicted better mother-child relationship quality (Stack et al., 2012). Thus, examining emotional availability in at-risk populations is significant as it provides an important means of understanding the specific components of relationship quality that are associated with subsequent outcomes.

The Current Study

As the preceding literature review has shown, the relationship between maternal emotional availability and maternal tactile behaviours has been underscored in several studies, wherein touch has been found to be an essential component of mother-infant exchanges. Nonetheless, research on touch remains sparse, particularly *in at-risk dyads* and the examination of the communicative properties of touch through a reciprocal, bi-directional process has yet to be examined.

The present study was designed to examine mutual touch during face-to-face interactions between mothers and their 5 ½ month old full-term infants, very low birth weight preterm (VLBW/preterm) infants, and infants at psychosocial risk. Simultaneous mother and infant touch is termed mutual touch, whereby both members of the dyad are dynamically, reciprocally, and continuously touching one another (Mantis, Ng, & Stack, 2010). The first objective was to document whether and how the quantitative (duration) and qualitative (type and infant/mother body area) aspects of touch employed by mothers and their infants varied across the normal periods of the SF procedure and how these were associated with risk status. With regards to the *types* of touch, the goal was to investigate how mutual touch occurs in

different interaction periods in relation to other types of co-touch behaviours, such as physical contact (i.e., touch eliciting no response from the member of the dyad being touched) and mutual contact (i.e., touch eliciting movement but not touch from the member of the dyad being touched). It was hypothesized that mutual touch and mutual contact would dominate interactions, in comparison to physical contact and no touch. Further, it was anticipated that results would provide a better understanding as to whether mothers' and infants' mutual touching episodes change (i.e., whether they increase or decrease) following a SF perturbation (i.e., maternal emotional unavailability in the SF period). Mutual touch may be serving different functions in at-risk dyads and it was expected that touch would be used in different ways compared to typically developing dyads. For example, it was hypothesized that mothers and their full-term infants would engage in similar amounts of mutual touch in the two normal periods of the SF procedure, while mothers of VLBW/preterm infants would engage in less mutual touch in the reunion-normal period (following a perturbation period, the SF). Finally, the second objective was to examine the association between co-touch and the quality of the mother-child relationship (i.e., measured via the Emotional Availability Scales). Findings were anticipated to contribute to a better understanding of how risk status (i.e., full-term infants as well as infants who are at biological and psychosocial risk) affects the quality of bi-directional exchanges during mother-infant interactions. For example, higher levels of maternal sensitivity were expected to be associated with mutual touch in the reunion-normal period and higher levels of child responsiveness were expected to be associated with mutual contact and mutual touch in the reunion-normal period.

Method

Participants

The final sample consisted of three groups of 5 ½ -month-old full-term (n = 40) infants, VLBW/preterm (n = 40) infants, and infants at psychosocial risk (n = 41) and their mothers drawn from a longitudinal project. All dyads were tested in their homes when infants reached 5 ½ months of age. Demographic and medical information can be found in Table 1.

Full-term group. Mothers and their infants were recruited from birth records from a major community hospital in the Montreal (Quebec, Canada) area. Following a letter outlining the general research, mothers were contacted by telephone and asked to voluntarily participate. Participants consisted of 48 mothers and their healthy, full-term infants born between 37 and 41 weeks gestation, and weighing more than 2750 g (6 lbs) at birth. Eight dyads were excluded from the current study based on various exclusion criteria including: mothers touching their infants for less than 10% of the time during the first normal period (n = 2), mothers not following instructions (n = 1), infant's gaze obstructed (n = 2), dyads taking a break between the SF and reunion-normal periods (n = 2), and excessive infant crying (n = 1). The final sample consisted of 40 infants (20 males, 20 females). The mean age of infants at the time of the study was 5 months and 12 days (SD = 6.70). The mean age of mothers was 30.6 years (range = 21 – 41, SD = 5.13) and 91% of the infants were from Caucasian families.

Very Low Birth Weight Preterm group. Subsequent to ethics approval and in collaboration with the chief neonatologist, VLBW/preterm infants were pre-screened for medical status variables by the nurse in charge of the follow-up clinic of a major community teaching hospital (Montreal, Quebec) during their 3-4 month clinic visit. These infants were

recruited from the same hospital as the full-term infants in order to ensure similarity in socio-economic status (SES) and ethnic backgrounds. Caregivers of these infants who met inclusion criteria were provided with a letter outlining the general description of the study and if interested, were contacted by telephone for participation. The VLBW/preterm group consisted of 63 mothers and their infants with gestational ages ranging from 26 to 32 weeks, and birthweight between 800 and 1500 g (approximately 1 lb, 12 oz to 3 lbs, 5 oz). Additional selection criteria limited the study population to healthy infants who were living with their biological mothers and excluded infants who suffered from any serious medical problems, or who had mothers with increased psychosocial risk (Table 2). Thus, our VLBW/preterm sample was composed of healthy infants who met rigorous inclusion/exclusion health criteria. Corrected age (i.e., postnatal age minus the number of weeks the infant was premature) was used to correct for prematurity. Corrected age is typically used in order for a premature infant's development on developmental evaluations to be most accurate for them; by correcting for prematurity the use of corrected age rather than chronological age allows for the early birth not to unfairly disadvantage the infant's scores (e.g., Siegel, 1983; Bayley, 2006). Twenty-three mother-infant dyads were excluded from the current group due to: mothers touching their infants for less than 10% of the time during the first normal period (n = 2), mothers' failure to follow instructions (n = 9), procedural error (n = 6), and SF period repeated more than once due to infants' fussiness (n = 6). The final sample consisted of 40 infants (18 males, 22 females). The mean age of infants at the time of the study was 5 months and 14 days (SD = 8.21). The mean age of mothers was 32.86 years (range = 21 – 41, SD = 5.68). The VLBW/preterm and full-term dyads were matched on infant sex, maternal age (within 5 years) and maternal education.

Table 1

Demographic and Medical Information

	Full-term (n = 40)		VLBW/preterm (n = 40)		Infants at psychosocial risk (n = 41)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Maternal age at birth (years)	30.62	5.13	32.86	5.68	29.12	3.09
Maternal education at birth	14.75	1.92	13.12	2.11	13.07	1.95
Infant birth weight (grams)	3476	395	1092	237	3324	635
Infants gestational age (weeks)	39.74	1.08	28.51	2.29	39.22	1.92
Emergency C-section (%)	30.00		81.00		--	
1 min APGAR	8.56	1.08	6.29	2.12	8.43	1.01
5 min APGAR	8.25	0.60	8.00	1.38	9.28	0.64
Length of hospital stay (days)	3.75	3.81	63.25	28.77	3.85	4.95
Infant length at birth (cm)	50.58	4.81	37.40	3.68	50.15	3.54
Infant head circumference (cm)	34.94	1.57	26.60	2.27	34.02	1.80
Infant weight at 5 ½ months (gram)	6800	0.89	6750	1.04	7114	724
Infant height at 5 ½ months (cm)	64.18	4.41	62.65	3.54	63.68	6.87

Table 2

Inclusion and Exclusion Criteria for the VLBW/preterm Infants

Inclusion Criteria	Exclusion Criteria
Aged between 26 and 33 weeks	Infants who were diagnosed with a major congenital abnormality or major congenital defects
Birth weight of 800 to 1500 g	Infants who suffered a Grade IV (or III) intra-ventricular hemorrhage or other major medical complications, illnesses or syndromes, such as hydrocephalus, severe neurological impairment, or those with hearing loss, retinopathy
Within 2 standard deviations on age in weeks, birth weight and head circumference	Infants who had a prolonged hospitalization since the neonatal period; if re-hospitalized must have been for short periods
Must have been living with their biological mother	Infants who had multiple hospitalizations since the neonatal period
Mothers must have spoken English or French	Infants who were diagnosed with a congenital abnormality
	Mothers at psychosocial risk due to a history of inadequate prenatal care, drug abuse, mental illness, etc

Psychosocial Risk group. The dyads at psychosocial risk constituted a sub-sample of the Concordia Longitudinal Risk Project (Concordia Project), a prospective, longitudinal, intergenerational study that began in 1976-1978 (Schwartzman, Ledingham, & Serbin, 1985). The sample is a large, community-based sample of children who attended French-language public schools serving lower socio-economic, inner-city areas of Montreal, Quebec, Canada. The Concordia Project began with the screening of 4,109 primarily French-speaking children in first-, fourth-, and seventh-grades along dimensions of aggression, social withdrawal, and likeability by means of a French translation of the Pupil Evaluation Inventory (PEI; Pekarik, Prinz, Liebert, Weintraub, & Neale, 1976; Appendix A presents sample items from this instrument). The PEI is both a reliable (internal consistency above 0.70 for all factors) and valid (concurrent validity between 0.54 and 0.65) measure for the assessment of children's social behaviour. Following the administration of the PEI, a total of 1,770 children (861 boys; 909 girls) met the inclusion criteria to make up the Concordia Project sample. Oversampling at the extremes of the sample (i.e., the upper ends of the aggression and withdrawal dimensions) was done deliberately when arriving at the final sample, allowing for a range of scores, including children from the same schools and neighbourhoods. This sample of children was subsequently followed in smaller representative subsamples at 3- to 5- year intervals. A more detailed description of the Concordia Project sample can be found in Schwartzman and colleagues (1985).

Mothers associated with the Concordia Project who were pregnant or who had recently given birth in 1997 were contacted to participate in the study. Fifty-six mothers participated in this phase of the project, however, fifteen mother-infant dyads were excluded based on the various exclusion criteria including: mothers' failure to follow instructions (n = 11),

procedural error (n = 1), and SF period repeated more than once due to infants' excessive crying (n = 3). All infants were normal, healthy full-term infants (17 males, 24 females), having gestational ages ranging from 37 to 41 weeks. The mean age of the at-risk infants was 5 months 8 days (SD = 0.86) and that of mothers was 29.5 years (range = 21 – 36 years, SD = 3.13).

Apparatus

All sessions took place at the participants' homes and were video-recorded for subsequent coding purposes. Testing was carried out in a spacious and well-lit room, usually the kitchen, and outside distractions were minimized (e.g., televisions and radios were turned off, siblings or pets remained outside of the room). Infants were securely fastened in an infant seat without toys or pacifiers. Mothers and infants were seated facing each other at eye-level, with a distance of approximately 70 cm between them. A stopwatch was used to time the duration of each period. A Sony Video camera was positioned on a tripod in order to simultaneously capture a full view of the infant's face and body and their mother's hands. To capture the mother's face, the set-up included a mirror that was strategically placed at an angle beside the infant seat on the table. Following the testing session, a time line was added to each 8 mm cassette using a Video Timer (FOR.J VTG -22). Video records were later coded second-by-second using a Sony VTR/TV remote control with slow speed shuttle function for the starting and stopping of the tape and slow motion viewing.

Procedure

During the home visit, mothers received information on the purpose of the study, and were given a consent form to read and sign (see Appendix B). Before beginning the study, mothers were reminded that they could withdraw from the study at any given moment. Each

dyad participated in the face-to-face SF procedure (Tronick et al., 1978), which consists of three 2-min face-to-face interaction periods (normal, Still-Face, and reunion-normal) between the mother and her infant. Each of these periods was separated by a transition period of 20 to 30-sec, where mothers received instructions for the subsequent period (see Figure 1). During this transition period, the dyads were free to interact with one another. During the first and third (i.e., reunion) normal periods, mothers were instructed to play with their infant as they normally would at home. During the second period, the SF, mothers were instructed to gaze at their infant with a still, neutral facial expression, and refrain from speaking to and touching their infant. That is, mothers were unresponsive and emotionally unavailable to their infants. The normal interaction periods and the SF period were each two minutes in duration, and the experimenter knocked on the wall to mark the beginning and end of each period. If infants fretted for 20 seconds or mothers wished to stop the session, the session was interrupted. At the end of the testing session, mothers were asked to complete a demographic questionnaire and answer questions in relation to their infants' developmental and medical histories (see Appendix C). Mothers were thanked for their participation and given an "Infant Scientist Award" for their infant, as a symbol of appreciation for their participation in the study.

Measures and Observational Coding

Following the testing sessions, behavioural coding was carried out in the research laboratory. Maternal compliance with instructions was verified prior to coding by previewing the video records and observing maternal behaviour during the normal and SF interaction periods. All behaviours were coded independently, and each measure was assigned a code for each second of the interaction (i.e., behaviours were coded for 1-second intervals). The

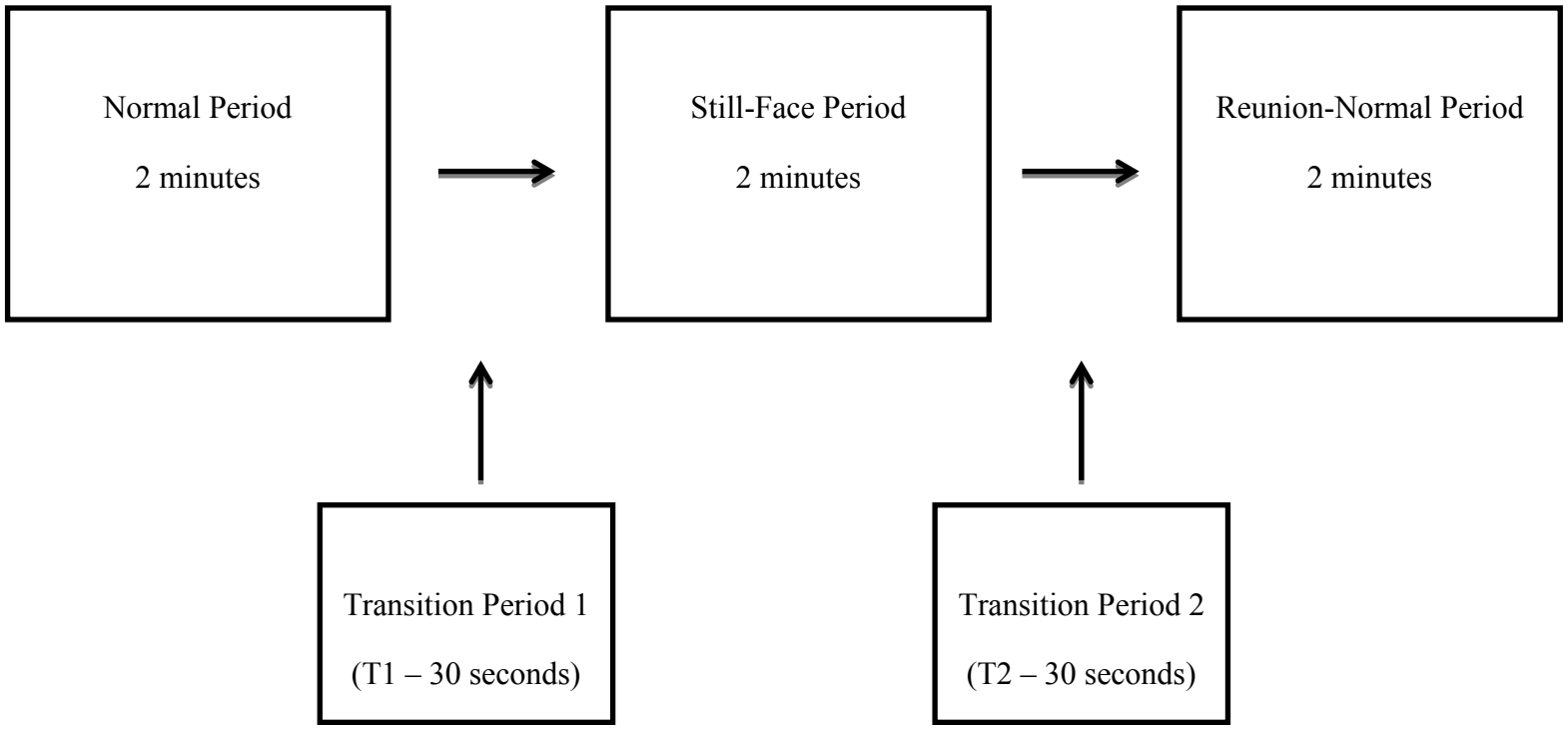

Figure 1. Procedure for the Current Study

percent duration of each dependent measure was defined as the percentage of time within a 120-second period for each of the three periods.

Co-Touch Behaviours. The Mother-Infant Co-Touch Scale (CTS; Mantis et al., 2010) was used to code mother and infant behaviours second-by-second. The CTS is a behavioural coding scheme designed to code co-touching behaviours between caregivers and their infants. Three types of co-touch were measured: physical contact, mutual contact and mutual touch (see Table 3). Physical contact was coded when one member of the dyad was actively or passively touching the other, while the latter remained passive (i.e., did not respond with movement). An example is a mother resting her hands on the legs of her infant who does not move. Mutual contact was coded when one member of the dyad was stimulated by another's active or passive touch, and he/she responded with a movement but not a touch. The movement did not involve actively/intentionally touching the other member and was not necessarily performed by the body part touched. For instance, an example of mutual contact is when mothers tickle their infant's torso and infants bring their hands to their mouth. Finally, mutual touch was defined as a reciprocal, continuous and dynamic touching behaviour between both members of the dyad. Mothers and infants engaging in a game of "patty-cake" (active hand game) is an example of mutual touch. Another example of mutual touch would be a mother tickling her infant's torso while the infant holds onto mothers' hands and arms with his/her feet. In addition to the types of co-touch being coded, areas of touch (areas of mothers' touch of infants and infants' touch of mothers), initiator of touch (the person who first touches the other member of the dyad), and infant engagement (an infant was considered engaged if he/she was looking at their mother or at what was occurring between them) were recorded (see Appendix D for more details on the CTS).

Table 3

Co-Touch Categories as they relate to the Mother-Infant Co-Touch Coding Scheme

Physical Contact	One member of the dyad is actively or passively touching any accessible part of the other's body, while the member being touched remains passive. There is no mutual activity between the dyad. It is a one-sided touching interaction. In its most typical form, the caregiver's hand(s) rest flatly on (or under) a part of the infant's body.
Mutual Contact	One member of the dyad is actively or passively touching any accessible body part of the other, while the member being touched shows movement or gesturing that is a clear response or reaction to being touched. Note that the movement must occur in quick succession following the touch. Of importance, the movement does not involve touching the other member of the dyad, but can include touching the self, and is not necessarily performed by the body part being touched.
Mutual Touch	Both members of the dyad are actively engaged in touching behaviours with each other. The touching behaviours are continuous and can involve different body parts.

To establish inter-rater reliability, a trained second coder blind to the hypotheses and to risk status double coded 30% of randomly chosen video records of mother-infant interactions. The coding results were then compared. Cohen's kappa coefficients (*rk*; Cohen, 1960) were then calculated to assess the reliability of coded co-touch behaviours. Cohen's kappa calculates the inter-observer agreement as a proportion of potential agreement following a correction made for chance agreements (Kaplan & Saccuzzo, 2001). The overall kappa coefficient for this study was $rk = 0.94$, indicating high inter-rater reliability. Kappa coefficients for the co-touch behaviours were all good to very good, and indicated high inter-rater reliability (Cohen, 1968). Specifically, the Cohen's kappa values obtained for no touch was $rk = 0.98$, physical contact was $rk = 0.83$, mutual contact was $rk = 0.97$, and mutual touch was $rk = 0.98$.

Emotional Availability Scales. The quality of the dyadic interactions (i.e., emotional availability) was coded using the Emotional Availability Scales (EAS; Biringen, Robinson, & Emde, 1993, 1998). Emotional availability is a relational construct reflecting the ability of mothers and infants to effectively regulate their interactions (Emde, 1980). Because they are relational scales, the behaviour of both mothers and infants is considered for each rating, and as such, scores could only be assigned during the normal periods when mothers were available. Mothers were rated for their levels of sensitivity (appropriately responding to infants' cues), structuring (guiding infants' play), and hostility (overt or covert expressed hostility); infants were rated for their level of responsiveness (i.e., degree of engagement in interaction). Maternal sensitivity was coded according to a 9-point rating scale, ranging from 1 (highly insensitive) to 9 (highly sensitive). Maternal hostility was also coded according to a 5-point scale, ranging between 1 (not hostile) and 5 (markedly overtly hostile). Although the

emotional availability dimension is nonhostility (Biringen, Robinson & Emde, 1998), the scores were inverted to use the name "hostility", given the sample. The maternal structuring dimension operated as a linear scale and was coded according to a 7-point scale, ranging between 1 (no structuring) and 7 (overly high structuring). Finally, infant responsiveness was rated according to a 7-point scale, ranging between 1 (unresponsive) and 7 (highly responsive; see Table 4 for more information on the EAS**).** One global rating was made on each scale for each normal interaction period. Since the EAS were originally designed for toddlers and children, an adapted version of the EAS was used to code the interactions between young infants and their mothers in the present study (Carter, Little, & Garrity-Rokous, 1998; Little & Carter, 2005). The emotional availability dimensions were coded by a research associate in our laboratory who was trained on the scales. Thirty percent of the sample was double coded by a trained second coder who was also blind to the hypotheses of the study and to risk status. Reliability was determined using intraclass correlation coefficients for each of the emotional availability dimensions and revealed highly satisfactory levels for all EAS (r = 0.82–0.99).

Results

Data screening procedures were undertaken to evaluate the data and to determine whether the assumptions underlying repeated measures ANOVAs and regressions had been met. Prior to conducting statistical analyses, all data were double-checked by the author and an undergraduate research assistant, in order to assure that there were no errors in initial data entry. Following confirmation of the data's integrity, descriptive statistics were used to assess the normality of the distribution, skewness and kurtosis for each variable, and to identify outliers. The data was normally distributed and did not reveal any outliers, skewness or kurtosis, thus no transformations were necessary. All statistical analyses were conducted using

Table 4

Operational Definitions for Emotional Availability Scales

CATEGORY	BRIEF DEFINITIONS	SCALE RANGE
	Maternal Dimensions	
Maternal Sensitivity	A more sensitive parent will be attuned to the child's ability to regulate emotional and physiological states, and provide stimulation or soothing as needed.	1 = Highly insensitive 5 = Optimally sensitive 9 = Highly sensitive
Maternal Structuring	This scale directly assesses the degree to which the mother structures her child's play, follows the child's lead, and sets limits.	1 = No structuring 5 = Optimal structuring 7 = Overly high structuring
Maternal Hostility	This scale assesses the presence and degree of overt and covert hostile behaviour expressed during the interaction with the child	1 = Not hostile 3 = Markedly covertly hostile 5 = Markedly overtly hostile
	Child Dimensions	
Child Responsiveness	The child's responsiveness to the mother reflects two aspects of the child's behaviour: a) willingness to engage with the mother and follow her bids; b) clear pleasure within the interaction with the mother.	1 = Unresponsive 5 = Moderately responsive 7 = Highly responsive

the Statistical Package for the Social Sciences for Macintosh (SPSS, version 18.0). Significant findings are reported in tables within the text.

Overall Duration. Descriptive statistics indicated that the mean percent duration of mutual touch for the full-term group in the normal period was 38.56 (*SD* = 24.70), whereas in the reunion-normal period, it was 36.87 (*SD* = 25.07). The mean percent duration of mutual touch for the VLBW/preterm group in the normal period was 54.31 (*SD* = 22.22), whereas in the reunion-normal period, it was 44.33 (*SD* = 24.69). Finally, the mean percent duration of mutual touch for the group at psychosocial risk in the normal period was 39.37 (*SD* = 25.81), whereas in the reunion-normal period, it was 45.88 (*SD* = 26.98). The means and standard deviations for types of co-touch, including no touch, are found in Table 5. See Figures 2-4 for the percent duration of co-touch in the normal and reunion-normal periods for full-term dyads, VLBW/preterm dyads, and dyads at psychosocial risk.

The total time that touch (overall duration) occurred during each normal period was obtained by grouping the types of touch from the Co-Touch Scale (physical contact, mutual contact, and mutual touch) into one total touch category. This analysis was conducted in order to ensure that differences obtained for types of touch were not the result of an overall difference in the total amount of touch provided across period. A paired-samples *t*-test revealed that collapsed across group, there was no significant difference in the amount of touch being provided across the two normal periods, $t(120) = .79$, $p = .43$ (normal period: $M = 80.02\%$, $SE = 1.81$; reunion-normal: $M = 81.63\%$, $SE = 1.90$), indicating that there was a consistent amount of touch occurring during both normal periods. Subsequent differences found for types of touch were therefore not the result of an overall difference in the amount of touch occurring across interaction periods.

Table 5

Mean Percent Duration and Standard Deviations of Co-Touch Variables in the Normal and Reunion-Normal Period

	Normal Period	**Reunion-Normal Period**
	M (SD)	*M (SD)*
No Touch		
Full-term	20.48 (18.84)	21.74 (24.48)
VLBW/preterm	15.87 (16.25)	13.99 (15.32)
Infants at psychosocial risk	23.31 (23.68)	19.63 (22.25)
Physical Contact		
Full-term	8.48 (8.49)	7.44 (8.03)
VLBW/preterm	10.65 (13.84)	9.05 (14.61)
Infants at psychosocial risk	6.30 (12.78)	4.10 (8.21)
Mutual Contact		
Full-term	32.47 (19.97)	33.93 (20.78)
VLBW/preterm	19.16 (13.72)	32.65 (20.71)
Infants at psychosocial risk	30.85 (22.16)	30.65 (21.14)
Mutual Touch		
Full-term	38.56 (24.70)	36.87(25.07)
VLBW/preterm	54.31 (22.22)	44.33 (24.69)
Infants at psychosocial risk	39.37 (25.81)	45.88 (26.98)

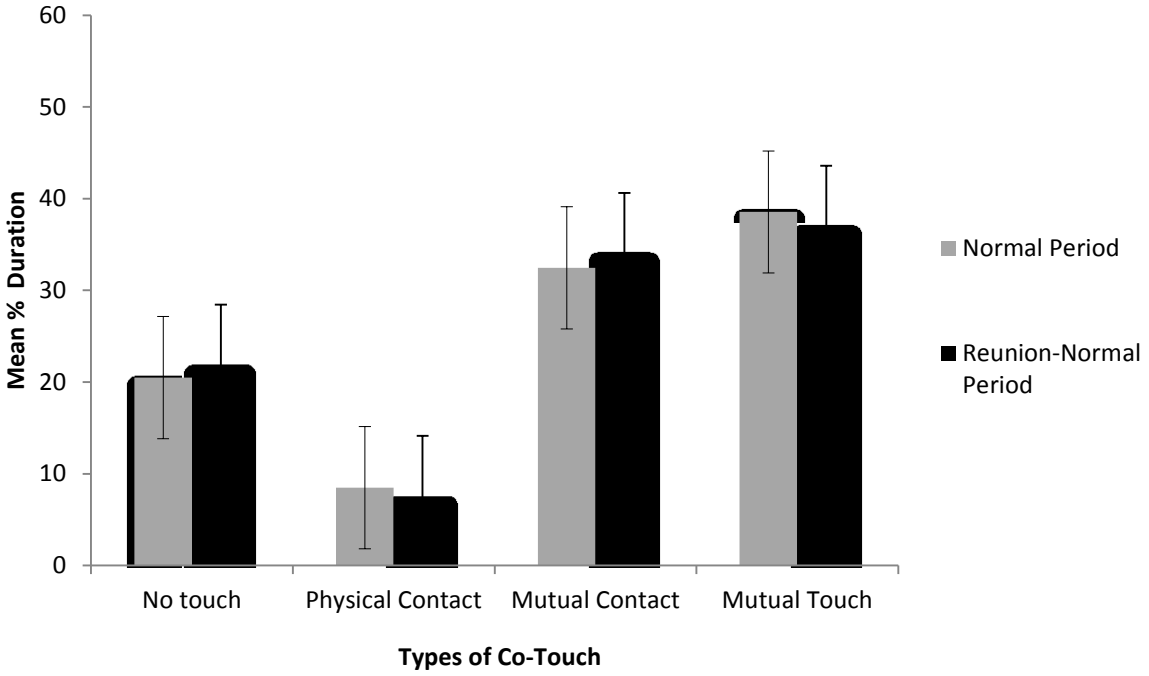

Figure 2. Percent Duration of Co-touch During the Normal and Reunion-Normal Periods for Mothers and their Full-Term Infants

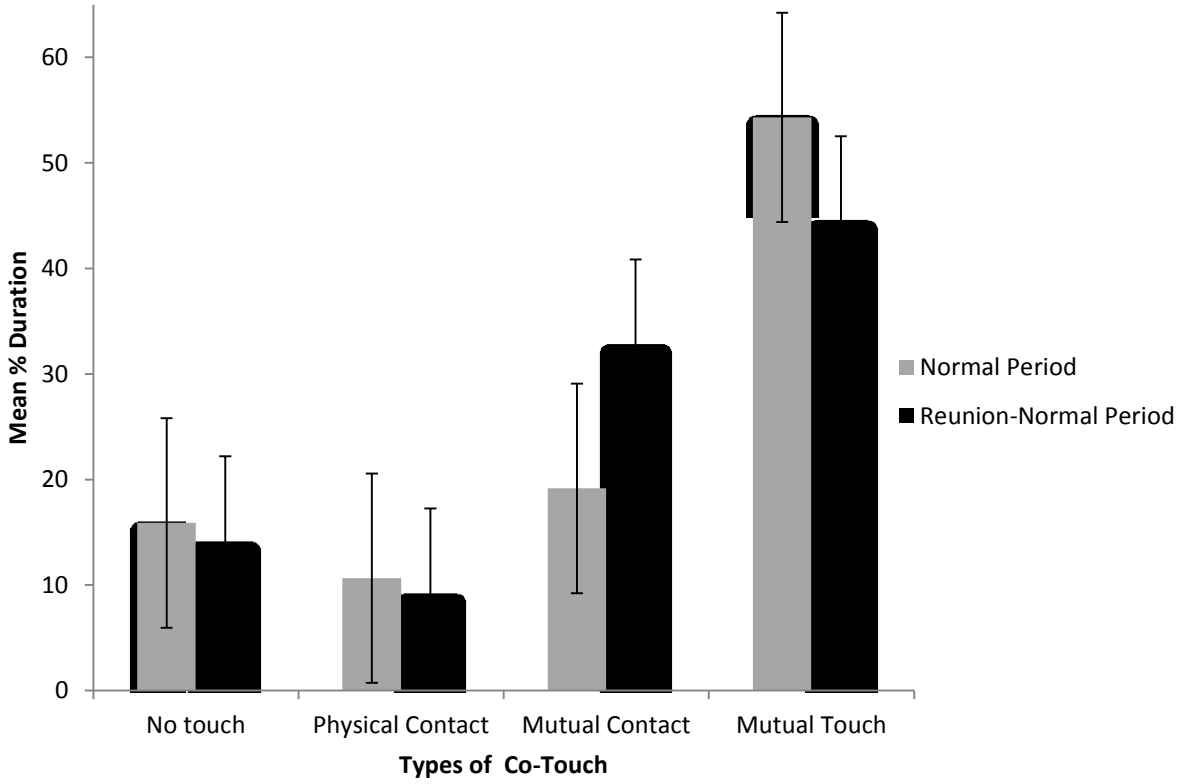

Figure 3. Percent Duration of Co-touch During the Normal and Reunion-Normal Periods for Mothers and their VLBW/preterm infants

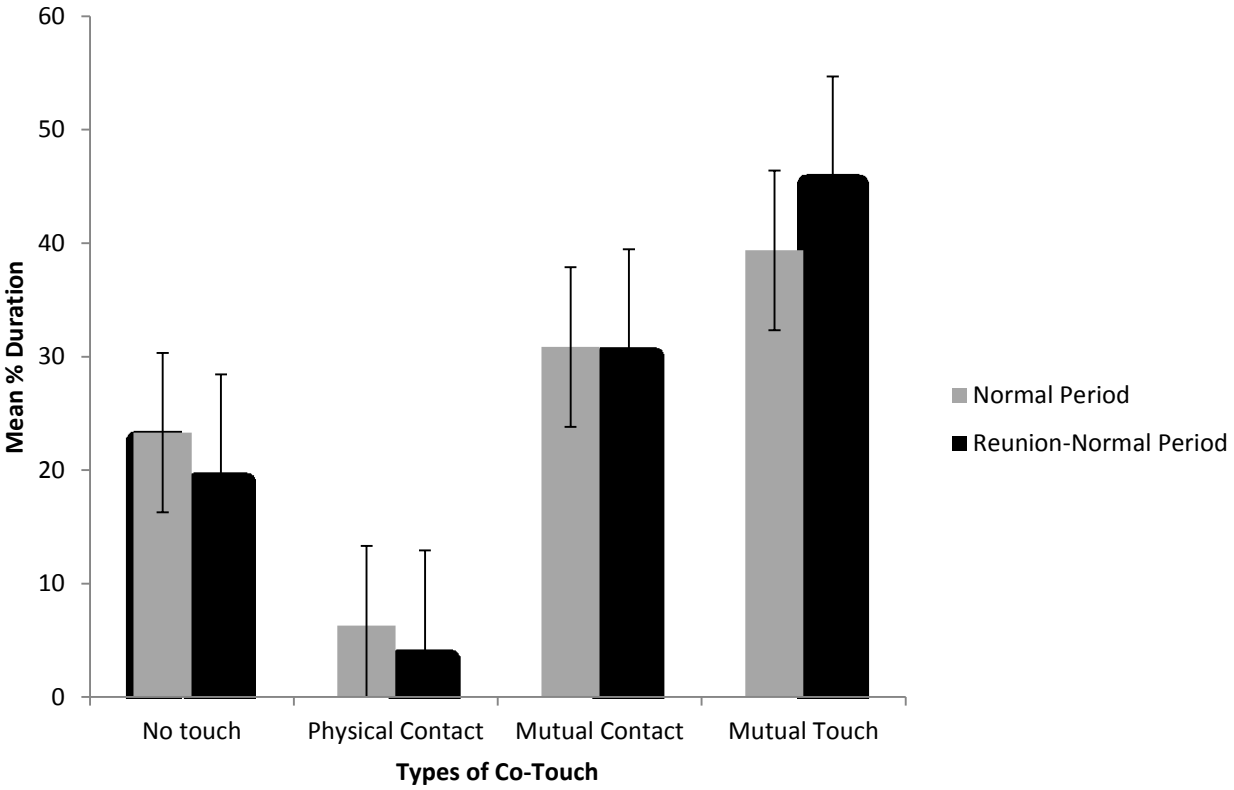

Figure 4. Percent Duration of Co-touch During the Normal and Reunion-Normal Periods for Mothers and their Infants at Psychosocial Risk

Following descriptive statistics, 3 (Group: full-term, VLBW/preterm, psychosocial risk) x 2 (Period: normal, reunion-normal) x 4 (types of Co-touch: physical contact, mutual contact, mutual touch, and no touch) repeated measures Analysis of Variance (ANOVA) were conducted. For all the analyses, significant main effects were followed with post hoc-*t*-tests and when ANOVAs revealed significant interactions, Bonferroni pairwise comparisons were used to isolate the source of the significance. Furthermore, correlations were used to assess the relation between the areas of the body where mothers and infants were being touched and the type of co-touch that dyads engaged in. Results were considered statistically significant at a critical alpha level of .05 and partial eta-squared (η_p^2) are reported as a measure of effect size (Olejnik & Algina, 2003; Kline, 2004). Finally, to examine the association between mutual touch and the quality of the mother-infant relationship as measured by the EAS, hierarchical regressions were conducted for the full-term dyads, VLBW/preterm dyads, and dyads at psychosocial risk.

Objective 1: The Investigation of Normal Interaction Periods and Infants' Birth Status on Co-Touch

To examine whether the percent duration of co-touch behaviours varied across the two periods of the interaction and across the full-term, VLBW/preterm, and psychosocial risk groups, a 3 (Group: full-term, VLBW/preterm, psychosocial risk) x 2 (Period: normal, reunion-normal) x 4 (types of Co-touch: physical contact, mutual contact, mutual touch, and no touch) repeated measures ANOVA was conducted. The between-subjects factor was group and the within-subject factors were the interaction period and types of co-touch. The dependent variable was the percent duration of each co-touch behaviour.

Results indicated that a statistically significant main effect of Co-touch was found, F (3,

354) = 82.34, η_p^2 = 0.41, $p < .001$. Post-hoc *t*-tests revealed that, collapsed across the two normal periods, dyads were most likely to engage in mutual touch (*M* = 43.22%, *SE* = 1.81), followed by mutual contact (*M* = 29.95%, *SE* = 1.42), no touch (*M* = 19.18%, *SE* = 1.55), and physical contact (*M* = 7.67%, *SE* = .83). No main effect was found for Period, thus, no significant differences were found for the types of Co-touch between the two normal periods.

An interaction between Co-Touch and Group, *F* (6, 354) = 2.64, η_p^2 = 0.04, $p < .05$, indicated that the amount of time dyads engaged in the various types of co-touch varied according to group. Mothers and their full-term infants engaged in significantly more mutual touch (*M* = 37.72%, *SE* = 3.15) than physical contact (*M* = 7.96%, *SE* = 1.44) and no touch (*M* = 21.12%, *SE* = 2.70). Mothers and their VLBW/preterm infants engaged in significantly more mutual touch (*M* = 49.95%, *SE* = 3.15) than mutual contact (*M* = 25.90%, *SE* = 2.48), physical contact (*M* = 9.85%, *SE* = 1.44) and no touch (*M* = 14.94%, *SE* = 2.70). Mothers and their infants at psychosocial risk engaged in significantly more mutual touch (*M* = 42.63%, *SE* = 3.12) than physical contact (*M* = 5.20%, *SE* = 1.43) and no touch (*M* = 21.48%, *SE* = 2.66).

Comparing Co-touch between groups, mothers and their VLBW/preterm infants engaged in significantly more mutual touch than did mothers and their full-term infants (mean difference = 11.61, *SE* = 4.45, $p < .05$). In addition, a trend was observed in that VLBW/preterm dyads tended to engage in more physical contact than dyads at psychosocial risk (mean difference = 4.65, *SE* = 2.03, *p* = 0.07).

A significant 3-way interaction between Period, Co-touch and Group was revealed *F* (6, 354) = 2.372, η_p^2 = 0.39, $p < .05$. Bonferroni pairwise comparisons revealed that mothers and their VLBW/preterm infants engaged in significantly more mutual touch in the normal period (*M* = 54.31, *SE* = 3.85) than in the reunion-normal period (*M* = 44.33, *SE* = 4.05). In addition,

mothers and their VLBW/preterm infants engaged in significantly less mutual contact (M = 19.16, SE = 3.00) in the normal period than did mothers and their full-term infants (M = 32.48, SE = 3.003) and mothers and their infants at psychosocial risk (M =30.86, SE = 2.97). Furthermore, mothers and their VLBW/preterm infants engaged in significantly more mutual touch (M = 54.31, SE = 3.84) in the normal period than did mothers and their full-term infants (M = 38.56, SE = 3.84) and mothers and their infants at psychosocial risk (M =39.37, SE = 3.78).

Given that mutual touch may have been distributed differently within each of the normal periods, a more precise and accurate representation of its occurrence was warranted in order to observe whether there were differences that were not being picked up by use of an average mutual touch score for the entire period. In order to obtain such a representation of mutual touch during the periods of the SF procedure, 30-s segments were compared. That is, a 2 x 4 repeated measures ANOVA was conducted for each group to evaluate: (1) the first 30-s of the normal period with the first 30-s of the reunion-normal period, (2) the last 30-s of the normal period with the last 30-s of the reunion-normal period, and (3) the last 30-s of the normal period with the first 30-s of the reunion-normal period. No statistically significant differences in mutual touch were discovered between the first 30-s of the two normal periods of the interaction. This was also true for the comparisons of the last 30-s of the normal period with the last 30-s of the reunion-normal period, and the last 30-s of the normal period with the first 30-s of the reunion-normal period as well.

Areas of touch on the mother/infant body. To assess the relation between types of co-touch and the areas on the body being touched, correlations were conducted. In all three groups, there was a significant positive correlation between mutual touch and infants' hands.

Regardless of the interaction period, mutual touch occurred most often between mothers' and infants' hands. Furthermore, a significant negative correlation between mutual touch and infant legs/feet was revealed, across all three groups. (See Table 6 and 7 for the correlations between types of co-touch and body areas).

Objective 2: Association Between Co-Touch Behaviours and the Quality of the Mother-Child Relationship

To address the second objective, hierarchical regressions were conducted for the full-term dyads, VLBW/preterm dyads, and dyads at psychosocial risk. In order to maximize power for the analyses, the number of predictors was kept to a maximum of three. Intercorrelations were conducted to ensure that the variables employed in the regressions were not too highly correlated with each other (Tabachnick & Fidell, 2001). Hierarchical regressions were carried out to clarify the relationships between maternal emotional availability and touch. Specifically, the associations between the each co-touch behaviour occurring during the normal and reunion-normal periods and the emotional availability dimensions in the normal period were examined. Separate hierarchical regressions were conducted for each outcome variable (e.g., maternal sensitivity, structuring, hostility and child responsiveness) in the normal period and type of co-touch (physical contact, mutual contact, mutual touch, no touch) in both the normal and reunion-normal periods. Only significant findings are reported in the text.

Full-Term and VLBW/Preterm Dyads

In the following regressions, predictor variables were maternal education, and Co-Touching behaviours and the outcome variables were emotional availability dimensions (e.g.,

Table 6

Correlations between Types of Co-Touch and Infant Body Areas

Areas	Face/head		Mouth		Hands/arms		Shoulder/neck		Trunk		Legs/feet	
Co-touch	N	R-N	N	R-N	N	R-N	N	R-N	N	R-N	N	R-N
Physical contact	.06	.25	.33*	.01	.54***	-.46**	.05	-.1	.35*	.08	.52***	.63***
Mutual contact	.00	.02	-.01	.07	-.46**	-.52***	.23	4.12	.26	.09	.79***	.86***
Mutual touch	-.12	-.01	-.13	.08	.89***	.90***	-.09	.02	-.19	-.09	-.52***	.55***

Note. *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. N represents Normal period; R-N represents Reunion-Normal period.

Table 7

Correlations between Types of Co-Touch and Mother Body Areas

Areas	Face/head		Mouth		Hands/arms		Shoulder/neck		Chair	
Co-touch	N	R-N	N	R-N	N	R-N	N	R-N	N	R-N
Physical contact	.30	.17	-	-	-.56***	-.46**	-	-	.11	-.04
Mutual contact	.24	.09	-	-	-.54***	-.56***	-	-	.11	-.04
Mutual touch	-.13	.01	-	-	.99***	.99***	-	-	-.34*	-.35*

Note. *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Dashes represent unavailable data. N represents Normal period; R-N represents Reunion-Normal period.

maternal sensitivity, structuring, hostility and child responsiveness). In all regressions, variables were entered chronologically, with maternal education entered in the first step as a control variable. In the final step, co-touch behaviours were included.

Full-term dyads. In the regression examining structuring (Table 8), there was a trend for physical contact in the normal period (*standardized Beta coefficients* = .28, p = .08). Mothers who showed more optimal levels of structuring were part of dyads that engaged in more physical contact during their interactions.

VLBW/preterm dyads. In the regression examining child responsiveness (Table 9), physical contact in the reunion-normal period emerged as a significant predictor (*Beta* = -.39, p = .02). Children who were more responsive during their interactions with their mothers were part of dyads that engaged in less physical contact during the reunion-normal interaction period.

In the regression examining child responsiveness (Table 10), there was a trend for mutual contact in the reunion-normal period (*Beta* = .27, p = .09). Children who were more responsive during their interactions with their mothers were part of dyads that engaged in more mutual contact during the reunion-normal interaction period.

Dyads at Psychosocial Risk

In the following regressions, predictor variables were maternal childhood histories of aggression, maternal education, and Co-touching behaviours and the outcome variables were emotional availability dimensions (e.g., maternal sensitivity, structuring, hostility and child responsiveness). In all regressions, predictor variables were entered chronologically, with maternal childhood risk status (Aggression) entered in the first step. Maternal education (step 2) was also controlled for in the analyses, since high levels of maternal education are a

Table 8

Full-Term Dyads: Maternal Education and Physical Contact in the Normal Period Predicting Maternal Structuring

Variables	*Beta*	Sr^2	T	R^2_{ch}	F_{ch}
Step 1				0.00	0.04
Maternal Education	0.03	0.00	0.199		
Step 2				0.08	3.19^t
Maternal Education	0.06	0.00	0.40		
Physical Contact (Normal Period)	0.28	0.08	1.79^t		
		R = 0.28	$R^2_{Adj} = 0.03$		$F = 0.08^t$

$^t p < 0.10$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Table 9

VLBW/Preterm Dyads: Maternal Education and Physical Contact in the Reunion-Normal Period Predicting Child Responsiveness

Variables	*Beta*	Sr^2	T	R^2_{ch}	F_{ch}
Step 1				0.03	1.29
Maternal Education	0.18	0.03	1.14		
Step 2				0.14	6.39*
Maternal Education	0.27	0.07	1.74		
Physical Contact (Reunion-Normal Period)	-0.39	0.15	-2.53*		
		R = 0.42	R^2_{Adj} = 0.13	F = 0.016	

$^t p < 0.10$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Table 10

VLBW/Preterm Dyads: Maternal Education and Mutual Contact in the Reunion-Normal Period Predicting Child Responsiveness

Variables	*Beta*	Sr^2	T	R^2_{ch}	F_{ch}
Step 1				0.33	1.29
Maternal Education	0.18	0.03	1.14		
Step 2				0.71	2.94^t
Maternal Education	0.12	0.01	0.76		
Mutual Contact (Reunion-Normal Period)	0.27	0.07	1.72		
		R = 0.32	$R^2_{Adj} = 0.06$	F = 0.95^t	

$^t p < 0.10$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

protective factor against risk in such a population (Serbin et al.,1998). In the final step (step 3), co-touch behaviours were included. In the regression examining sensitivity (Table 11), there was a trend for maternal education (*Beta* = .30, *p* = .08). Mothers who had more years of education showed higher levels of sensitivity during their interactions with their infants.

In the following regression, predictor variables were entered chronologically, with maternal childhood risk status (Aggression, Social Withdrawal) entered separately in the first step. In the second step, co-touch behaviours were included, and in the final step, the interaction between levels of Aggression and Social Withdrawal was entered for each regression, in order to consider the influence of the main effects (i.e., Aggression and Withdrawal) first (Cohen & Cohen, 1983).

In the regression examining sensitivity (Table 12), the interaction between aggression and social withdrawal emerged as a significant predictor of sensitivity (*Beta* = .35, *p* = .05). Mothers with childhood histories of Aggression and Social Withdrawal who showed higher levels of sensitivity engaged in more "no touch" in the reunion-normal period.

Discussion

The present study was designed to examine mutual touch during face-to-face interactions between mothers and their 5 ½ month old full-term infants, VLBW/preterm infants, and infants at psychosocial risk. The first objective was to investigate how the quantitative (duration) and qualitative (type and area) aspects of touch employed by mothers and their infants varied across the normal periods of the SF procedure and according to risk status. With regard to the *types* of touch, the goal was to compare mutual touch with the other types of co-touch behaviours (physical contact and mutual contact) during the two normal periods. In line with what was hypothesized, the amount of touch was found to be

Table 11

Dyads at Psychosocial Risk: Maternal Childhood Levels of Aggression, Maternal Education and No Touch in the Reunion-Normal Period Predicting Maternal Sensitivity

Variables	Beta	Sr^2	T	R^2_{ch}	F_{ch}
Step 1				0.01	0.28
Childhood Aggression	-0.84	0.71	-0.53		
Step 2				0.08	3.21^t
Childhood Aggression	0.29	0.08	0.17		
Maternal Education	0.30	0.09	1.79^t		
Step 3				0.02	0.76
Childhood Aggression	0.40	0.16	0.24		
Maternal Education	0.29	0.08	1.73		
No Touch (Reunion Period)	0.14	0.02	0.87		
		R = 0.32	$R^2_{Adj} = 0.03$		F = 0.39

$^t p < 0.10$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Table 12

Dyads at Psychosocial Risk: Maternal Childhood Levels of Aggression and Social Withdrawal, and No Touch in the Reunion-Normal Period Predicting Sensitivity

Variables	Beta	Sr^2	T	R^2_{ch}	F_{ch}
Step 1				0.73	1.50
Childhood Aggression	-0.08	0.01	-0.54		
Childhood Withdrawal	-0.26	0.07	-1.64		
Step 2				0.03	1.17
Childhood Aggression	-0.07	0.00	-0.42		
Childhood Withdrawal	-0.27	0.07	-1.71		
No Touch (Reunion-Normal Period)	1.17	1.37	1.08		
Step 3				0.09	4.14*
Childhood Aggression	-0.23	0.05	-1.35		
Childhood Withdrawal	-0.29	0.08	-1.90		
No Touch (Reunion-Normal Period)	0.18	0.03	1.21		
Childhood Aggression x Withdrawal	0.35	0.12	2.03		
		$R = 0.44$	$R^2_{Adj} = 0.11$	$F = 0.49$	

$^t p < 0.10$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

consistently high across both normal periods of the mother-infant interaction. Specifically, mutual touch and mutual contact were found to dominate interactions, in comparison to physical contact and no touch. This is consistent with previous literature suggesting that active types of touch are prominent in mother-infant interactions (Kaye & Fogel, 1980; Jean, Stack, Girouard, & Fogel, 2004; Stack & Muir, 1990, 1992). The low levels of no touch that were found further supports the accumulating evidence that touch is an important communicative channel within the mother-infant dyad and that it is a prominent form of interaction.

In line with expectations, mothers and their full-term infants engaged in similar amounts of mutual touch in both the normal and reunion-normal periods of the SF procedure. In contrast, mothers and their VLBW/preterm infants engaged in higher levels of mutual touch in the normal period compared to the reunion-normal period. Thus, the SF period did not appear to negatively affect the amount of mutual touch mothers and their full-term infants engaged in, while it did for mothers and their VLBW/preterm infants. Such a carry-over effect from the Still-Face to the reunion-normal period is consistent with previous literature indicating that preterm infants have less efficient self-regulatory strategies than full-term infants. Specifically, infants born prematurely demonstrate greater reactivity and sensitivity to distress, lower thresholds for displaying reactions to negative stimuli, and more difficulty soothing and regulating negative arousal (Als et al., 1988; Field, 1982; Lester et al., 1996). During the SF period, a social exchange is being unexpectedly violated by the mother. Such a violation is considered to be somewhat stressful for the infant (Field et al., 1986; Gianino & Tronick, 1988) as their mothers have become emotionally unavailable, interfering with their ability to regulate their affective state (Stack & Muir, 1990, Tronick et al., 1978). Given that

full-term infants likely have better coping responses during maternal unavailability than VLBW/preterm infants, the aforementioned finding is not surprising.

Mothers and their infants at psychosocial risk engaged in significantly more mutual touch than physical contact and no touch, collapsed across periods. In addition, mothers and their infants at psychosocial risk used similar amounts of mutual touch across both the normal and reunion-normal interaction periods. While a number of studies have examined touch in typically developing infants, few if any, have examined nonverbal behaviour in at-risk infants and particularly in the type of risk group considered in the present study (i.e., infants at high psychosocial risk due to disadvantage and problematic patterns of social behaviour and peer relations in their mothers' childhood histories). Yet, it has been shown that maternal characteristics such as sensitivity and hostility affect infants' engagement in touching behaviours (Moszkowski, 2009). This suggests that levels of engagement, and most probably other characteristics of interactions, vary within mother-infant social exchanges. While the overall amount of touch has been found to be consistent in both the normal and reunion-normal periods (Arnold, 2003; Jean & Stack, 2009; Stack & Muir, 1990, 1992), Jean and Stack (2009) found a difference across the normal and reunion-normal periods for functions of touch used by mothers and infants. Mothers used nurturing touch in greater amounts in the reunion-normal period to soothe their infants following the SF period (Jean & Stack, 2009). These higher levels of nurturing touch, combined with infants' use of more active types of touch in the reunion-normal period (Moszkowski, Jean, & Stack, 2005), may be contributing factors as to why mothers and their full-term infants and mothers and their infants at psychosocial risk in the present study engaged in the same amount of mutual touch before and after the SF period. Examining mutual touch and its qualitative characteristics

across each period as well as how it serves as an accompaniment to other modalities of communication is warranted in future studies.

It is also important to note that following the SF period, there is a brief 30-s transition period between the SF and reunion-normal period during which the experimenter provides the instructions for the subsequent period. Jean and Stack (2009) investigated the quality of maternal regulatory behaviours during transition periods and found that the quality of maternal regulatory behaviours during the second transition period (prior to the reunion-normal period) predicted the amount of nurturing touch provided to the infant in the reunion-normal period, underscoring the importance of examining these transitions. In examining whether mothers re-engaged in their interactions with their infants immediately following the SF period (i.e., during the second transition) or whether they waited for the next period (i.e., reunion-normal), may reveal crucial information pertaining to the various co-touch behaviours.

Although the transition periods were not examined in the present study, 30-s segments in each period were examined, given that the patterns of mutual touch within a period may have varied and not been captured by the mean of the entire period. For example, mothers and infants may have engaged in mutual touch consistently throughout the 2-minute normal period, whereas in the reunion-normal they may have first engaged in less mutual touch, which increased to a peak at the end of the period. In order to allow for a more accurate representation of the co-touching behaviours in the normal periods, the first 30-s of both periods, the last 30-s of both periods and the last 30-s of the normal period with the first 30-s of the reunion-normal period were compared (30-s segments were judged to be an adequate length of time for a behaviour to occur). The absence of observed differences in

mutual touch duration between the normal and reunion-normal periods, when the first and last 30-s of the periods were examined, might reflect a need for a more sophisticated coding system that would take into account more qualitative and quantitative components of touching behaviours.

One aspect of the impact of touching beyond its qualitative and quantitative components is the area of the body being touched (Stack & LePage, 1996). Findings from the present study revealed that mutual touch was associated with mothers' and infants' hands during both the normal and reunion-normal periods of the SF procedure, illustrating that hands are used as a primary means to touch one another. Hands appear to be meaningful tools of communication and clearly contribute to mutual touch in mother-infant interactions. Perhaps examining mutual touch in different interactive contexts (e.g., free play session where positioning and posture are different) would highlight other areas that would be of more use during mother-infant interactions (Stack & Muir, 1992; Stack & Arnold, 1998).

The second objective was to examine the association between mutual touch and the quality of the mother-child relationship (i.e., measured via the Emotional Availability Scales). Mothers with childhood histories of aggression and social withdrawal who showed higher levels of sensitivity, engaged in more "no touch" in the reunion-normal period. Although this is contrary to what was expected, it may be the case that infants were making their mothers appear more sensitive than they were in the normal period (e.g., infants who were more involved in the interaction; infants with a greater ability to draw their mother in). However, following the SF period, when an infant requires external sources of regulation (i.e., from their mother), it may have been the case that they were not obtaining this external regulation from their mothers. It may have also been the case that mothers with childhood

histories of aggression and social withdrawal who showed higher levels of sensitivity, engaged in more "no touch" in the reunion-normal period because they may have been using other modes of communication to regulate their infants (e.g., vocalizations), other than touch.

Overall, findings from the second objective of the present study indicate that examining different types of at-risk infants contribute to a better understanding of what can affect the quality of the bi-directional exchanges during mother-infant interactions. Furthermore, it is important to note that there is likely more taking place during these mother-infant interactions, particularly as they relate to the quality of the mother-child relationship. Therefore, an examination of what is accompanying the co-touch behaviours during mother-infant face-to-face interactions when they occur, as well as what is occurring during such interactions while co-touching is *absent,* is warranted.

Limitations

There are a few noteworthy limitations to the present study. First, even though interactions were filmed in the participants' homes, the ecological validity is somewhat limited. Specifically, the interaction setting was controlled in that infants were constrained to the infant seat, consequently limiting their range of movement. It may have been that infants wanted to touch their mothers but could not. Furthermore, only four minutes of interactions were coded per mother-infant dyad. Given that four minutes is relatively short in duration, it may not be truly representative of the daily interactions between mothers and their infants. However, face-to-face interactions in the lap and on the floor also have these limitations, and most of the studies to date have consistently used this procedure. Furthermore, 2-minute interaction periods are consistent with the majority of studies, while some have used shorter (60-90 seconds) or longer (three minutes) periods.

Future Directions and Conclusions

This study was the first to explore mutual touch. Consequently, there are several potential avenues for future research that would significantly add to the limited body of knowledge on nonverbal communication. First, studies should be designed to examine the functional components of mutual touch, as well as the patterns and quality of mutual touch during the SF procedure. It would also be of significance to examine mutual touch in the aforementioned regard, across various interactive contexts and conditions. Infants spend increasing amounts of time playing with toys during early social exchanges (Bakeman, Adamson, Konner, & Barr, 1990). Thus, triadic interactions (mother, infant and toy) would be an excellent context in which to further examine the role of mutual touch and its role in infants' social and communicative experiences. Moreover, since previous research has demonstrated that the quality of maternal touch changes across infants' age (Arnold, 2003; Jean, Stack, & Fogel, 2006), a longitudinal investigation of how mutual touching episodes evolve and change across age-periods is vital to better understanding its role in early mother-infant interactions. Moreover, up until now, most studies have neglected to study paternal touch. Fathers are sensitive and important partners in the development of children's emotional regulation and control (Pougnet, Serbin, Stack, & Schwartzman, 2011). It may be that mutual touching surfaces differently and serves different functions during father-infant interactions. Second, there would be much value in investigating infants' reactions to the SF as well as maternal distress (Jean & Stack, 2009). Investigating infants' and mothers' level of distress could shed light on its impact on their subsequent regulatory and tactile behaviours. Third, in order to increase our understanding of the influence of the SF period on subsequent mothers' and infants' behaviour, it is crucial to examine the transition periods of the SF

procedure. Specifically, in examining these transition periods, crucial information pertaining to the processes of dyadic co-regulation and mutual touch may be revealed.

While further work is required to gain a more complete understanding of the role of mutual touch in mother-infant interactions, the present study was the first to directly code mutual touch in early mother-infant social interactions. Results from the current study have important implications and set the stage for future research on mutual touch. Results from the present study support existing evidence that touch is integral to mother-infant interactions, and emphasize the dynamic and communicative quality of maternal touch. Specifically, mothers and their full-term infants engaged in consistently high levels of touching across both interaction periods. Mothers and their VLBW/preterm infants appeared to be more sensitive to changes in the environments as their mothers' sudden change in facial expression and emotional availability during the SF period negatively affected the infants. Together, the results contribute to a greater understanding of how mothers *and* their infants participate in shaping and co-regulating their interactions through the use of touch. Ultimately, findings could have implications for the design of preventive interventions and programs of early touch stimulation for at-risk infants.

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Appendix A

Sample Items from the Pupil Evaluation Inventory (PEI)

Aggression Items

3. Those who can't sit still.

4. Those who try to get other people into trouble.

8. Those who play the clown and get others to laugh.

9. Those who start a fight over nothing.

20. Those who bother people when they're trying to work.

23. Those who are rude to the teacher.

24. Those who are mean and cruel to other children.

Withdrawal Items

5. Those who are too shy to make friends easily.

10. Those who never seem to be having a good time.

11. Those who are upset when called on to answer questions in class.

13. Those who are usually chosen last to join in group activities.

17. Those who have very few friends.

28. Those who often don't want to play.

32. Those who aren't noticed much.

Likeability Items

14. Those who everyone likes.

17. Those who have very few friends.

24. Those who are particularly nice.

34. Those who appear to always understand what's going on.

Appendix B

English and French Consent Forms

HÔPITAL GÉNÉRAL JUIF
SIR MORTIMER B. DAVIS
JEWISH GENERAL HOSPITAL

Department of Neonatology
Département de Néonatologie

UNIVERSITE
Concordia

Centre for Research in Human Development
Centre de recherche en développement humain

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 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. 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 you have any questions regarding your 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: _____

RESEARCH ETHICS
05 DEC 2003
APPROVAL

HÔPITAL GÉNÉRAL JUIF
SIR MORTIMER B. DAVIS
JEWISH GENERAL HOSPITAL

Department of Neonatology
Département de Néonatologie

UNIVERSITÉ
Concordia

Centre for Research in Human Development
Centre de recherche en développement humain

Formulaire de consentement
Interaction Mère-Enfant

Cette étude a pour but d'examiner le développement social des enfants et comment les parents et leurs jeunes enfants jouent ensemble.

Je comprends que mon enfant participera à une séance d'observation de 60 minutes divisées en deux parties: Une première partie où mon enfant sera assis(e) dans un siège d'enfant me faisant face. Cette partie sera composée de plusieurs périodes de deux à trois minutes chacune. Durant certaine de ces périodes, je devrai demeurer silencieuse et conserver une expression faciale assez neutre lors de mes interactions avec mon enfant. La seconde partie sera une période de jeu libre où mon enfant et moi jouerons ensemble pour une période de huit minutes environ. Chaque période d'observation sera séparée par une courte pause et les manipulations expérimentales ne sont aucunement dangereuses pour mon enfant. Finalement, j'aurai également quelques questionnaires à compléter.

La séance entière sera filmée sur vidéo afin de permettre la cotation des réactions de mon enfant ultérieurement. Je comprends que toute les informations que nous fournissons, qu'elles soient écrites ou filmées, sont strictement confidentielles et ne serviront qu'à des fins de recherche. Je suis informée de la possibilité qu'on me demande de participer encore à cette recherche lorsque mon enfant aura 12 mois et une autre fois à 18 mois.

Je comprends que ma participation est entièrement volontaire et que je peux y soustraire mon enfant en tout temps et cela, sans avoir à donner d'autres explications. Je comprends aussi que j'ai le droit d'exiger que le ruban magnétoscopique soit détruit. Je permets que les résultats de cette recherche soient publiés, sachant que mon nom et celui de mon enfant seront gardés confidentiels. Dans toutes les circonstances, je suis assuré(e) que l'anonymat sera conservé.

Dans l'éventualité où j'aurais des questions ou une plainte à formuler concernant cette étude, je peux m'adresser aux directeurs du projet: Dr. Dale Stack (848-2424, ext. 7565), Dr. Lisa Serbin (848-2424, ext. 2255) ou Dr. Alex Schwartzman (848-2424, ext. 2251) du département de psychologie de l'Université Concordia, ainsi que Mme Laurie Berlin (340-8222, ext.5853), représentante des patients à l'Hôpital Général Juif. Vous pouvez contactez Mme Berlin si vous avez des questions en regard de vos droits en tant que participant volontaire à la recherche.

Merci de votre coopération.

Je, _____, m'engage volontairement avec mon enfant _____, à participer à l'étude effectuée par le Dr. Dale Stack à l'Université Concordia, en collaboration avec l'Hôpital Général Juif. Une copie de la déclaration de consentement m'a été remise.

Signature du parent au nom de l'enfant : _____ date : _____
Signature du parent : _____ date : _____
Témoin : _____ date : _____

RESEARCH ETHICS
05 DEC 2003
APPROVAL

Appendix C

Demographic Information Questionnaire

Mother-Infant Interaction

Demographic Information Questionnaire

Order :

Study # :_____

Infant # :_____

Test Date:_____

Infant's Name:_____

D. O. B.:_____ EDOB :_____

Age:_____ Sex:_____

Mother's Name:_____ Age:_____

Languages Spoken:_____

Father's Name:_____ Age:_____

Languages Spoken:_____

Ethnic origin:_____

Phone #:_____

Address:_____

_____

Birth Weight:_____ Length of Labor:_____

Pregnancy 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 ¾ ½ ¼ <¼

Father: all day ¾ ½ ¼ <¼

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 D

Mother-Infant Co-Touch Scale

THE MOTHER-INFANT CO-TOUCH SCALE (CTS):

A coding scheme designed to document mutual touch between caregivers and infants during their early social interactions

Mantis, I., Ng, L., & Stack, D.M. (Unpublished)

This systematic coding scheme is designed to measure mutual touch between caregivers and infants during the first year of life (5 ½ months in the present study) during interactions.

Note: Although this coding scheme was created to measure tactile behavior between 5 ½-month-old infants and their caregivers, it is applicable to younger and older infants as well.

CODING DETAILS OF CO-TOUCHING

Co-touching is defined by physical contact between a mother and her infant.

Behaviors are coded second by second. A touching behavior must be a minimum of 0.5 seconds to be coded.

Each second consists of 30 frames. In order for a behavior to be considered, it must be at least 15 frames long (1/2 s). For example, if a mutual contact behavior begins at 00:01:32:04 and ends at 00:01:38:05 (hour: minute: second: frame), this would mean that the behavior only begins at frame 04 of the 32nd second. Therefore, the 32nd second would represent the start of the behavior since there is mutual contact behavior during the remaining 21 frames of the second (i.e., more than 15 frames). However, since the mutual contact behavior ends at frame 05 of the 38th second and consequently occurs during only 5 frames of the second, the 38th second is not considered the "terminating second" of the behavior. Rather, the precedent second (second 37) is.

Co-touching behaviors are not always constant. In other words, a certain episode of co-touch can consist of simultaneous touch (contact) and brief pauses (no contact). For example, in the case of mutual touch, the mutual touching behaviors may coincide with *brief* pauses of touch during which the mother and infant are preparing to touch one another again. This pattern of mutual touch and brief pauses is coded as one single instance of mutual touch behavior. The beginning and end of the behavior would start and finish at the first and last occurrence of mutual touch, respectively. An example of such a situation is when a mother and her infant are playing a hand game (e.g., pat-a-cake).

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

The three categories of co-touching are mutually exclusive.

CATEGORIES OF CO-TOUCHING

1. **Physical contact**: One member of the dyad is actively or passively touching any accessible part of the other's body, while the member being touched remains passive. There is no mutual activity between the dyad. It is a one-sided touching interaction. In its most typical form, the caregiver's hand(s) rest flatly on (or under) a part of the infant's body.

   Other examples include:

   - Mother strokes infant's legs and infant does not move
   - Mother pokes infants belly while the infant remains immobile
   - Infant caresses mother's hand that is resting on the side of the infant seat and mother does not move her hand
   - Mother holds infant's feet and neither member moves

2. **Mutual contact**: One member of the dyad is actively or passively touching any accessible body part of the other, while the member being touched shows movement or gesturing that is a clear response or reaction to being touched. Note that the movement must occur in quick succession following the touch. Of importance, the movement does not involve touching the other member of the dyad, but can include touching the self, and is not necessarily performed by the body part being touched.

   Examples include:

   - Mother grabs infant's wrists and infant wiggles fingers
   - Mother is tickling infant's legs and infant shakes arms
   - Mother tickles infant's torso and infant brings hands to mouth
   - Mother grabs infant's arms and infant pulls arms away
   - Mother massages infant's feet and infant curls his/her toes
   - Mother grabs infant wrists and moves them and infant moves along

3. **Mutual touch**: Both members of the dyad are actively engaged in touching behaviors with each other. The touching behaviors are *reciprocal* and continuous and can involve different body parts.

   Exception: Any hand-in-hand/finger touching behaviors are considered mutual touch, regardless of whether there is movement or not.

   > Note: Touching the back of a hand is not considered hand-in-hand activity and is coded according to the definition of mutual touch given previously.

Examples include:

- Mother and infant play a game of patty-cake
- Mother shakes her hands while infant grabs her thumbs and moves along
- Mother tickles infant's torso and infant holds on to mother's hands and arms with his/her hands/feet
- Mother keeps hands in front of infant and infant grabs mother's fingers
- Mother puts finger in infant's mouth and infant sucks on it
- Infant approaches mother with his/her head and mother kisses infant's forehead

Mutual touch and mutual contact: engagement vs. disengagement

Engagement and disengagement are also coded second by second and are coded via gaze solely. An infant is engaged if he/she is looking at their mother or at what is occurring between them (e.g. looking at mother's hands). An infant is disengaged when he/she is looking away from their mother or what is occurring between them.

Engagement

An infant is engaged when his/her attention is focused on the interaction with his/her mother and is attentive to what is happening between them. The infant is participating in and committing to the interaction by responding to mother's behaviors and affect and/or showing initiative in shaping the interaction. A typical engagement behavior is gazing at the mother's face or hands.

Disengagement

An infant is disengaged when his/her attention is directed away from the interaction with his/her mother (e.g., attention focused on the camera or blank stare in emptiness). During this period of disengagement, the mother is most likely trying to regain the infants' attention but the infant remains impassive to the mother's attempts at engaging him/her. The infant is not involved in the interaction and does not try to influence the exchange with his/her mother, thereby making the interaction a unidirectional one.

Location of touch

Locations of mother touch of infants and infant touch of mothers are coded. In the circumstances where a mother or her infant's two hands are touching the other person, the area touched by the hand performing the "higher" level of co-touch is coded. For example, if the mother's right hand is resting on the infant's legs, and the mother's left hand if actively playing with the infant's hand, we would code the area being touched by the mother's left hand. Therefore, the area coded would be the hands, and not the legs.

Mother touch of infant:

1. Face/head
2. Mouth
3. Hands/arms
4. Shoulder/neck
5. Trunk (chest/belly)
6. Feet/legs

Infant touch of mother:

1. Face/head
2. Mouth
3. Hands/arms
4. Shoulder/neck
5. Chair

Initiator of touch

The initiator of each co-touch exchange (mother or infant) is coded. The person who first touches the other member of the dyad is considered the initiator of the subsequent co-touch behavior.

SPECIAL CASES AND DECISION MAKING

Dominance decision rule: a type of co-touch has dominance over another if it is the main theme of the bout. The "intruder" touch is short in duration (less than 1 second) and/or accidental. For example, during a bout when mothers are tickling their infants and infants are wiggling their limbs (bout of mutual contact), if it happens that for 1 second or less, the mothers hold the infants feet and the infant does not show movement (brief moment of physical contact), the bout is considered one of mutual contact.

If there is more than one type of co-touch occurring simultaneously, the "higher level" takes precedence. For example, if mother and infant are displaying physical contact and mutual touch with different hands/body parts at the same time, mutual touch is coded.