Love at First Touch:

Maternal, Paternal, and Infant Touch During Early Triadic and Dyadic Parent-Infant Interactions.

Marisa Mercuri

A

Thesis

In

The Department

Of

Psychology

Presented in Partial Fulfillment of the Requirements

for the Degree of Master of Arts (Psychology) at

Concordia University

Montreal, Quebec, Canada

May 2017

CONCORDIA UNIVERSITY
School of Graduate Studies

This is to certify that the thesis prepared

By: Marisa Mercuri

Entitled: Love at First Touch: Maternal, Paternal, and Infant Touch During Early Triadic and Dyadic Parent-Infant Interactions

and submitted in partial fulfillment of the requirements for the degree of

Master of Arts (Psychology)

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

Signed by the final examining committee:

_____ Chair Dr. Andrew Chapman

_____ Examiner Dr. Erin Barker

_____ Co-Supervisor Dr. Lisa Serbin

_____ Supervisor Dr. Dale Stack

Approved by _____
Chair of Department or Graduate Program Director

_____
Dean of Faculty

Date May 24, 2017

General Abstract

Marisa Mercuri

Love at First Touch:

Maternal, Paternal, and Infant Touch During Early Triadic and Dyadic Parent-Infant Interactions.

The parent-infant relationship is the first to develop for the infant, as parents are infants most common and significant social partners. Further, touch represents a critical means of communication between infants and their parents. As such, parent-infant interactions serve as a primary context in which the progression of touch can be studied.

A series of two studies examined the quality and quantity of mothers', fathers', and infants' use of touch during triadic and dyadic parent-infant interactions using longitudinal research designs. The first study (Study 1) investigated mothers' and fathers' specific touching behaviours during their very first interaction with their newborn infants, as well as mothers' and infants' touching behaviours 3−months later both before and after a perturbed interaction (i.e. the still-face period). The second study (Study 2) investigated how both mothers and infants utilize touch during naturalistic face-to-face interactions from 3- to 5-months, and considered how mothers and infants compare in regards to their use of specific touching behaviours.

Findings revealed that parents and their infants employ a wide range of touching behaviours over the course of their interactions, as well as the variability in the quantity (frequency, duration) and quality (type) of their touch during the first 5-months of life. Across both studies, infants were observed to employ many of the same types of touch as their mothers, and at frequencies and durations that were comparable to their mothers. As such, infants appear to be competent in their ability to utilize touch to communicate, and also contribute substantially to their interactions through touch.

Taken together, the present research expanded our knowledge of the progression of parental and infant touch during early parent-infant exchanges and how it changes as a function of the infant's age and the nature of the interactive context. Results highlighted the importance of investigating touch from

multiple parameters and longitudinally. Finally, the results provide a first step in our understanding of how and how much mothers, fathers, and infants use touch to contribute to their social interactions.

Acknowledgements

First and foremost, I would like to extend my deepest gratitude to Dr. Dale M. Stack for her continuous and unconditional guidance, support, and encouragement throughout the course of my thesis. It has genuinely been a pleasure working with you and having you as my supervisor. I would also like to thank my co-supervisor, Dr. Lisa A. Serbin, for her invaluable support, input, and contributions to this research. Moreover, I thank Dr. Erin Barker for her helpful revisions and comments. I would like to gratefully acknowledge Dr. Rosario Montirosso, Dr. Alan Fogel, and their colleagues for their collaboration, and the mothers, fathers, and infants who participated in these studies: without you all, this research would not have been possible.

To the members of the Stack Lab: I am so fortunate to have had you all by my side over the course of the last two years. Your support and encouragement has meant the world to me. Irene, you have been a mentor to me and I thank you for introducing to me to the touch domain. Ciara, thank you for enthusiastically cheering me on every step of the way. Kelly, thank you for always checking in on me, and for engaging me in discussions about Real Housewives when I needed a break. Saskia, thank you for your endless supply of snacks and hugs, which you always offer at just the right times. Nicole, I am so happy to have shared an office with you; thanks to you (and Bob) for always having the time to listen to me vent. Each of your willingness to help and advise me has been invaluable. I would also like to thank Joelle and Catherine, in addition to the volunteers, for their continuous assistance. Emerald, thank you so much for your patience and hard work coding.

Mom, Dad, and Matthew: Thank you for your endless love and support, and for always reminding me of how proud you are of my accomplishments. Your unrelenting encouragement and reassurance has kept me going. I am so fortunate to have you as family.

Last, but not least: Chris, my best friend and soul mate. Thank you for reminding me of my strength in times of doubt, and for being my strength in times of weakness. I could not have done this without you.

Table of Contents

Abstract iii

Acknowledgment v

General Introduction 1

Study 1 5

Abstract 6

Introduction 8

Method 18

Results 23

Discussion 28

References 36

Tables/Figure 51

Study 2 56

Abstract 57

Introduction 58

Method 61

Results 64

Discussion 67

References 72

Tables/Figure 79

General Discussion 89

References 94

Appendix A: Consent Forms 99

Appendix B: Coding Criteria for Behavioural Observation Coding Schemes 103

Chapter 1: General Introduction

Touch is one of the most critical components of human development (Gallace & Spence, 2016; Grobbel, Cooke, & Bonet, 2017; Montagu, 1986). It is the earliest of all sensorial systems to develop and the skin is the largest and oldest sense organ (Field, 2010; Montagu, 1986). The fetus begins perceiving and responding to tactile stimulation in the womb at 6-weeks gestation (Atkinson & Braddick, 1982; Barnett, 1972; Montagu, 1971), as well as during and immediately following birth and delivery (Lowe et al., 2016; Wiberg, 1990). Typically, beginning when the infant is only minutes old, the infant is in close physical contact with his or her parents: through touch, the infant is fed, cleaned, changed, held, carried, soothed, and cradled. In addition to these functional purposes of touch, parents use touch to engage and play with their infants, demonstrate affection, communicate, provide comfort, and reduce infants' distress (Jean & Stack, 2009; Stack, 2010). Distress reducing and soothing qualities of caregivers' touch, in particular, are especially relevant for pre-term and at-risk infants, as evidenced by decreased cortisol levels (Asadollahi, Jabraeili, Mahallei, Jafarabadi, & Ebrahimi, 2016), enhanced cortisol regulation (Neu, Laudenslager, & Robinson, 2008), and increased sleep quantity (Ferber & Makhoul, 2004) among these infants in response to touch. Infants themselves rely on touch to learn about and interact with their world (Field, 2014), and to communicate and regulate their emotions (Hertenstein, & Campos, 2001; Jean, Stack, & Arnold, 2014; Mantis, Stack, Ng, Serbin, & Schwartzman, 2014; Moszkowski & Stack, 2007; Stack, 2010). Touch is thus the infant's very first, and most primary, means of contact with his or her parents (Gallace & Spence, 2016), and represents a vital lifeline between them (Heller, 2014).

Given the centrality of touch, it plays a pervasive role within the parent-infant relationship (Stack, 2004, 2010). The parent-infant relationship is the first to develop, as parents

are infants' most common and frequent social partners. Parent-infant interactions serve as the foundation for the parent-infant relationship and provide a framework for the infant's future interactions and relationships (Mercer, 2006). During frequent early exchanges with their parents, infants learn how to engage in reciprocal social exchanges, regulate their emotions, and communicate effectively (Peláez-Noguera, Gewirtz, Field, Cigales, Malphurs, Clasky, & Sanchez, 1996; Stack, 2010). The parent-infant relationship thus serves as a primary context in which the infant's social, emotional, and communicative development is supported and shaped (Hall et al., 2015; Rhoades, 2017). The significance of touch to infant development, and to the parent-infant relationship as a whole, highlights early parent-infant exchanges as a critical context in which the progression of touch should be studied (Chen et al., 2016; Stack, 2010).

Despite the primordial nature of touch, and its centrality to infant development, touch remains the most neglected and understudied sense (Field, 2010; Hertenstein, 2002; Stack, 2010). To date, few researchers have investigated touch within the context of the parent-infant relationship (Field, 2010). Therefore, little is known about how much and what types of touch infants receive from their parents (Field, 2010), and even less is known about the kinds of touch infants employ during these same interactions (Mantis et al., 2014). According to the dynamic systems perspective, parents and their infants form a mutually regulated bidirectional system (Fogel, 1992, 1993). From this perspective, and that of the transactional model of development, it is posited that parents and infants are sensitive and responsive to behavioural changes in one another (Field, 2014; Kuczyinski & De Mol, 2015; Pesonen et al., 2008; Sameroff, 2009, 2010). Thus, while most of the available studies have investigated *either* parental (usually maternal) *or* infant touch, it is important to assess changes in parental and infant touch concurrently (Beebe et al., 2016; Cohn & Tronick, 1988; Menashe & Atzaba-Poria, 2016; Petit & Arsiwalla, 2008).

Moreover, few researchers have implemented longitudinal investigations of touch (Stack & Jean, 2011), yet such research designs are necessary in order to understand the progression of touch across time. In response to the paucity of research on parental and infant touch and to fill important gaps, the present studies were devised.

Two studies were designed to explore parents' and infants' touching behaviours during early parent-infant interactions, and how these touching behaviours progress over time. Study 1 investigated maternal and paternal touching behaviours during a triadic, naturalistic, interaction between mothers, fathers, and their newborn infants, occurring immediately after birth and delivery while in the hospital. This first study also investigated maternal and infant touch among these same mothers and infants 3-months later during dyadic face-to-face interactions; that is, both before and after a perturbed interaction in which social norms were violated (i.e., the still-face procedure). In general, the aims of this study were to explore how mothers and fathers utilize touch during their very first interaction with their newborn infant, to assess the development of maternal touch over time, and to explore the full range of touching behaviours displayed by infants. Building on the objectives of Study 1, Study 2 was designed to investigate both maternal and infant touching behaviours during a naturalistic face-to-face interaction at 3-months postpartum and another subsequently at 5-months postpartum. The primary aim of this study was to assess how mothers' and infants' touching behaviours change over time. Both studies considered how mothers and infants compare in their displays of touch during their face-to-face interactions.

Together, these studies captured how mothers, fathers, and infants contribute to and shape their social exchanges through touch, starting immediately after birth through the first few months of life. Given that this series of two studies examined touch across multiple interactive

contexts and infant age, the findings contribute to expanding our knowledge of how touch develops within the parent-infant relationship and have implications for parenting and interventions for at-risk infants.

Chapter 2: Study 1

Abstract: Study 1

Marisa Mercuri

Parental and Infant Touching Behaviours During Triadic and Dyadic Parent-Infant Interactions Occurring Immediately After Birth and at 3-months Postpartum

Starting immediately after birth, touch is an integral part of infant development and a primary means of communication within the parent-infant relationship. The present study examined the quantitative and qualitative characteristics of maternal, paternal, and infant touch during triadic and dyadic parent-infant interactions occurring across the first 3-months of life. Twenty-two mothers, fathers, and their infants participated. Mothers and fathers first engaged in a naturalistic interaction with their newborn infants, which took place in the hospital and within the first hour after birth. Three months later, these same mothers and infants engaged in the Still-Face procedure (SF; Tronick et al., 1978), a series of dyadic face-to-face interactions where mothers interacted naturally for two periods, separated by a brief period of perturbation. Interactions were video-recorded and coded using reliable and systematic behavioral observation coding systems. During the newborn time point, mothers' and fathers' touching behaviours were coded using the Caregiver-Infant Touch Scale – Adapted (CITS-Adapted; Stack et al., 2014). At the 3-month time point, mothers' and infants' touching behaviours were coded using the Caregiver Infant Touch Scale (CITS; Stack et al., 1996) and the Infant Touch Scale (ITS; Moszkowski & Stack, 2007), respectively.

Results revealed that mothers, fathers, and infants display a range of touching behaviours when interacting with one another. While mothers utilized all types of touch at significantly higher frequencies and durations than fathers, mothers and fathers demonstrated similarities with regards to the quality of their touch during their first interaction with their infants. That is,

parents tended to use more nurturing types of touch such as static and stroking and caressing at this time. Results also revealed that maternal touch during the immediate postpartum period was predictive of maternal touch after, but not before, the perturbation period of the SF procedure. Further, infants and their mothers grasped and pulled significantly more frequently, and for a longer amount of time, during the reunion period as compared to the normal period. Together, these findings contribute to our understanding of the development of touch within the context of parent-infant interactions and across different kinds of parent-infant interactions.

Parental and Infant Touching Behaviours During Triadic and Dyadic Parent-Infant Interactions After Birth and at 3-months Postpartum

Touch has been universally regarded as the most fundamental and primal form of communication (Barnett, 2005; Hertenstein, 2002; Mammen et al., 2016). Touch is implicated in all stages of human life; however, it is particularly central to the lives of infants (Hertenstein, 2002). Throughout infancy, infants receive substantial tactile stimulation from their caregivers, as touch is utilized during the large majority of everyday parent-infant interactions (Aznar & Tenebaum, 2016; Underdown, Barlow, & Stewart-Brown, 2010). During brief mother-infant interactions, for example, touch has been found to occur between 55% and 99% of the time (Field, 1984; Jean, Stack, & Fogel, 2009; Stack & Muir, 1990). Parents utilize touch to nurture and soothe their infants, to demonstrate affection, to get their infants' attention, and to play and engage with their infants (Jean & Stack, 2009), among other functions. In addition, touch is used for practical and utilitarian purposes such as to hold, carry, or cradle infants and to adjust an infant's positioning (Wiberg, 1990). As such, physical contact between the infant and his or her caregiver is one of the most important aspects of human development (Gallace & Spence, 2016). In particular, touch serves an integral role in infants' social, emotional, and communicative development (Barnett, 2005; Underdown et al., 2010). It is within the context of the parent-infant relationship that infants acquire social, emotional, and communicative skills (Stack, 2010). Consequently, touch is central to the parent-infant relationship.

Touch is also integral to infants' physical growth (Barnett, 2005; Underdown et al., 2010), as reflected in the fact that the somaesthetic system is the very first of all sensory systems to develop within the human embryo (Montagu, 1971). Touch is already well developed in the fetus. As early as 6-weeks gestation, the embryo can already perceive and respond to tactile

stimulation (Atkinson & Braddick, 1982; Bremner, Lewkowicz, & Spence, 2012; Gallace & Spence, 2016), and experiences tactile stimulation in the womb through its mother's abdominal wall (Barnett, 1972; Montagu, 1971; Stack, 2010; Wiberg, 1990). The infant continues to receive tactile stimulation during birth itself as well as immediately after birth, when only minutes old (Lowe et al., 2016; Wiberg, 1990). According to Ferber and Makhoul (2004), the transition from fetal to neonatal life is one of the most dynamic and precarious life events. Immediate tactile stimulation has been regarded as the best means of helping infants adapt in this transition and adjust to life outside of the womb (Ferber & Makhoul, 2004; Phillips, 2013). Touch serves as the very first means of contact that the infant uses to interact with the outside world (Gallace & Spence, 2016) and provides infants with a sense of comfort and familiarity within their new environment (Grossmann, Thane, Grossmann, 1981; Phillips, 2013).

While the first hour after birth is an important period of adjustment for the newborn, it is also a significant time for both mothers and fathers to have contact with their newborn child for the first time (Greenberg & Morris, 1974; Wiberg, 1990). As noted by Phillips (2013), the first hour after birth is a unique, momentous, and extremely special event. It has also been regarded as a particularly sensitive and critical period for the development of the parent-infant relationship: the infant's very first relationship (Anisfield & Lipper, 1983; Klaus & Kennell, 1976; Phillips, 2013). At this time, tactile contact is pervasive and plays a central role in parents' very first interactions with their newborn. Through touch, parents begin to develop powerful physical and emotional connections with their infants, that serve as the foundation for the progression of the parent-infant relationship (Moszkowski & Stack, 2007; Underdown et al., 2010). Much like touch facilitates the infant's transition outside the womb, touch facilitates mothers' and fathers' transition into parenthood (Chen et al., 2017). That is, touch occurring immediately after birth

encourages parent-infant bonding and attachment (Anisfeld & Lipper, 1983; Greenberg & Morris, 1974; Moore, Anderson, Bergman, & Dowswell, 2007), and has been found to be associated with subsequent contact behaviours. For example, De Chateau and Wiberg (1977) found that mothers that provided their infants with tactile contact immediately after birth were more comfortable handling and caring for their infants, and kissed their babies more frequently three months later. Thus, it appears that tactile contact occurring during this momentous occasion sets the stage for parents' future interactions with their infants.

Tactile stimulation during the neonatal period is also deemed critical for the infant's social, emotional, and physical development (Scheu, 1979; Wiberg, 1990). Research investigating tactile stimulation within the context of skin-to-skin contact (i.e. Kangaroo care), where the infant's naked body is placed on his or her caregiver's chest, has highlighted the benefits of touch during the neonatal period (Beijers, Cillessen, & Zijlmans, 2016; Chen et al., 2017; Ferber & Makhoul, 2004). Infants that received skin-to-skin contact from their mothers or fathers shortly after birth were found to be calmer, sleep longer, and cry less during the first few hours after birth than infants that did not receive early skin-to-skin contact (Erlandsson, Dsilna, Fagerberg & Christensson, 2007; Ferber & Makhoul, 2004). Moreover, immediate tactile contact has been found to regulate neonates' temperature and breathing in the first 15 days of life (Acosta, 2016; Winberg, 2005). Studies investigating newborn infants who begin their lives in Neonatal Intensive Care Units (NICUs), in which infants are exposed to a number of stressors such as painful medical procedures and parental separation (D'Agata, Sanders, Grasso, Young, Cong, & Mcgrath, 2017; Montirosso, Tronick, & Borgatti, 2016), have demonstrated that physical contact is beneficial for preterm or at-risk infants as well (Beijers et al., 2016). Such benefits include: enhanced cortisol regulation (Neu, Laudenslager, & Robinson, 2008), increased

sleep quantity (Ferber & Makhoul, 2004), greater weight gain (Conde-Agudelo, Diaz-Rosello, & Belizan, 2000; Field, Diego, & Hernandez-Reif, 2010), and improved neurobehavioural stability (Montirosso & Provenzi, 2015). Early skin-to-skin contact has also been found to be associated with better self-regulatory abilities, less emotional negativity, and less irritability in infants one year after birth (Bystrova et al., 2009). Therefore, the positive regulatory effects of early skin-to-skin contact appear to be both proximate and long-lasting. Taken together, tactile contact between parents and their newborns immediately following birth likely contributes to the infant's developing social, emotional, and physical needs (Kisilevsky, Stack, & Muir, 1991; Stack, 2010; Stack & Jean, 2011).

However, the centrality of touch to infant development goes well beyond its mere presence. Touch is a dynamic, complex, and multidimensional system (Hertenstein, 2002). As such, it is important to consider how infants may be influenced by the particular *type* of touch (Botero, 2016; Jean, Stack, & Arnold, 2014). Early work conducted by Brazelton (1977) suggested that newborns prefer tactual contact that is soft and warm, as they orient toward the source of such touch and are visibly soothed by it. More recent work has demonstrated that gentle touch such as stroking during the neonatal period has beneficial neurodevelopmental effects (McGlone, Cerritelli, Walker, & Esteves, 2017) and is associated with improved physiological and behavioural indices of emotional reactivity in infants of depressed mothers (Sharp, Pickles, Meaney, Marshall, Tibu, & Hill, 2012). Nurturing touch has been found to effectively soothe full-term infants, very-low-birth-weight infants, and preterm infants (Jean & Stack, 2012). In addition, massage has been regarded as an advantageous intervention to reduce newborns' crying and distress (Elliott, Reilly, Drummond & Letourneau, 2002; Underdown, et al., 2010; Field, 2016). In contrast, infants that receive more intrusive types of touch such as

poking and rough tickling from their mothers have been found to display more negative affect and behaviour (Malphurs, Raag, Field, Pickens, & Pelaez-Nogueras, 1996). Together, these findings suggest that certain types of touch, and not just touch in general, contributes favorably to infants' wellbeing (Mantis, Mercuri, Stack, & Field, submitted).

The distinctiveness of the immediate postpartum period, combined with the pronounced benefits of touch for the newborn and its development described above, highlights the importance of investigating parents' naturalistic displays of touching behaviours during the first hour after birth. Early investigations of mothers' first contact with their newborns by Rubin (1963) and then later by Klaus, Kennell, Plumb and Zuehlke (1970) revealed that maternal touch followed an orderly pattern or sequence whereby mothers began stroking their infants' extremities with their fingertips and proceeded to massage their infants' trunks using their palms. Similarly, Rödholm and Larsson (1979) investigated fathers' first interactions with their newborns, and found that fathers displayed a very similar pattern of touch as the maternal pattern described by Klaus and colleagues (1970). However, studies conducted by both Trevathan (1981) and Wiberg (1990) revealed that maternal touching behaviours are more variable than previously suggested, and do not follow a specific sequence. Congruently, research conducted by Robin (1982) indicated that, instead of a particular sequence of touch, mothers most frequently employ utilitarian tactile contact such as wiping the infant's mouth and feeding the infant in the days following birth. Wiberg (1990) also reported that fathers display varied touching behaviours rather than a specific pattern of touch. Given the paucity of research on parental touching behaviours during the immediate postpartum period, the typical progression, range, and variability of parents' touching behaviours during this distinct life event remain unclear. A more

thorough investigation is warranted, as the immediate postpartum period is an important interactive context among parents and their infants that has been vastly overlooked.

Face-to-face parent-infant exchanges are also important interactive contexts in which a more thorough investigation of touch is required. During such interactions, the infant and his or her caregiver are seated in front of one another at eye-level and engage in a series of brief interactions (Stack, 2010). The still-face (SF; Tronick, Als, Adamson, Wise, & Brazelton, 1978) procedure is one type of face-to-face parent-infant interaction that has been commonly utilized as a perturbed context in which interactions among mothers and their infants, and their communicative and regulatory behaviours, have been explored (e.g., Adamson & Frick, 2003; Gusella, Muir, & Tronick, 1988; Mesman, van Ijzendoorn, & Bakermans-Kranenburg, 2009; Moszkowski & Stack, 2007; Stack & Muir, 1992). The SF procedure is a structured face-to-face interaction that consists of two normal interaction periods during which mothers are instructed to interact with their infants as they normally would, separated by another period (i.e., the SF period) where mothers are instructed to stare blankly at their infants while maintaining a neutral facial expression and providing neither vocal nor tactile stimulation (Mantis, Stack, Ng, Serbin, & Schwartzman, 2014; Mastergeorge, Paschall, Loeb, & Dixon, 2014; Moszkowski & Stack, 2007; Tronick et al., 1978). The SF period is a time during which mothers appear emotionally unavailable, despite being physically present (Mantis et al., submitted; Moszkowski, Stack, & Chiarella, 2009; Stack, 2010). Consequently, the SF period serves as a valid stressor for infants aged 3- to 10-months-old (Lowe et al., 2016; Stifter & Braungart, 1995; Stack & Muir, 1992; Tronick et al., 1978) and has been found to produce a signature SF effect in infants. That is, in response to the SF period, infants tend to display decreased smiling and gazing at their mothers'

faces and increased neutral and negative affect (Lamb, Morrison, & Malkin, 1987; Mayes & Carter, 1990; Muir & Lee, 2003; Stack, 2010).

The findings documenting the SF effect reflect the fact that most investigations of infants during the SF procedure have focused on more distal modalities such as gaze and affect (Gusella et al., 1988; Mayes & Carter, 1990; Moszkowski & Stack, 2007; Stack, 2010). However, touch is the primary modality that young infants use to engage and interact with their world (Field, 2014; Mammen et al., 2016; Stack & Muir, 1992). For infants, touch represents a means through which they can non-verbally communicate their needs (Hertenstein, 2002; Lowe et al., 2016) and discover objects, others, and themselves (Mammen et al., 2016; Stack, 2010; Striano & Bushnell, 2005; Field, 2014). Due to the pre-linguistic nature of infancy, touch is critical for the development of such skills (Mantis et al., 2014; Stack & Jean, 2011). Furthermore, infants spend approximately 85% of their time engaging in touching behaviours during social exchanges (Stack & Muir, 1990, 1992; Moszkowski & Stack, 2007). The diverse purposes of infant touch combined with its pervasive presence during early interactions, warrants an investigation of infants' touching behaviours during the very first weeks of life (Moszkowski et al., 2009; Stack, 2010).

To date, research on infant touch has been quite scant. Furthermore, few studies have implemented the SF procedure as a means of assessing infants' touch (Harder, Lange, Hansen, Væver, & Køppe, 2015). A study conducted by Toda and Fogel (1993) revealed that infants engage in more self-touch and grasping during the SF period. Moszkowski and Stack's (2007) study demonstrated that the SF affects infants' touching behaviours whereby infants display more active and soothing types of touch during the SF period, as compared to more passive touch during the normal periods. Furthermore, a follow-up study conducted by Moszkowski and

colleagues (2009) revealed that infants use more regulatory and exploratory functions of touch during the SF period, but more calming and reactive touch during the two normal periods. These studies have underscored how infants use touch to express and regulate their emotions, and to respond to changes in their mothers' behaviours (Jean & Stack, 2012; Stack & LePage, 1996; Tronick, 2003).

Much like the literature on infant touch, the SF procedure has been primarily used to investigate infants' behaviors in response to changes in maternal visual and vocal expressions (Stack & Muir, 1992). As such, fewer researchers have used it to investigate changes in maternal touch (Mesman et al., 2009; Stack & Jean, 2011). For example, Field, Vega-Lahr, Scafidi and Goldstein (1986) demonstrated that mothers exhibited increased maternal tactile kinesthetic behaviour following, as compared to preceding, the SF period, revealing that the SF elicits changes in maternal tactile behaviours as well (Field, Vega-Lahr, Scafidi, & Goldstein, 1986). Stack and Muir (1990) compared the standard SF procedure to a modified version of the SF procedure, in which mothers touched their infants throughout the SF period. The infants in this modified condition showed increased levels of positive and decreased levels of negative affect, demonstrating that touch has the ability to moderate the SF effect. Therefore, touch alone can, at least temporarily, significantly diminish infant distress (Feldman, Singer, & Zagoory, 2010; Jeanet al., 2014; Stack & Muir, 1990; 1992). A more recent study of note is that of Jean and Stack (2009), who used the SF procedure to examine changes in maternal functions of touch. These researchers found that the specific functions of maternal touch varied according to the interaction period; mothers' touch during the period before the SF was attention-getting, but it was more nurturing during the period after the SF. They also found that the specific functions of maternal touch were predictive of their infants' subsequent behaviour; playful touch predicted

infant smiling and nurturing touch predicted infant fretting. These findings demonstrate how, like infant touch, maternal touch is purposeful and serves a range of diverse functions (Ferber, Feldman, & Makhoul, 2008; Jean & Stack, 2009; Jean et al., 2009). Furthermore, maternal touch relates to changes in infant behaviour.

Taken together, the aforementioned studies have highlighted the SF procedure as a valuable tool for the exploration of mother and infant touch (Stack, 2010). They also highlighted the reciprocity that is inherent in face-to-face interactions (Mastergeorge et al., 2014) and the collaborative partnership that is intrinsic to the mother-infant dyad. According to the dynamic systems perspective, mothers and their infants form a mutually regulated bidirectional system in which they are sensitive to changes in their partner (Beebe et al., 2016; Doiron & Stack, in press; Fogel, 1992; McQuaid, Bibok, & Carpendale, 2009; Pesonen, Räikkönen, Heinonen, Komsi, Järvenpää, & Strandberg, 2008; Provenzi, Borgatti, Menozzi, & Montirosso, 2015; Sameroff, 2009; 2010; Field, 2014). This view is consistent with transactional models of development which posit that behavioural changes of a parent will likely have an influence on the infant or child's behaviour, and vice versa (Field, 2005; Pesonen et al., 2008; Sameroff, 2010; Kucyzinski & De Mol, 2015). Mothers and their infants can thus be viewed as a coupled system (Beebe et al., 2016). Still, systems views of mother-infant and mother-child dyads remain relatively unexplored (Beebe et al., 2016; Enns et al., in preparation; Fogel, 1992; Serbin, Kingdon, Ruttle, & Stack, 2015). Finally, touch has been predominantly investigated from a *unidirectional* perspective; that is, previous studies assessing touch, including those mentioned above, have assessed either maternal and infant touch, but not both (Mantis et al., 2014). Ultimately, investigations should capture *both* mothers and their infants as active and competent social partners, and be reflective of the very reciprocal nature of their developing relationship (Fogel,

1993; Field, 2014; Pettit & Arsiwalla, 2008). Therefore, in the current study, we considered both maternal and infant touch, which allowed us to obtain a more complete picture of how both mothers and infants use touch to contribute to the same interaction.

The Present Study

The current study was designed to examine and describe mothers', fathers', and infants' displays of touching behaviours during parent-infant interactions. Touching behaviours were assessed in terms of the frequency and duration of the specific type of touch displayed. As such, both the quantitative (frequency, duration) and qualitative (type of touch) aspects of touch were considered. Maternal and paternal touching were investigated during a triadic, naturalistic interaction between mothers, fathers, and their newborn infants, occurring immediately after birth and delivery while in the hospital. In addition, touching behaviours of these same mothers and infants were examined during the SF procedure, a series of dyadic face-to-face interactions, in which mothers and their infants engaged in 3-months postpartum.

The objectives of the current study were to: 1) explore how mothers and fathers utilize touch during their very first interaction with their newborn infant, 2) to assess the progression of maternal touch during early mother-infant interactions as a function of infants' age and interactive context at newborn and again at 3-months, 3) explore the full range of touching behaviours displayed by infants at 3-months postpartum, and 4) examine changes in maternal and infant touch across the periods of the SF procedure when infants were 3-months-old.

The current study was designed to provide unique directions for the study of parent-infant relationships and development, as well as a more complete understanding of touch as a primary means of early communication. It is the first of its kind to consider the range of specific touching behaviours of both mothers and fathers during the first hour after birth. The results from our

study enrich the very scant knowledge of the naturalistic trajectory of parents' touch during their first encounter with their newborns. It will also be the first to consider how mothers' very first displays of touch relate to their later touching of their infants at 3-months, as well as simultaneous changes in infant and mother touch across interaction periods of the SF procedure. Given that infant development occurs within a familial context (Hall, Hoffenkamp, Tooten, Braeken, Vingerhoets, & van Bakel, 2015) and that infants learn how to engage in reciprocal social exchanges, regulate their emotions, and communicate effectively during interactions with their parents (Peláez-Noguera et al., 1996; Stack, 2010), an exploration of touch in both the context of the parent-infant relationship as a whole and at a micro-behavioral level has important implications for our understanding of children's development of social, emotional, and communicative skills (Stack & Jean, 2011; Stack & Muir, 1992).

Method

Participants

Mothers were recruited in Italy (locations specified below) during the last trimester of pregnancy. To participate, mothers must not have been single parents, under the age of 18 years, or using recreational drugs. Mothers diagnosed with emotional disorders, or undergoing an at-risk pregnancy, were also excluded from the current study. Thirty-one mothers and fathers agreed to participate in the current study with their infants. Due to technical difficulties regarding the video recording of the parent-infant interactions, 9 families were excluded. The final sample thus included 22 mothers, fathers, and infants. Mothers' ages ranged from 22 to 42 years (M = 33.43, SD = 5.63), whereas fathers' ages ranged from 28 to 46 years (M = 36.78, SD = 5.02). All couples were either cohabitating or married, and having their first child together. During the first time point (Time 1), infants were only minutes old, having just been born. All infants were full-

term, and delivered vaginally and without analgesia. These were all medically judged to be low-risk deliveries. During the second time point (Time 2), infants were approximately 3-months-old; specifically, their ages ranged from 2.9 to 4.6 months (M = 3.16, SD = .35). Of the 22 infants, 13 were male and 9 were female. An index of family socio-economic status was obtained according to Hollingshead (1978) classification (Hollingshead, 1975); lower scores reflect lower SES. On this index, scores ranged from 30 to 90 (M = 54.09, SD = 16.81), indicating that families were of middle to upper social class. Participants were all of Italian nationality.

Measures

Demographic Questionnaire. This self-report demographic questionnaire consisted of questions concerning mothers' and fathers' ages, occupations, and education, and families' socioeconomic statuses.

Apparatus

Using a hand-held video camera, the Neonatologist (one of the co-authors on this paper) recorded each interaction period of the procedure at Time 1. For Time 2, the camera was fixed on a tripod. Videotapes were later digitized and transferred onto a computer. The video records were then reviewed for behavioural coding using the software system, Mangold INTERACT 9.0. Mangold is a professional software system for behavioural research that allows for the live second-by-second qualitative and quantitative analysis of multimedia data.

Procedure

During the third trimester of pregnancy, mothers and fathers provided their informed consent (See Appendix A). They then completed a variety of questionnaire measures, including the demographic questionnaire. Minutes after labour and delivery, infants were placed on their mother's chest and the Neonatologist began video recording this very first interaction among

newborn infants and their mothers and fathers. No instructions were given to the infants' parents; parents interacted with their infants as they wanted. All deliveries took place at the Sacra Famiglia Hospital in Erba, Como, Italy.

Approximately three months later, these same mothers and their infants participated in the Still-Face procedure (SF; Tronick et al., 1978). Mothers and their infants completed this procedure at the 0-3 Centre for the At-Risk Infant Laboratory of the Scientific Institute (IRCCS Eugenio Medea) in Bosisio Parini, Lecco, Italy (research in collaboration with Dr. Rosario Montirosso and colleagues; Montirosso & Provenzi, 2015). Mothers and their infants were seated comfortably in a room at the research laboratory while being video recorded (consent given) during three face-to-face interaction periods. Infants were securely fastened in a car seat, which was placed on a table facing their mothers. Mothers were seated directly in front of their infants and at eye-level. The first interaction period, the normal period, entailed a normal interaction in which mothers were instructed to play with their infants as they normally would, including visual, vocal, and tactile stimulation. The second interaction period, the SF period, involved mothers looking at their infants using a still, expressionless, neutral, facial expression. During this period, mothers were also asked to abstain from smiling, talking, or touching their infants in order to appear emotionally neutral and were thus unavailable to their infants, although physically present. The final interaction period, the reunion period, involved another interaction period in which mothers were again instructed to play with their infants as they normally would, including any form of stimulation. Each interaction period lasted two minutes. The experimenter was in an adjacent room behind a one-way mirror monitoring the video recording and produced a knocking sound to signal the end of each interaction period. Mothers were informed that they were free to discontinue the sessions at any time if desired.

Observational Coding

Videotapes were reviewed and coded for touching using the Caregiver-Infant Touch Scale (CITS; Jean et al., 2009; Stack, 2010; Stack, LePage, Hains, & Muir, 1996), an adapted version of the CITS, the Caregiver-Infant Touch Scale – Adapted (CITS-Adapted; Stack et al., 2014), and the Infant Touch Scale (ITS; Moszkowski & Stack, 2007), all of which are reliable and systematic coding systems. Refer to Appendix B for brief descriptions of the coding categories within each these coding schemes.

Both the CITS and the CITS-Adapted are measures of the qualitative (and quantitative) changes in tactile stimulation produced by caregivers when interacting with their infants. The CITS consists of 8 categories of touch: (1) static touch, (2) stroke/caress/rub/massage, (3) pat/tap, (4) squeeze/pinch/grasp, (5) tickle/finger walk/prod/poke/push, (6) shake/wiggle, (7) pull/lift/extension/clap, and (8) other (i.e., wiping the infant's mouth or nose, adjusting the infants' posture or clothing, kissing, etc.). The CITS-Adapted consists of 9 categories of touch: (1) static touch, (2) stroke/caress, (3) massage/rub, (4) holding, (5) palmar grasp reflex, (6) rocking, (7) utilitarian/instrumental, (8) other, and (9) kissing. Based on the CITS, the CITS-Adapted was designed to measure the qualitative changes in touching behavior used by caregivers during the immediate postpartum period and the touching characteristic of this type of interaction. Consequently, the pat/tap, squeeze/pinch/grasp, tickle/finger walk/prod/poke/push, shake/wiggle, pull/lift/extension/clap were not included in the CITS-Adapted. Given that these behaviours are more playful in nature, they were not characteristic of the immediate postpartum period, but are characteristic behaviours of the later post-delivery period. Instead, holding, rocking, and utilitarian/instrumental behaviours were included.

The ITS is a measure of qualitative (and quantitative) changes in tactile stimulation

produced by infants when interacting with their caregivers. It consists of 7 categories of touch: (1) static touch, (2) rub/caress/wipe/stroke, (3) grasping/clutching/clasping, (4) manipulating/fingering/scrumble/poke/prod, (5) mouthing, (6) tap/pat, (7) pull/push/clap/lift. All touching behaviours were coded second-by-second.

Coders were trained on the CITS and ITS before coding began to reach a high level of reliability before formal coding commenced. When discrepancies between raters occurred during the training period, coders reviewed the corresponding portion of the video, discussed and deliberated the appropriate type of touch for the particular segment on the video, and subsequently re-coded that portion of the video with the agreed upon category of touch. Inter-rater reliability was subsequently conducted between coders; one of the coders was blind to the hypotheses of the study. Inter-rater reliability was determined using kappa coefficients for 30% of the sample. On the CITS, a very high inter-rater reliability between coders was determined for touch overall (k = .89) and for each of the 8 types of touch individually (k = .70 to .93). On the ITS, a very high inter-rater reliability among coders was determined for touch overall (k = .88) and for each of the 7 types of touch individually (k = .81 to 1.00).

Statistical Analyses

Percent durations and relative frequencies for each type of touch were used as dependent variables for each of the analyses. Percent duration refers to the percentage of time over the length of the interaction for each dyad that was allocated to a specific type of touch. It is calculated by dividing the raw duration of a specific touch divided by the length of the corresponding interaction period (and multiplied by 100). Relative frequency refers to the proportionalized frequency as a function of the length of the interaction period. This was calculated by dividing the raw frequency of a specific touch by the total length of the

corresponding interaction period (multiplied by 100). The percent durations and relative frequencies were calculated for each type of touch to control for differences in the length of the interaction periods at each interaction time point (Herrera, Reissland, & Shepard, 2004).

Results

Data Integrity

Data were screened for integrity and to ensure that the assumptions of repeated measures ANOVAs and regression analyses were met within the current sample. The data cleaning process involved checking for outliers, or scores more than 3 standard deviations away from the mean. Standardized scores were used to identify outliers. Outliers were retained and adjusted by changing their values to the next highest score (Tabachnick & Fidell, 2001; Kline, 2009). Statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS, version 18.0).

Objective 1: Mothers' and fathers' touching behaviors during their first interaction with their newborn

Descriptive statistics were used to investigate the touching behaviours of mothers and fathers during their very first interaction with their newborn infants. "Holding" was the highest percent duration touch behavior, whereas "Stoke/Caress' was the highest relative frequency touch variable, utilized by mothers. "Kissing" was the lowest percent duration touch variable, whereas "Rocking" was the lowest relative frequency touch variable, utilized by mothers. "Stroke/Caress' was both the highest percent duration and highest relative frequency type of touch employed by fathers. Aside from "Blowing" and "Palmar Grasp Reflex," which were not displayed by fathers, "Kissing" was both the shortest percent duration and lowest relative

frequency type of touch employed by fathers. The means and the standard errors for mothers' and fathers' touching behaviours are included in Table 1.

A one-way MANOVA was conducted to compare mothers and fathers with regards to the proportionalized frequency of their touching behaviours. Parent (mother or father) was the independent variable. The dependent variables utilized for this analysis were the relative frequencies of those touching behaviours that were coded for both mothers and fathers. "Rocking" and "Blowing" were thus not included as dependent variables, as the former category was used only for mothers and the latter category was coded only for fathers. Results revealed a statistically significant difference between mothers and fathers based on the frequency of their touching behaviours, F (8, 33) = 5.12, p = .000; Wilk's Λ = .446, partial η^2 = .55. Univariate ANOVAs revealed that parent had a statistically significant effect on the following relative frequency of touching behaviours: "Kissing" (F (1, 40) = 7.78, p = .008; R^2 = .16), "Stroke/Caress" (F (1, 40) = 27.92, p = .000; R^2 = .41), "Utilitarian/Instrumental" (F (1, 40) = 19.06, p = .000; R^2 = .32), "Holding" (F (1, 40) = 18.16, p = .000; R^2 = .31), "Massage/Rub" (F (1, 40) = 7.86, p = .008; R^2 = .16), "Other" (F (1, 40) = 5.97, p = .019; R^2 = .13), and "Palmar Grasp Reflex" (F (1, 40) = 5.87, p = .020; R^2 = .13). Bonferonni pairwise comparisons revealed that mothers touched their infants significantly more frequently using kissing (p = .011), stroke/caress (p = .000), utilitarian/instrumental (p = .000), holding (p = .001), massage/rub (p = .014), other (p = .018), and palmar grasp reflex (p = .030) than fathers.

A one-way MANOVA was conducted to compare mothers and fathers with regards to the percent duration of their touching behaviours. Parent (mother or father) was the independent variable. The dependent variables utilized for this analysis were those touching behaviours that were coded for both mothers and fathers. "Rocking" and "Blowing" were thus not included as

dependent variables, as the former category was used only for mothers and the latter category was coded only for fathers. Results revealed a statistically significant difference between mothers and fathers based on the duration of their touching behaviours, F (8, 33) = 4.99, p = .000; Wilk's Λ = .453, partial η^2 = 58. Univariate ANOVAs revealed that parent had a statistically significant effect on the following touching behaviours: "Kissing" (F (1, 40) = 7.23, p = .010; R^2 = .15), "Stroke/Caress" (F (1, 40) = 16.86, p = .000; R^2 = .30), "Utilitarian/Instrumental" (F (1, 40) = 16.02, p = .000; R^2 = .29), "Holding" (F (1, 40) = 9.83, p = .003 ; R^2 = .20), "Massage/Rub" (F (1, 40) = 10.16, p = .003; R^2 = .08), and "Other" (F(1, 40) = 4.72, p = .036; R^2 = 12). Bonferonni pairwise comparisons revealed that mothers spent significantly more time touching their infants using kissing (p = .010), stroke/caress (p = .000), utilitarian/instrumental (p = .000), holding (p = .003), massage/rub (p = .003) and other (p = .036) than fathers.

Objective 2: Development of maternal touch from newborn to 3 months

A series of linear regression analyses were used to determine whether maternal touching behaviours displayed immediately after birth were predictive of maternal touching behaviours displayed 3-months postpartum. It should be noted that, in line with previous investigations of maternal touch (Mantis et al., submitted; Moszkowski & Stack, 2007; Moszkowski et al., 2009), maternal touching behaviours during the SF procedure were classified as either passive or active touch (see Table 2). Passive touch included those types of touch that would be calming or soothing to the infant and involved minimal amount of effort on behalf of the mother. Active touch included those types of touch that were more playful and engaging and involved more effort on behalf of the mother. Previous investigations utilizing this categorization of passive and active types of touch have yielded meaningful findings (i.e., Mantis et al., submitted;

Moszkowski & Stack, 2007; Moszkowski et al., 2009).

Results revealed that the total relative frequency of touch at Time 1 did not significantly predict the total relative frequency of touch (collapsed across normal and reunion periods) at Time 2 ($\beta = .16$, $p > .05$), nor did it significantly predict the total relative frequency of touch during the normal period at Time 2 ($\beta = -.30$, $p > .05$). However, the total relative frequency of touch at Time 1 was found to be a statistically significant predictor of the total relative frequency of touch during the reunion period at Time 2 ($\beta = .52$, $t = 2.37$, $p = .032$).

Results revealed that the total percentage of time spent touching at Time 1 did not significantly predict the total percentage of touch (collapsed across normal and reunion periods) at Time 2 ($\beta = -.00$, $p > .05$), nor did it significantly predict the total percentage of touch during the normal period ($\beta = -.40$, $p > .05$) or during the reunion period at Time 2 ($\beta = .14$, $p > .05$).

The total percentage of touch at Time 1 was found to be a significant predictor of passive touching behaviours displayed during the reunion period ($\beta = .61$, $t = 2.49$, $p = .010$), but not of passive touching behaviours displayed during the normal period ($\beta = -.34$, $p > .05$) at Time 2. Total percentage of touch at Time 1 was not a significant predictor of active touching behaviours displayed during neither the normal ($\beta = -.41$, $p > .05$) nor the reunion ($\beta = -.19$, $p > .05$) periods at Time 2.

Objective 3: Infant touch at 3-months

Descriptive statistics were used to investigate the touching behaviours of infants during face-to-face interactions with their mothers at 3-months postpartum. During both the normal and reunion periods, infants used “Static” most frequently. They used “Grasping/ Clutching/ Clasping” for the longest percentage of time during the normal period and “Static” for the longest percentage of time during the reunion period. During both the normal and reunion

periods, "Mouthing" was the least used touching behaviour displayed by infants in terms of both relative frequency and percent duration. Refer to Table 3 for the means and standard errors for infants' touching behaviours.

Objective 4: Mothers' and infant's touching behaviours across the periods of the SF procedure

A 2 x 2 (partner x period) mixed MANOVA was performed to investigate the effects of partner (mother, infant) and period (normal, reunion) on 6 dependent variables: the relative frequency of "Grasping," "Pat/Tap," "Pull," "Rub/Stroke/Caress/Wipe/Massage," "Static," and "Poke/Prod/Push." Results revealed a statistically significant main effect of partner on the composite of these touching variables, F (6, 27) = 6.21, p = .000, Wilk's Λ = .420, partial η^2 = .58. Univariate ANOVAs revealed that partner had a statistically significant effect on "Static," (F (1, 32) = 31.00, p = .000, R^2 = .49), "Pat/Tap," (F (1, 32) = 10.89, p = .002, R^2 = .25), and "Pull" (F (1, 32) = 9.40, p = .004, R^2 = .23). Bonferroni pairwise comparisons revealed that infants used static (p = .000), pat/tap (p = .002), and pull (p = .004) more frequently than their mothers.

Results also revealed a statistically significant main effect of period on the composite of these touching variables, F (6, 27) = 2.64, p = .038, Wilk's Λ = .631, partial η^2 = .37. Univariate ANOVAs revealed that period had a statistically significant effect on "Grasping" (F (1, 32) = 8.93, p = .005; partial η^2 = .22), whereby mothers and infants used grasping more frequently during the normal period (M = 7.12, SE = .93) than the reunion period (M = 4.62, SE = .53).

While a statistically significant partner by period interaction was not found on the composite of these touching variables, (F (6, 27) = 1.90, p = n.s.), univariate ANOVAs revealed that there was a significant partner by period interaction on "Rub/Stroke/Caress/Massage" (F(1, 32) = 5.47, p = .026, R^2 = .15; see Figure 1). That is, during the normal period, infants (M = 4.23,

SE = .60) used this touch more frequently than mothers (*M* =3.45, *SE* = .60), whereas during the reunion period, mothers (*M* = 4.75, *SE* = .78) used this touch more frequently than infants (*M* = 3.17, *SE* = .77).

A 2 x 2 (partner x period) mixed MANOVA was performed to investigate the effects of partner (mother, infant) and period (normal, reunion) on 6 dependent variables: the percent duration of "Grasping," "Pat/Tap," "Pull," "Rub/Stroke/Caress/Wipe/Massage," "Static," and "Poke/Prod/Push." Results revealed a statistically significant main effect of partner on the composite of these touching variables, F (6, 27) = p = .000, Wilk's Λ = .215, partial η^2 = .78. Univariate ANOVAS revealed that partner had a statistically significant effect on the following touching behaviours: "Static" (F (1, 32) = 25.81, p = .000; R^2 = .47), "Pat/Tap" (F (1, 32) = 7.34, p = .011, R^2 = .19), and "Pull" (F (1, 32) = 6.64, p = .011, R^2 = .17). Bonferroni pairwise comparisons revealed that infants had significantly higher percent durations in regards to static (p = .000), pat/tap (p = .011), and pull (p = .016) than their mothers. Note that a main effect of period and a period by partner interaction was not found for these variables. Refer to Tables 3 and 4 for the means and standard errors associated with these analyses.

Discussion

Touch is a primary channel of communication utilized by parents and their infants, and plays an important role in infants' development and the relationship that is formed with parents. Accordingly, the present study was designed to examine and describe mothers' and fathers' displays of touching behaviours during a triadic interaction with their newborn infants occurring immediately after birth, and to explore mothers' and infants' displays of touching behaviours during a series of face-to-face dyadic interactions occurring 3-months postpartum in the same dyads.

The first objective was to assess how mothers and fathers utilize touch during their very first interaction with their first newborn child. Results indicated that both mothers and fathers display a range of touching behaviours when interacting with their infants for the first time, including stroking and caressing, massaging or rubbing, holding, and kissing, as well as static touch. This is congruent with Wiberg's (1990) description of mother and father touch during the immediate postpartum period; she found mother and father touch to be varied and diverse. Parents in our study also displayed similarities in their touching behaviours. That is, mothers and fathers used static touch at similar frequencies. Furthermore, both mothers and fathers used the stroking and caressing category of touch more (in terms of frequency and duration) than any of the other types of touch. This was likely due to the nature of the interaction context and the fact that the infant was just born. Compared to all other touch categories, both mothers and fathers used kissing the least (in terms of frequency and duration) when interacting with their infants for the first time. It is possible that the positioning of the infant being in the mother's arms may have made it more difficult for mothers and fathers to kiss their infants. Differences among mothers and fathers were most apparent in the quantity of their touch. Results indicated that mothers touched their infants significantly more than did fathers; specifically, they used stroke/caress, utilitarian/instrumental, holding, massage/rub, palmar grasp reflex, kissing, and other types of touch more frequently than fathers. Mothers also spent significantly more time utilizing stroke/caress, utilitarian/instrumental, holding, massage/rub, kissing, and other more than fathers. This is not surprising considering that infants were placed in their mothers' arms after delivery, which provided mothers with more opportunity to touch their infants. Nonetheless, these findings are supported by Harrison and Woods' (1991) study that revealed that mothers use more touch than fathers.

The second objective was to assess whether maternal touching behaviours in the first minutes to an hour after birth were predictive of touching behaviours three months later. Results indicated that the frequency of overall touch displayed during the immediate postpartum period (Time 1) was not predictive of overall touch collapsed across the normal and reunion periods of the SF procedure (Time 2). However, the frequency of overall touch during the first hour after birth was predictive of the frequency of overall touch specifically during the reunion period of the SF procedure. The total percentage of maternal touch immediately after birth was also a significant predictor of passive types of touch during the reunion period; yet, it was not a significant predictors of passive types of touch during the normal period, nor was it a significant predictor of active types of touch during the normal and reunions periods. Together, these results underscore the similarities between the immediate postpartum period at Time 1 and the reunion period at Time 2. Evidently, labour is a stressful time for both the mother and her infant (Phillips, 2013). Furthermore, the SF period has been cited as a valid mild stressor for mothers and their infants (Lowe et al., 2016; Stifter & Braungart, 1995). Therefore, both of these interactions follow a period of perturbation, the delivery of the newborn at Time 1 and the SF period at Time 2, which call for more passive (i.e. soothing, calming, regulating) types of touch. As such, the nature of these interaction contexts may be parallel and have important implications for understanding the use of touch, as well as the predictive components of touch.

Previous investigations have demonstrated the predictive quality of maternal touch. In a study conducted by Grossman and colleagues (1981), it was revealed that mothers who had immediate contact with their infants after delivery touched their infants more tenderly during the first five days of hospitalization than mothers who had delayed contact with their infants. Another study conducted by De Chateau and Wilberg (1977) demonstrated that mother-infant

tactual contact occurring immediately after birth was associated with more maternal touching and holding one year later. Results from these studies suggest that mother-infant touch occurring immediately after birth is associated with subsequent mother-infant touch. However, as Hertenstein (2002) notes, the type of touch directed to a given infant will be dependent on the context of the situation. Indeed, our results suggest that the particular interactive context, such as the naturalistic immediate post-delivery period or a post-perturbation face-to-face interaction, as well as the preceding events (e.g., perturbations such as the SF period) of mother-infant interactions, are important to consider.

The third objective of the present study was to explore the range of touching behaviours displayed by 3-month-old infants. Like mothers and fathers, infants displayed a range of touching behaviours, including rub/caress/wipe/stroke, grasping/clutching/clasping, manipulating/fingering/scrumble/poke/prod, mouthing, tap/pat, pull/push/clap/lift and static touch. Infants displayed static types of touch most frequently, but spent the most amount of time engaging in grasping/clutching/clasping behaviours during both the normal and reunion periods of the SF procedure. Mouthing was the lowest frequency and duration touching behaviour infants displayed during both periods. Compared to mothers, infants utilized the static, pat/tap, and pull/push/clap/lift categories of touch more frequently and for longer durations of time.

Infants' (and mothers') touching behaviours were further examined within the framework of the fourth objective, which examined how infant (and mother) touch differed before and after the SF period. Results revealed that both infants and their mothers used the grasping (i.e. squeeze/pinched) category of touch more frequently during the normal period than the reunion period. These results suggest that infants and their mothers utilize certain touching behaviours in a similar manner during face-to-face interactions. Such findings may relate to the dynamic

systems perspective and transactional models of development, which view mothers and their infants as a mutually regulated bidirectional system and posit that behavioural changes among one interaction partner will coincide with changes in the other (Beebe et al., 2016; Fogel, 1992; McQuaid et al., 2009; Pesonen et al., 2008; Provenzi et al., 2015; Sameroff, 2009; 2010). That is, these findings highlight the reciprocity and matching of behaviours that is characteristic of face-to-face mother-infant interactions (Mastergeorge et al., 2014; Doiron & Stack, in press).

During the normal period, infants displayed the rub/stroke/caress/massage/wipe category of touch more frequently than mothers. Thus, it appears that, just as infants display decreased smiling and gazing toward their mothers in response to the SF (Jean et al., 2012; Stack & LePage, 1996; Tronick, 2003), they also decreased their use of rubbing, stroking, caressing, and wiping following the SF period. These touching behaviours can be described as passive and regulatory in kind. Thus, contrary to findings reported by Moszkowski and colleagues (2007; 2009), infants *decrease* their use of soothing or passive touch following the SF period. However, it is possible that this decrease in infant touch relates to concurrent changes in maternal touch. During the reunion period, mothers displayed this category of touch more frequently than infants, thereby exhibiting an increase in their engagement of comforting touching behaviours following the SF period.

According to Cohn, Campbell, Matias and Hopkins (1990), maternal behaviours and the affective quality of these behaviours are contingent on the infant's behaviour. As reported by Gusella and colleagues (1988), withdrawing maternal tactile stimulation can be displeasing for infants. Infants may be alarmed when their mothers become suddenly unresponsive during a typically interactive situation (Field, Diego, Hernandez-Reif, Figueiredo, Schanberg, & Kuhn, 2007). In response to their mothers' apparent unavailability, infants may have displayed a SF

effect. The reported decrease in infants' regulatory touching behaviours in the reunion period can be taken as evidence for a SF effect in the current sample. It is possible that mothers perceived a negative change in their infants' affect and adjusted their own behaviour accordingly. This maternal sensitivity or a mother's ability to be aware of her infant and respond to her infant's needs (Ainsworth, 1979; Pearson et al., 2012) is an important characteristic of early parenting and relationship quality. Indeed, mothers use touch to demonstrate affection, with the aim of comforting their infants and reducing infants' distress (Jean & Stack, 2009; Stack, 2010). The increase in soothing touch on behalf of mothers may also reflect their attempt to compensate for the absence of touch and apparent unavailability during the SF period.

Because the current study measured the tactile modality, whether infants displayed the signature SF effect, characterized by decreased levels of vocalizing, smiling, and gazing, cannot be verified. As such, it is not clear whether the observed change in mothers' regulatory touching behaviours were in response to a change in their infant's affect. Assessing other modalities of communication may have provided a more complete understanding of infants' affective states. Nonetheless, the results of the present study suggest that changes in maternal touch appear to coincide with changes in infant touch, and are closely tied to one another. These findings are consistent with dynamic systems theories that highlight the reciprocity of social exchanges, and underline the importance of investigating simultaneous changes in mothers and their infants (Beebe et al., 2016; Fogel, 1992; Pettit & Arsiwalla, 2008).

The bidirectionality of social exchanges, and the importance of considering simultaneous behavioural changes, applies to father-infant interactions as well. Thus, another limitation of the present study is that father touch was only assessed at a single time point, as fathers and their 3-month-old infants did not engage in a series of face-to-face interactions within the context of the

present study. Therefore, it remains unknown whether changes in father touch coincide with changes in infant touch. Further, it is not clear whether father touch has the same predictive quality as maternal touch, and whether they continue to use less touch than mothers throughout their child's infancy. Although the literature on father-infant interactions is expanding (Feldman, 2003; Mantis et al., 2014) research investigating father touch is limited (Weiss & Goebel, 2003; Baber, 2016; Aznar, & Tenenbaum, 2016; Kim, Kim, & Cho, 2016; Chen et al., 2017). Given that fathers are among infants' most common social partners, investigating father-infant interactions and the role of touch during such interactions is a necessary future direction.

Another important direction for future investigations of touch is examining infant touch immediately after birth. An exploration of the full range of infant touch during the immediate neonatal period would add to our knowledge about how infants and their parents interact for the first time. The skin is the largest and earliest sense organ to develop (Field, 2010; Montagu, 1986). In addition, in utero, the fetus demonstrates touching behaviours such as sucking and grasping (Hernandez-Reif, Field, & Diego, 2004). Immediately following birth, infants begin to utilize tactile behaviours to explore themselves, others, and their surroundings, and to communicate with their caregivers (Mammen et al., 2016). Thus, contrary to other human senses, while newborns may be limited with regard to their fine motor abilities, their sense of touch is already well developed (Gallace & Spence, 2016). An investigation of infant touch during the immediate postpartum period would contribute to our understanding of the development evolution of infant touch.

While further work is required to expand our knowledge on the role of touch during parent-infant interactions, the results of our study have added to our limited knowledge. Our findings have further underscored the centrality of touch during parent-infant interactions and

infant development, and the pervasiveness of touch during such interactions, starting immediately after delivery and birth. Our study also provided a number of unique contributions to the literature on touch. To our knowledge, the current study was the first to thoroughly investigate maternal *and* paternal touching behaviours *simultaneously* during the first hour after birth. It was also the first to consider simultaneous changes in both maternal and infant touch during a series of face-to-face mother-infant interactions three-months postpartum. Findings from the present study shed light on the manner in which mothers and fathers use touch when interacting with their infants for the first time, and how it relates to touch during subsequent interactions at a later age. Moreover, our findings highlight the significance of considering the particular interactive context when examining and interpreting the predictive quality of maternal touch. Furthermore, the results of the current study provide support for the notion that, for certain types of touch, changes in infant touch coincide with changes in maternal touch. Thus, both mothers and infants actively contribute to and shape their social exchanges. Beginning immediately after birth, touch is undoubtedly an intrinsic part of caregiving and infant behaviour, with direct implications for infant development and the parent-infant relationship.

References

Acosta, A. C. A. (2016). *Impact de trois interventions: Méthode Mère Kangourou, Massage en Incubateur et Massage en Position Kangourou sur la croissance et le développement des enfants prématurés nés à moins de 33 semaines d'âge gestationnel* (Unpublished doctoral dissertation). Université Laval, Québec, QC.

Adamson, L. B., & Frick, J. E. (2003). The still face: A history of a shared experimental paradigm. *Infancy, 4*(4), 451-473. doi: 10.1207/S15327078IN0404_01

Ainsworth, M. S. (1979). Infant-mother attachment. *American Psychologist, 34*(10), 932-937. doi:10.1037/0003-066X.34.10.932

Anisfeld, E., & Lipper, E. (1983). Early contact, social support, and mother-infant bonding. *Pediatrics, 72*(1), 79–83.

Atkinson, J., & Braddick, O. (1982). Sensory and perceptual capacities of the neonate. In: Stratton, P. (Ed.), *Psychobiology of the Human Newborn*: John Wiley, London (pp. 191–220).

Aznar, A., & Tenenbaum, H. R. (2016). Parent–child positive touch: Gender, age, and task differences. *Journal of nonverbal behavior, 40*(4), 317–333. doi:10.1007/s10919-016-0236-x

Baber, K. K. (2016). *The role of touch and parental depression in the development of the mother-infant and father-infant attachment relationship* (Unpublished doctoral dissertation). Texas Christian University, Fort Worth, TX.

Barnett, K. (1972). A theoretical construct of the concepts of touch as they relate to nursing. *Nursing Research, 21*(2), 102–110.

Barnett, L. (2005). Keep in touch: The importance of touch in infant development. *Infant*

Observation, *8*(2), 115–123. doi: 10.1080/13698030500171530

Beebe, B., Messinger, D., Bahrick, L. E., Margolis, A., Buck, K. A., & Chen, H. (2016). A systems view of mother–infant face-to-face communication. *Developmental Psychology, 52*(4), 556–571. doi:10.1037/a0040085

Beijers, R., Cillessen, L., & Zijlmans, M. A. (2016). An experimental study on mother-infant skin-to-skin contact in full-terms. *Infant Behavior and Development, 43*, 58–65. doi:10.1016/j.infbeh.2016.01.001

Botero, M. (2016). Tactless scientists: Ignoring touch in the study of joint attention. *Philosophical Psychology, 29*(8), 1200–1214. doi: 10.1080/09515089.2016.1225293

Brazelton, T. B. (1977). Implications of infant development among the Mayan Indians of Mexico. In P. H. Leiderman, S. R. Tulkin, & A. Rosenfeld (Eds.), *Culture and Infancy: Variations in Human Experience* (pp. 151–188). New York: Academic.

Bremner, A. J., Lewkowicz, D. J., & Spence, C. (Eds.). (2012). *Multisensory development.* Oxford, UK: Oxford University Press.

Bystrova, K., Ivanova, V., Edhborg, M., Matthiesen, A. S., Ransjö-Arvidson, A. B., Mukhamedrakhimov, R., Uvnäs-Moberg, K., & Widström, A. M. (2009). Early contact versus separation: Effects on mother-infant interaction one year later. *Birth: Issues in Perinatal Care, 36*(2), 97–109. doi:10.1111/j.1523-536X.2009.00307.x

Chen, E. M., Gau, M. L., Liu, C. Y., & Lee, T. Y. (2017). Effects of father-neonate skin-to-skin contact on attachment: A randomized controlled trial. *Nursing Research and Practice*, *2017*, 1–8. doi:10.1155/2017/8612024

Cohn, J., Campbell, S., Matias, R., & Hopkins, J. (1990). Face-to-face interactions of postpartum depressed and non-depressed mother–infant pairs at 2 months. *Developmental Psychology, 26*(1), 15–23. doi:10.1037/0012-1649.26.1.15

Conde-Agudelo, A., Diaz-Rosello, J. L., & Belizan, J. M. (2000). Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. *The Cochrane Database of Systematic Reviews, (4), CD002771*.

D'Agata, A. L., Sanders, M. R., Grasso, D. J., Young, E. E., Cong, X., & Mcgrath, J. M. (2017). Unpacking the burden of care for infants in the NICU. *Infant Mental Health Journal, 38*(2), 306–317. doi:10.1002/imhj.21636

De Chateau, P. & Wiberg, B. (1977). Long-term effect on mother-infant behaviour of extra contact during the first hour post partum. *Acta Paediatrica Scandinavica, 66*(2), 145–151.

Doiron, K. M., & Stack, D. M. (In press). Coregulation and the quality of the relationship in full-term and very low-birthweight preterm infant-mother dyads during face-to-face interactions. *Infancy,* 1-17. doi:10.1111/infa.12187

Elliott, M. R., Reilly, S. M., Drummond, J., & Letourneau, N. (2002). The effect of different soothing interventions on infant crying and on parent–infant interaction. *Infant Mental Health Journal*, *23*(3), 310–328. doi:10.1002/imhj.10018

Enns, L.N., Stack, D.M., Langevin, R., Serbin, L.A., Ledingham. J., & Schwartzman, A.E. (2017). Emotional flexibility and shared expressions in high-risk dyads: Unpacking the processes underlying mother-child nonverbal emotion communication in middle childhood. To be submitted, *Journal of Applied Developmental Psychology*.

Erlandsson, K., Dsilna, A., Fagerberg, I., & Christensson, K. (2007). Skin-to-skin care with

the father after cesarean birth and its effect on newborn crying and prefeeding behavior. *Birth, 34*(2), 105–114. doi:10.1111/j.1523-536X.2007.00162.x

Feldman, R. (2003). Infant-mother and infant-father synchrony: The coregulation of positive arousal. *Infant Mental Health Journal, 24*(1)*,* 1-23. doi:10.1002/imhj.10041

Feldman, R., Singer, M., & Zagoory, O. (2010). Touch attenuates infants' physiological reactivity to stress. *Developmental Science, 13*(2), 271–278. doi:10.1111/j.1467-7687.2009.00890.x

Ferber, S. G., Feldman, R., & Makhoul, I. R. (2008). The development of maternal touch across the first year of life. *Early Human Development*, *84*(6), 363–370. doi:10.1016/j.earlhumdev.2007.09.019

Ferber, S. G., & Makhoul, I. R. (2004). The effect of skin-to-skin contact (kangaroo care) shortly after birth on the neurobehavioral responses of the term newborn: a randomized, controlled trial. *Pediatrics, 113*(4), 858–865. doi:10.1016/j.jpeds.2004.08.039

Field, T. (1984). Early interactions between infants and their postpartum depressed mothers. *Infant Behavior and Development, 7*(4), 517-522. doi:10.1016/S0163-6383(84)80010-7

Field, T. (2005). Massage therapy for skin conditions in young children. *Dermatologic Clinics, 23*(4), 717-721. doi:10.1016/j.det.2005.05.009

Field, T. (Ed.). (2014). *Touch in early development*. New York (NY): Psychology Press.

Field, T. (2010). Touch for socioemotional and physical well-being: A review. *Developmental Review*, *30*(4), 367–383. doi:10.1016/j.dr.2011.01.001

Field, T. (2016). Moderate pressure massage therapy. In H. Olausson, J. Wessberg, I. Morrison, & F. McGlone (Eds.), *Affective Touch and the Neurophysiology of CT Afferents* (pp. 385–396). New York: Springer.

Field, T., Diego, M., & Hernandez-Reif, M. (2010). Preterm infant massage therapy research: A review. *Infant Behavior and Development, 33*(2), 115–124. doi:10.1016/j.infbeh.2009.12.004

Field, T., Diego, M., Hernandez-Reif, M., Figueiredo, B., Schanberg, S., & Kuhn, C. (2007). Sleep disturbances in depressed pregnant women and their newborns. *Infant Behavior and Development, 30*(1), 127-133. doi:10.1016/j.infbeh.2006.08.002

Field, T., Vega-Lahr, N., Scafidi, F., & Goldstein, S. (1986). Effects of maternal unavailability on mother-infant interactions. *Infant Behavior and Development, 9*(4), 473–478.

Fogel, A. (1992). Movement and communication in human infancy: The social dynamics of development. *Human Movement Science, 11*, 387–423.

Fogel, A. (1993). *Developing through relationships: Origins of communication, self, and culture*. Chicago, IL: University of Chicago Press.

Gallace, A., & Spence, C. (2016). Social touch. In H. Olausson, J. Wessberg, I. Morrison, & F. McGlone (Eds.), *Affective Touch and the Neurophysiology of CT Afferents* (pp. 227–238). New York: Springer.

Greenberg, M., & Morris, N. (1974). Engrossment: The newborn's impact upon the father. *American Journal of Orthopsychiatry, 44*(4), 520–531. doi:10.1111/j.1939-0025.1974.tb00906.x

Grossmann, K., Thane, K., & Grossmann, K. E. (1981). Maternal tactual contact of the newborn after various postpartum conditions of mother–infant contact. *Developmental Psychology, 17*(2), 158–169. doi:10.1037/0012-1649.17.2.158

Gusella, J. L., Muir, D., & Tronick, E. Z. (1988). The effect of manipulating maternal behavior during an interaction on three- and six-month-olds' affect and attention. *Child Development, 59*(4), 1111-1124.

Hall, R. A. S., Hoffenkamp, H. N., Tooten, A., Braeken, J., Vingerhoets, A. J. J. M., & van Bakel, H. J. A. (2015). The quality of parent–infant interaction in the first 2 years after full-term and preterm birth. *Parenting, 15*(4), 247-268, doi:10.1080/15295192.2015.1053333

Harder, S., Lange, T., Hansen, G. F., Væver, M., & Køppe, S. (2015). A longitudinal study of coordination in mother–infant vocal interaction from age 4 to 10 months. *Developmental Psychology, 51*(12), 1778–1790. doi:10.1037/a0039834

Harrison, L. L., & Woods, S. (1991). Early parental touch and preterm infants. *Journal of Obstetric, Gynecologic, & Neonatal Nursing, 20*(4), 299–306. doi:10.1111/j.1552-6909.1991.tb01693.x

Hernandez-Reif, M., Field, T., & Diego, M. (2004). Touch perception in neonates. In T. Field (Ed.), *Touch and Massage in Early Child Development* (pp. 15–37). Johnson & Johnson Pediatric Institute, L.L.C.

Herrera, E., Reissland, N., & Shepherd, J. (2004). Maternal touch and maternal child-directed speech: Effects of depressed mood in the postnatal period. *Journal of Affective Disorders, 81*(1), 29–39. doi:10.1016/j.jad.2003.07.001

Hertenstein, M. J. (2002). Touch: Its communicative functions in infancy. *Human Development*, *45*(2), 70–94. doi:10.1159/000048154

Hollingshead, A. B. (1975). Four factor index of social status (Unpublished manuscript). New Haven, CT: Yale University.

Hollingshead, A.B. (1978). *Four factor index of social status*. New Haven, CT: Yale University.

Jean, A. D., & Stack, D. M. (2009). Functions of maternal touch and infants' affect during face-to-face interactions: New directions for the still-face. *Infant Behavior and Development*, *32*(1), 123–128. doi:10.1016/j.infbeh.2008.09.008

Jean, A. D., & Stack, D. M. (2012). Full-term and very-low-birth-weight preterm infants' self-regulating behaviors during a Still-Face interaction: Influences of maternal touch. *Infant Behavior and Development, 35*(4), 779–791. doi:10.1016/j.infbeh.2012.07.023

Jean, A. D., Stack, D. M., & Arnold, S. (2014). Investigating maternal touch and infants' self-regulatory behaviours during a modified face-to-face Still-Face with touch procedure. *Infant and Child Development, 23*(6), 557–574. doi:10.1002/icd.1870

Jean, A. D., Stack, D. M., & Fogel, A. (2009). A longitudinal investigation of maternal touching across the first 6 months of life: Age and context effects. *Infant Behavior and Development*, *32*(3), 344–349. doi:10.1002/icd.1870

Klaus, M., & Kennell, J. (1976). *Maternal-infant bonding*. St. Louis, MO: Mosby.

Klaus, M., Kennell, J., Plumb, N., & Zuehlke, S. (1970). Human maternal behavior at first contact with her young. *Pediatrics, 46,* 187-192.

Kim, M. A., Kim, S. J., & Cho, H. (2016). Effects of tactile stimulation by fathers on physiological responses and paternal attachment in infants in the NICU: A pilot study. *Journal of Child Health Care*, *21*(1), 36–45. doi:10.1177/1367493516666729

Kisilevsky, B. S., Stack, D. M., & Muir, D. W. (1991). Fetal and infant response to tactile stimulation. In M. J. Weiss & P. R. Zelazo (Eds.), *Newborn Attention: Biological Constraints and the Influence of Experience* (pp. 63–98). Norwood, NJL: Ablex.

Kline, R. B. (2009). *Becoming a behavioural researcher: A guide to producing research that*

matters. New York, NY: Guilford Press.

Kuczynski, L., & De Mol, J. (2015). *Dialectical models of socialization*. In W. F. Overton & P. C. M. Molenaar (Eds.), *Theory and Method (*Vol. 1*): Handbook of Child Psychology and Developmental Science* (7th ed.). Hoboken, NJ: Wiley. doi:10.1002/9781118963418.childpsy109

Lamb, M. E., Morrison, D. C., & Malkin, C. M. (1987). The development of infant social expectations in face-to-face interaction: A longitudinal study. *Merrill-Palmer Quarterly, 33,* 241-254.

Jean, A. D., & Stack, D. M. (2009). Functions of maternal touch and infants' affect during face-to-face interactions: New directions for the still-face. *Infant Behavior and Development*, *32*(1), 123–128. doi:10.1016/j.infbeh.2008.09.008

Jean, A. D., & Stack, D. M. (2012). Full-term and very-low-birth-weight preterm infants' self-regulating behaviors during a Still-Face interaction: Influences of maternal touch. *Infant Behavior and Development, 35*(4), 779–791. doi:10.1016/j.infbeh.2012.07.023

Jean, A. D., Stack, D. M., & Arnold, S. (2014). Investigating maternal touch and infants' self-regulatory behaviours during a modified face-to-face Still-Face with touch procedure. *Infant and Child Development, 23*(6), 557–574. doi:10.1002/icd.1870

Jean, A. D., Stack, D. M., & Fogel, A. (2009). A longitudinal investigation of maternal touching across the first 6 months of life: Age and context effects. *Infant Behavior and Development*, *32*(3), 344–349. doi:10.1002/icd.1870

Lowe, J. R., Coulombe, P., Moss, N. C., Rieger, R. E., Aragón, C., MacLean, P. C., Caprihan,

A., … & Handal, A. J. (2016). Maternal touch and infant affect in the Still Face Paradigm: A cross-cultural examination. *Infant Behavior and Development, 44*, 110–120. doi:10.1016/j.infbeh.2016.06.009

Malphurs, J. E., Raag, T., Field, T., Pickens, J., & Pelaez-Nogueras, M. (1996). Touch by intrusive and withdrawn mothers with depressive symptoms. *Early Development and Parenting, 5*(2), 111–115.

Mammen, M. A., Moore, G. A., Scaramella, L. V., Reiss, D., Shaw, D. S., Leve, L. D., & Neiderhiser, J. M. (2016). Infant patterns of reactivity to tactile stimulation during parent-child interaction. *Infant Behavior and Development, 44*, 121–132. doi:10.1016/j.infbeh.2016.06.004

Mantis, I., Mercuri, M., Stack, D. M., & Field, T. M. (Submitted). Depressed and non-depressed mothers' touching during social interactions with their infants. *Developmental Cognitive Neuroscience, Social Touch: A new vista for developmental cognitive neuroscience?*

Mantis, I., Stack, D. M., Ng, L., Serbin, L. A., & Schwartzman, A. E. (2014). Mutual touch during mother–infant face-to-face still-face interactions: Influences of interaction period and infant birth status. *Infant Behavior and Development*, *37*(3), 258–267. doi:10.1016/j.infbeh.2014.04.005

Mastergeorge, A. M., Paschall, K., Loeb, S. R., & Dixon, A. (2014). The still-face paradigm and bidirectionality: Associations with maternal sensitivity, self-esteem and infant emotional reactivity. *Infant Behavior and Development, 37*(3), 387–397. doi:10.1016/j.infbeh.2014.05.006

Mayes, L. C., & Carter, A. S. (1990). Emerging social regulatory capacities as seen in the Still-

Face situation. *Child Development, 61*(3), 754–763. doi:10.1111/j.1467-8624.1990.tb02818.x

McGlone, F., Cerritelli, F., Walker, S., & Esteves, J. (2017). The role of gentle touch in perinatal osteopathic manual therapy. *Neuroscience & Biobehavioral Reviews*, *72*, 1–9. doi:10.1016/j.neubiorev.2016.11.009

McQuaid, N. E., Bibok, M. B., & Carpendale, J. I. (2009). Relation between maternal contingent responsiveness and infant social expectations. *Infancy*, *14*(3), 390–401. doi:10.1080/15250000902839!955

Mesman, J., van IJzendoorn, M. H., & Bakermans-Kranenburg, M. J. (2009). The many faces of the Still-Face Paradigm: A review and meta-analysis. *Developmental Review, 29*(2), 120–162. doi:10.1016/j.dr.2009.02.001

Montagu, A. (1971). *Touching: The human significance of the skin.* New York: Columbia University Press.

Montagu, A. (1986). *Touching: The human significance of the skin* (3rd ed.). New York: Harper

Montirosso, R., & Provenzi, L. (2015). Implications of epigenetics and stress regulation on research and developmental care of preterm infants. *Journal of Obstetric, Gynecologic & Neonatal Nursing, 44*(2), 174–182. doi:10.1111/1552-6909.12559

Montirosso, R., Tronick, E., & Borgatti, R. (2016). Promoting neuroprotective care in neonatal intensive care units and preterm infant development: Insights from the neonatal adequate care for quality of life study. *Child Development Perspectives, 11*(1), 9–15. doi:10.1111/cdep.12208.

Moore, E. R., Anderson, G. C., Bergman, N., & Dowswell, T. (2007). Early skin-to-skin contact for mothers and their healthy newborn infants. *Cochrane Database System Rev, 3*(3), 1–75. doi:10.1002/14651858.CD003519.pub3.

Moszkowski, R. J., & Stack, D. M. (2007). Infant touching behaviour during mother–infant face-to-face interactions. *Infant and Child Development*, *16*(3), 307–319. doi:10.1038/srep09177

Moszkowski, R. J., Stack, D. M., & Chiarella, S. S. (2009). Infant touch with gaze and affective behaviors during mother–infant still-face interactions: Co-occurrence and functions of touch. *Infant Behavior and Development, 32*(4), 392–403. doi:10.1016/j.infbeh.2009.06.00

Muir, D., & Lee, K. (2003). The still-face effect: Methodological issues and new applications. *Infancy, 4*(4)*,* 483-491. doi:10.1207/S15327078IN0404_03

Neu, M., Laudenslager, M. L., & Robinson, J. (2008). Coregulation in salivary cortisol during maternal holding of premature infants. *Biological Research for Nursing*, *10*(3), 226–240. doi:10.1177/1099800408327789

Pearson, R. M., Melotti, R., Heron, J., Joinson, C., Stein, A., Ramchandani, P. G., & Evans, J. (2012). Disruption to the development of maternal responsiveness? The impact of prenatal depression on mother–infant interactions. *Infant Behavior and Development, 35*(4), 613-626. doi:10.1016/j.infbeh.2012.07.020

Peláez-Nogueras, M., Gewirtz, J. L., Field, T., Cigales, M., Malphurs, J., Clasky, S., & Sanchez, A. (1996). Infants' preference for touch stimulation in face-to-face interactions. *Journal of Applied Developmental Psychology*, *17*(2), 199–213. doi:10.1016/S0193-3973(96)90025-8

Pesonen, A. K., Räikkönen, K., Heinonen, K., Komsi, N., Järvenpää, A. L., & Strandberg, T. (2008). A transactional model of temperamental development: Evidence of a relationship between child temperament and maternal stress over five years. *Social Development, 17*(2), 326–340. doi:10.1111/j.1467-9507.2007.00427.x

Pettit, G. S., & Arsiwalla, D. D. (2008). Commentary on special section on "Bidirectional parent-child relationships: The continuing evolution of dynamic, transactional models of parenting and youth behavior problems". *Journal of Abnormal Child Psychology, 36*(5), 711–718. doi:10.1007/s10802-008-9242-8

Phillips, R. (2013). The sacred hour: Uninterrupted skin-to-skin contact immediately after birth. *Newborn and Infant Nursing Reviews, 13*(2), 67–72. doi:10.1053/j.nainr.2013.04.001

Provenzi, L., Borgatti, R., Menozzi, G., & Montirosso, R. (2015). A dynamic system analysis of dyadic flexibility and stability across the Face-to-Face Still-Face procedure: Application of the State Space Grid. *Infant Behavior and Development, 38,* 1-10. doi:10.1016/j.infbeh.2014.10.001

Robin, M. (1982). Neonate-mother interaction: Tactile contacts in the days following birth. *Early Child Development and Care, 9*(3-4), 221–236. doi:10.1080/0300443820090302

Rodholm, M., & Larsson, K. (1979). Father-infant interaction at the first contact after delivery. *Early Human Development, 3,* 21-27.

Rubin, R. (1963). Maternal Touch. *Nursing Outlook, 11*, 828–829.

Sameroff, A. (2009). *The transactional model of development: How children and contexts shape each other*. Washington, DC: American Psychological Association.

Sameroff, A. (2010). A unified theory of development: A dialectic integration of nature and nurture. *Child Development, 81*(1), 6–22. doi:10.1111/j.1467-8624.2009.01378.x

Scheu, U. (1979). Vi föds inte till flickor, vi görs till det., translated edition (translation into Swedish from German) Stockholm: Prisma.

Serbin, L.A., Kingdon, D., Ruttle, P.L., & Stack, D.M. (2015). The impact of children's internalizing and externalizing problems on parenting: Transactional processes and reciprocal change over time. Development and Psychopathology, 27(2015), 969-986. doi: 10.1017/S0954579415000632

Sharp, H., Pickles, A., Meaney, M., Marshall, K., Tibu, F., & Hill, J. (2012). Frequency of infant stroking reported by mothers moderates the effect of prenatal depression on infant behavioural and physiological outcomes. *PloS One, 7*(10), e45446. doi:10.1371/journal.pone.0045446

Stack, D. M. (2010). Touch and physical contact during infancy: Discovering the richness of the forgotten sense. In G. Bremner, & T. D. Wachs (Eds.), *The Wiley-Blackwell Handbook of Infant Development* (Vol. 1, pp. 532-567). Oxford, UK: Blackwell Publishing.

Stack, D. M., & Jean, A. D. (2011). Communicating through touch: Touching during parent-infant interactions. In M. J. Hertenstein & S. Weiss (Eds.), *The Handbook of Touch: Neuroscience, Behavioral, and Health Perspectives* (pp. 273–298).

Stack, D. M. & LePage, D. E. (1996). Infants' sensitivity to manipulation of maternal touch during face-to- face interactions. *Social Development, 5*(1), 41-55. doi:10.1111/j.1467-9507.1996.tb00071.x

Stack, D. M., LePage, D. E., Hains, S., & Muir, D. W. (1996). Qualitative changes in maternal touch as a function of instructional condition during face-to-face social interactions. *Infant Behavior and Development*, 19, 761. doi:10.1016/j.infbeh.2009.04.005

Stack, D. M., & Muir, D. W. (1990). Tactile stimulation as a component of social interchange: New interpretations for the still-face effect. *British Journal of Developmental Psychology, 8*(2), 131-154. doi: 10.1111/j.2044-835X.1990.tb00828.x

Stack, D. M., & Muir, D. W. (1992). Adult tactile stimulation during face-to-face interactions modulates 5-months-olds' affect and attention. *Child Development, 63*, 1509–1525. doi: 10.1111/j.1467-8624.1992.tb01711.x

Stifter, C. A., & Braungart, J. M. (1995). The regulation of negative reactivity in infancy: Function and development. *Developmental Psychology*, *31*(3), 448–455. doi:10.1037/0012-1649.31.3.448

Striano, T., & Bushnell, E. W. (2005). Haptic perception of material properties by 3-month-old infants. *Infant Behavior and Development*, *28*, 266–289. doi:10.1016/j.infbeh.2005.05.008

Tabachnick, B. G., & Fidell, L. S. (2001). Using multivariate analysis. California State University Northridge: Harper Collins College Publishers.

Toda, S., & Fogel, A. (1993). Infant response to the still-face situation at 3 and 6 months. *Developmental Psychology, 29*(3), 532-538. doi:10.1037/0012-1649.29.3.532

Trevathan, W. R. (1981). Maternal touch at 1st contact with the newborn infant. *Developmental Psychobiology, 14*(6), 549–558. doi:10.1002/dev.420140608

Tronick, E. Z. (2003). Things still to be done on the Still−Face Effect. *Infancy*, *4*(4), 475–482. doi:10.1207/S15327078IN0404_02

Tronick, E. Z., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). The infant's

response to entrapment between contradictory message in face-to-face interaction. *Journal of the American Academy of Child Psychiatry, 17*, 1–13. doi:10.1016/S0002-7138(09)62273-1

Underdown, A., Barlow, J., & Stewart-Brown, S. (2010). Tactile stimulation in physically healthy infants: Results of a systematic review. *Journal of Reproductive and Infant Psychology, 28*(1), 11–29. doi:10.1080/02646830903247209

Weiss, S. J., & Goebel, P. W. R. (2003). Parents' touch of their preterm infants and its relationship to their state of mind regarding touch. *Journal of Prenatal & Perinatal Psychology & Health, 17*(3), 185–202.

Wiberg, B. (1990). *The first hour of life and mother-infant behaviour and development of their mutual relationship* (Doctoral dissertation). Umeå: Umeå Universitet.

Winberg, J. (2005). Mother and newborn baby: mutual regulation of physiology and behavior: A selective review. *Developmental Psychobiology, 47*(3), 217–229. doi:10.1002/dev.20094

Table 1

Means and standard errors for the percent duration and relative frequencies of mothers' and fathers' touching behaviours immediately after birth.

	Mother		Father		Total		Range	
Type of Touch	*M*	*SE*	*M*	*SE*	*M*	*SE*	Minimum	Maximum
Static								
Relative Frequency	.17	.04	.06	.04	.11	.03	.00	.75
Percent Duration	2.13	.60	.49	.60	1.31	.44	.00	12.68
Stroke/Caress								
Relative Frequency	1.22	.17	.26	.07	.74	.12	.00	2.66
Percent Duration	8.85	1.94	1.12	1.94	5.39	.99	.00	25.78
Kissing								
Relative Frequency	.05	.02	.00	.00	.03	.01	.00	.28
Percent Duration	.08	.02	.00	.02	.04	.02	.00	.45
Holding								
Relative Frequency	.37	.08	.00	.00	.19	.05	.00	1.19
Percent Duration	16.39	3.60	.44	3.60	8.41	2.80	.00	70.48
Massage/Rub								
Relative Frequency	.09	.02	.02	.01	.06	.01	.00	.28
Percent Duration	1.04	.20	.15	.20	.59	.15	.00	3.80
Rocking								
Relative Frequency	.01	.00	-	-	.29	.14	.00	2.00
Percent Duration	.00	.00	-	-	.05	.02	.00	.30
Blowing								
Relative Frequency	-	-	.00	.00	-	-	.00	.00
Percent Duration	-	-	.00	.00	-	-	.00	.00
Palmar Grasp Reflex								
Relative Frequency	.01	.00	.00	.00	.01	.00	.00	.09
Percent Duration	.25	.10	.00	.10	.13	.07	.00	2.08
Utilitarian/Instrumental								
Relative Frequency	.42	.07	.08	.03	.25	.05	.00	1.53
Percent Duration	2.13	.29	.51	.29	1.32	.24	.00	5.97
Other								
Relative Frequency	.13	.04	.02	.00	.07	.02	.00	.58
Percent Duration	1.13	.35	.07	.35	.60	.26	.00	7.08

Note. Rocking category was only coded for mothers, and Blowing category was only coded for fathers.

Table 2

Passive and Active Touch Categories

Passive	Active
Static	Squeeze/ Pinch/ Grasp
Stroke/ Caress/ Rub/ Massage	Tickle/ Fingerwalk/ Prod/ Poke/ Push
Pat/ Tap	Pull/ Lift/ Extension/ Clap
Other	Shake/ Wiggle

Note. Categorization consistent with Mantis et al., 2017, submitted for publication.

Table 3

Means and standard errors for the relative frequencies and percent durations of infants' touching behaviours at 3-months postpartum.

	Normal Period		Reunion Period	
Type of Touch	*M*	*SE*	*M*	*SE*
Static				
Relative Frequency	7.04	.56	8.41	.89
Percent Duration	5.10	2.94	8.18	4.00
Rub/Caress/Wipe/Stroke				
Relative Frequency	4.23	.60	3.18	.78
Percent Duration	6.55	1.10	9.96	1.92
Grasping/Clutching/Clasping				
Relative Frequency	5.61	1.31	4.09	.74
Percent Duration	30.74	6.13	24.54	5.55
Manipulating/Fingering/Scrumble/Poke/Prod				
Relative Frequency	3.73	.73	3.82	.88
Percent Duration	7.20	1.78	6.96	3.37
Mouthing				
Relative Frequency	.81	.24	.20	.09
Percent Duration	3.95	1.73	1.20	.75
Tap/Pat				
Relative Frequency	3.78	.54	5.13	1.03
Percent Duration	.65	1.21	1.91	1.29
Pull/Push/Clap/Lift				
Relative Frequency	3.37	.64	2.84	.56
Percent Duration	2.66	1.65	1.45	1.56
Total				
Relative Frequency	27.27	2.29	27.68	3.68
Percent Duration	86.88	3.83	87.21	3.07

Table 4

Means and standard errors for relative frequencies and percent durations of mothers' touching behaviours at 3-months postpartum.

	Normal Period		Reunion Period	
Type of Touch	*M*	*SE*	*M*	*SE*
Static				
Relative Frequency	2.34	.57	3.35	.89
Percent Duration	24.65	2.94	31.1	4.00
Stroke/Caress/Rub/Massage				
Relative Frequency	3.45	.60	4.75	.78
Percent Duration	4.75	1.10	4.22	1.92
Squeeze/Pinch/Grasp				
Relative Frequency	8.65	1.31	5.16	.74
Percent Duration	34.85	6.13	21.70	5.55
Tickle/Fingerwalk/Poke/Prod/Push				
Relative Frequency	4.18	.73	3.83	.88
Percent Duration	7.69	1.78	15.99	3.37
Other				
Relative Frequency	3.23	.48	3.73	.93
Percent Duration	11.49	2.27	10.20	3.02
Pat/Tap				
Relative Frequency	.79	.54	1.41	1.30
Percent Duration	4.83	1.21	6.30	1.29
Pull/Push/Lift/Extension/Clap				
Relative Frequency	.83	.64	.50	.56
Percent Duration	8.35	1.65	6.69	1.56
Shake/Wiggle				
Relative Frequency	2.99	.81	1.23	.32
Percent Duration	6.85	1.67	3.38	1.16
Total				
Relative Frequency	24.65	2.80	23.95	2.25
Percent Duration	68.50	5.58	66.58	5.24

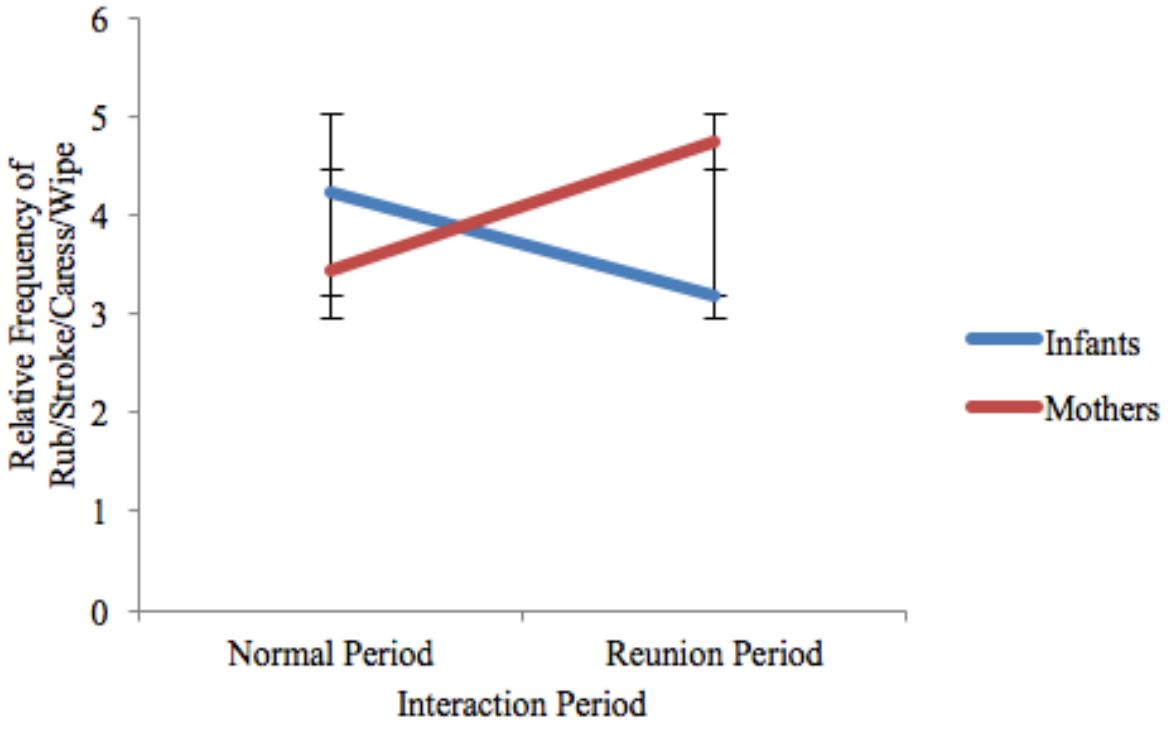

Figure 1. A statistically significant period (normal, reunion) by partner (infant, mother) interaction for the frequency of Rub/Massage/Stroke/Caress/Wipe. During the normal period, infants utilized Rub/Massage/Stroke/Caress/Wipe more frequently than mothers. However, the opposite was found during the reunion period.

Chapter 3: Study 2

Abstract: Study 2

Maternal and Infant Touch During Mother-Infant Interactions Across Time

Given that touch is a primary and fundamental means of communication between mothers and their infants during the early stages of infancy, the present study examined the quantitative and qualitative aspects of mothers' and infants' specific touching behaviours, and how they change from 3- to 5-months postpartum. Twelve mothers and their full-term infants participated in two five-minute naturalistic face-to-face interactions: one occurring when infants were 3-months-old, and another at 5-months-old. Maternal and infant touching behaviours were video recorded and coded using the Caregiver Infant Touch Scale (CITS; Stack et al., 1996) and the Infant Touch Scale (ITS; Moszkowski & Stack, 2007), respectively.

Results revealed significant differences between mothers and infants in regards to their use of touch, as well as significant differences in their touch over time. When comparing infants and mothers to one another, mothers demonstrated higher durations of touch overall. Mothers also spent more time engaging in active types of touch than infants overall. However, both infants and mothers increased their use of active touch from 3- to 5-months. Moreover, infants were found to decrease the frequency of their passive touch from 3- to 5-months, whereas mothers' passive touch remained stable over time. These results contribute to our understanding of how mothers and infants use touch over the course their interactions as well as how this progresses from 3- to 5-months of life.

Maternal and Infant Touch During Mother-Infant Interactions Across Time

The importance of touch in regards to infant development has been well established (Field, 2014; Gallace & Spence, 2016; Stack, 2010). Touch has been found to effectively diminish infant distress (Feldman, Singer, & Zagoory, 2010; Jean, Stack, & Arnold, 2014; Stack & Muir, 1990; 1992; Peláez-Nogueras, Field, Hossain, & Pickens, 1996), facilitate parent-infant bonding and attachment (Anisfeld & Lipper, 1983; Greenberg & Morris, 1974; Moore, Anderson, Bergman, & Dowswell, 2007; Wiberg, 1990), regulate infant breathing, temperature, and salivary cortisol levels (Acosta, 2016; Winberg, 2005; Neu, Laudenslager, & Robinson, 2008), and support the maturation of the prefrontal cortex (Feldman, Rosenthal, & Eidelman, 2014). As such, touch is integral to the infant's emotional, social, physical, and neurological growth, highlighting the necessity of studying the development of touch and how it may change over the course of the first year of life. Because touch is a primary and fundamental means of communication between mothers and their infants (Herrera, Reissland, & Shepherd, 2004; Mantis, Stack, Ng, Serbin, & Schwartzman, 2014), mothers are infants' most common and significant social partners (Biringen, Derscheid, Vliegen, Closson, & Easterbrooks, 2014), and the mother-infant relationship is the first to develop (Lund, 2016; Menashe & Atzaba-Poria, 2016). Consequently, the context of the mother-infant interaction is a primary context within which to study touch (Stack & Jean, 2011; Perez & Gewirtz, 2004).

During any given interaction, mothers and infants regularly and frequently touch one another using different types of touch, including caressing, stroking, kissing, patting, tapping, and squeezing, each lasting for varying lengths of time (Hertenstein, 2002; Stack, 2010). Accordingly, touch is deemed a dynamic, complex, and multidimensional modality (Hertenstein, 2002; Stack, 2010; Stack & Jean, 2011). Still, previous investigations of maternal and infant

touch have either regarded touch as a one-dimensional construct (i.e., overall or total touch), or categorized touching behaviours into global constructs (for example, affectionate, stimulating, or instrumental touch; Ferber, Feldman, & Makhoul, 2008; Stack, 2010; Moszkowski, Stack, Girouard, Field, Hernandex-Reif, & Diego, 2009). Researchers have thus rarely described mothers' and infants' touching behaviours beyond broad and general terms. As such, descriptions of touch remain ambiguous and relatively undefined, and the amount and types of touch infants and mothers utilize during their interactions are still unclear (Field, 2010).

The few studies (i.e., Jean, Stack, & Fogel, 2009; Moszkowski et al., 2009; Stack & Muir, 1990) that have examined mothers' and infants' individual touching behaviours during mother-infant interactions have revealed that mothers and infants do in fact engage in a diverse range of touching behaviours that vary according to the nature of the interactive context and the infant's age. With regard to the interactive context, mothers have been found to use more touch in general, and more static touch, when infants are seated on their lap than when seated on the floor; when on the floor, mothers have been found to use more tickling and shaking behaviours (Jean, Stack, & Fogel, 2009). Infants have been found to use more reactive (pulling, patting) types of touch during a face-to-face interaction in which their mothers displayed a still or neutral facial expression (Moszkowski et al., 2009). Moreover, mothers have been found to demonstrate a decrease in the duration of nurturing types of touch (i.e., stroking) as their infants age (Jean, et al., 2009). A small number of studies have also revealed that certain types of touch, such as massage and stroking, are beneficial to infants' physical and emotional well-being (Mantis, Mercuri, Stack, & Field, submitted; Elliott, Reilly, Drummond & Letourneau, 2002; Underdown, Barlow & Stewart-Brown, 2010). These findings underscore the significance of investigating specific rather than general types of touch, including the qualitative variations of touch, while

considering the age of infants and quality of the physical and social environment in which the interaction takes place. Investigations of the like are essential to our understanding of how mothers and infants employ touch over the course of mother-infant interactions.

To date, investigations of touch during mother-infant interactions have also largely assessed touch from a unidirectional perspective. That is, studies have mostly examined *either* maternal *or* infant touch, but not both (Mantis et al, 2014). Yet, both mothers and their infants contribute to and shape their interactions through touch (Mantis et al., 2014). Given the inherent reciprocity that is characteristic of mother-infant interactions (Doiron & Stack, in press), and that mothers and infants are responsive and sensitive to one another's behaviours, it is important to investigate changes in maternal and infant touch concurrently and during the same interaction (Cohn & Tronick, 1988; Beebe, Messinger, Bahrick, Margolis, Buck, & Chen, 2016; Petit & Arsiwalla, 2008; Fogel, 1992; Fogel, 1993; Menashe & Atzaba-Poria, 2016).

Finally, most investigations of touch have used cross-sectional designs (Stack & Jean, 2011). However, as the infant's motor abilities continue to develop with age, the infant's touching behaviours are expected to evolve. Longitudinal designs of touch must thus be employed in order to assess how maternal and infant touch change with age (Widom, Raphael, & DuMont, 2004), and how touch develops in general. The first 6-months of the infant's life in particular is a time in which touch is crucial to mother-infant interactions; touch is the most developed communicative modality in the infant at this time and thus the infant's primary channel of communication (Kaye & Fogel, 1980; Field, 2010). Because the typical trajectory of the development of touch within the context of mother-infant interactions is still relatively unknown, an investigation of such is warranted. Jean and her colleagues (2009) took the first steps in establishing the progression of touch, as they examined maternal touch across the first 5-

months of life. The current study builds upon their work, as it examined *both* mothers' and infants' use of touch across this time.

The present study was designed to address the apparent gaps in the mother-infant touch literature described above. The primary objective of the present study was to investigate the *specific* touching behaviours, considering the amount (frequency, duration) and individual types of touch, of both mothers and their infants during mother-infant interactions. Further, the current study sought to investigate the change and stability of the amount and type of mothers' and infants' touch as a function of infants' age, and how mothers and infants differ from one another in regards to their use of touch. The aim of the present study was thus to obtain a more complete understanding of how mothers and infants use touch to contribute to their interactions, as well as how this progresses from 3- to 5- months of life.

Method

Twelve mothers and their full-term infants participated in the current study. Participants were recruited through birth announcements published in local newspapers in a Midwestern community in the USA. Eight infants were male, and four infants were female. Mothers were aged 21 years and older, had a high school level of education or higher, and came from intact middle-class families. All mothers were Caucasian, with the exception of one mother, who was African-American (Jean et al., 2009; Hsu, & Fogel, 2001; 2003).

Dyads were videotaped at two different time points. During the first time point, infants were approximately 3-months-old, and their ages ranged from 13 to 14 weeks old (Time 1). During the second time point, infants were approximately 5-months old, and their ages ranged from 22 to 23 weeks old (Time 2). These ages were selected because infants have been found to be effective communicators through touch, and to be responsive and sensitive to their mothers'

touch, at this time (Kaye & Fogel, 1980). At both time points, mothers and their infants engaged in a face-to-face interaction. Mothers sat on a straight chair with their infants on their laps and were asked to play with them as they would normally at home. Interactions lasted for 5 minutes.

Apparatus

Videotapes were made with three wall-mounted cameras. Videotapes were later digitized and transferred onto a computer. The video recordings were reviewed for behavioral coding using a professional software system for behavioural research, Mangold INTERACT 9.0, which allows live second-by-second qualitative and quantitative analysis of multimedia data.

Observational Coding

Maternal touch was coded second-by-second using the Caregiver-Infant Touch Scale (CITS; Stack, LePage, Hains, & Muir, 1996; Jean et al., 2009; Stack, 2010), a measure of qualitative and quantitative changes in tactile stimulation produced by caregivers during interactions with their infants. The CITS consists of 8 categories of touch: (1) static touch, (2) stroke/caress/rub/massage, (3) pat/tap, (4) squeeze/pinch/grasp, (5) tickle/finger-walk/prod/poke/push, (6) shake/wiggle, (7) pull/lift/extension/clap, and (8) other (i.e., wiping infant's mouth or noise, adjusting infant's posture or clothing, kissing, etc.).

Infant touch was coded second-by-second using the Infant Touch Scale (ITS; Moszkowski & Stack, 2007), a measure of qualitative and quantitative changes in tactile stimulation produced by infants during interactions with their caregivers. The ITS consists of 7 categories of touch: (1) static touch, (2) rub/caress/wipe/stroke, (3) grasping/clutching/clasping, (4) manipulating/fingering/scrumble/poke/prod, (5) mouthing, (6) pat/tap, (7) pull/push/clap/lift. Refer to Appendix B for brief descriptions of the coding categories within the CITS and ITS.

The CITS and the ITS are reliable and systematic coding systems. Inter-rater reliability was obtained among coders; one coder was blind to the hypotheses of the current study, and reliability was determined using kappa coefficients for 15-30% of the sample. A very high inter-rater reliability was determined for both the CITS (k = .90) and the ITS (k = .92).

Statistical Analyses

Data were screened for integrity and to ensure that the assumptions of repeated measures ANOVAs were met within the current sample. The data cleaning process involved checking for outliers, or scores more than 3 standard deviations away from the mean. Standardized scores were used to identify outliers. Outliers were retained and adjusted for by changing their values to the next highest score (Tabachnick & Fidell, 2001; Kline, 2009).

A series of 2 x 2 mixed analyses of variance (ANOVA) and mixed multivariate analysis of variance (MANOVA) were conducted. For each analysis, partner (mother, infant) was the between subjects variable and time (Time 1: 3-months postpartum, Time 2: 5-months postpartum) was the within subjects variable. The dependent variable(s) included the type of touch displayed by mothers and their infants. Type of touch included the overlapping categories of touch coded between the CITS and ITS (see Table 1), as well as overall (total) touch, which was a composite value computed by combining (adding) all possible types of touch. For a portion of the analyses, specific touching behaviours were categorized as either passive or active touch (see Table 2). Passive touch included those types of touch that involved minimal amount of effort. Active touch included those types of touch that were more effortful. Previous investigations utilizing this categorization of passive and active types of touch have yielded meaningful findings (i.e., Mantis et al., submitted; Moszkowski & Stack, 2007; Moszkowski et al., 2009).

Percent durations and relative frequencies for each type of touch were used as dependent variables for each of the analyses. Percent duration refers to the percentage of time over the length of the interaction for each dyad that was allocated to a specific type of touch. It is calculated by dividing the raw duration of a specific touch divided by the length of the corresponding interaction period (and multiplied by 100). Relative frequency refers to the proportionalized frequency as a function of the length of the interaction period. This was calculated by dividing the raw frequency of a specific touch by the total length of the corresponding interaction period (multiplied by 100). The percent durations and relative frequencies were calculated for each type of touch to control for differences in the length of the interaction periods at each interaction time point and across dyads (Herrera, Reissland, & Shepard, 2004). Results were considered statistically significant at a critical alpha level of .05 and partial eta squared (partial η^2) was reported as a measure of effect size. Statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS, version 18.0).

Results

Overall (Total) Touch: Relative Frequency and Percent Duration

A 2 x 2 (partner x age) mixed ANOVA was conducted to investigate the effects of age and partner on the relative frequency of overall touching behaviours (that is, the composite of all individual types of touch). No significant main effects of partner or age were found, nor was there a significant partner by age interaction.

A 2 x 2 (partner x age) mixed ANOVA was conducted to investigate the effects of age and partner on the percent duration of overall touching behaviours (that is, the composite of all individual types of touch). Results revealed a significant main effect of partner, $F(1, 23)) = 43.83$, $p = .000$, partial $\eta^2 = .66$; across age, mothers ($M = 99.08$, $SE = 3.69$) spent significantly

more time engaging in touch than did infants (M = 65.15, SE = 3.55). There was no main effect of age, nor was there a significant partner by age interaction.

Passive and Active Touch: Relative Frequency and Percent Duration

Passive

A 2 x 2 (partner x age) mixed ANOVA was conducted to investigate the effects of age and partner on the relative frequency of passive touch. No significant main effects of partner or age were found, nor was there a significant partner by age interaction.

A 2 x 2 (partner x age) mixed ANOVA was conducted to investigate the effects of age and partner on the percent duration of passive touch. A significant main effect of partner was found, $F(1, 23) = 15.71$, $p = .001$, partial $\eta^2 = .41$; mothers (M = 52.26, SE = 3.54) spent more time engaged in passive types of touch than their infants (M = 32.80, SE = 3.40) overall. Moreover, a significant age by partner interaction was found, $F(1, 23) = 5.53$, $p = .028$, partial $\eta^2 = .19$ (Figure 1). Specifically, infants demonstrated a significant decrease in the duration of their passive touch from 3-months (M = 42.41, SE = 5.52) to 5-months (M = 23.19, SE = 3.37), whereas mothers demonstrated similar levels of this type of touch from 3-months (M = 51.48, SE = 5.75) to 5-months (M = 53.05, SE = 3.50).

Active

A 2 x 2 (partner x age) mixed ANOVA was conducted to investigate the effects of age and partner on the relative frequency of active touch. A significant main effect of age was found, $F(1, 23) = 5.36$, $p = .030$, partial $\eta^2 = .19$, in that mothers and infants demonstrated an increase in the frequency of active touching behaviours from 3-months (M = 5.66, SE = .69) to 5-months (M = 12.26, SE = 2.94). No significant main effect of partner or partner by age interaction were found.

A 2 x 2 (partner x age) mixed ANOVA was conducted to investigate the effects of age and partner on the percent duration of active touch. Results revealed a significant main effect of age, $F(1, 23) = 14.27$, $p = .001$, partial $\eta^2 = .38$; mothers and infants spent more time utilizing active types of touch at 5-months ($M = 30.34$, $SE = 3.19$) than at 3-months ($M = 16.76$, $SE = 2.85$). A significant main effect of partner was also found, $F(1, 23) = 5.33$, $p = .030$, partial $\eta^2 = .19$; overall, mothers ($M = 28.98$, $SE = 3.27$) spent more age engaging in active types of touch than their infants ($M = 18.53$, $SE = 3.14$). Table 3 provides the means and standard errors associated with these analyses.

Individual Types of Touch: Relative Frequency and Percent Duration

A 2 x 2 (partner x age) mixed multivariate analysis of variance (MANOVA) was performed to investigate the effects of age and partner on 6 dependent variables: the relative frequency of static touch, stroke/caress/rub, pat/tap, grasp, poke/prod, and pull/lift/clap. Results revealed a statistically significant main effect of age (F (6, 18) = 4.34, $p = .007$; Wilk's $\Lambda = .409$, partial $\eta^2 = .56$), and a statistically significant main effect of partner (F (6, 18) = 14.52, $p = .000$; Wilk's $\Lambda = .172$, partial $\eta^2 = .83$) on the composite of these touching behaviours. Univariate ANOVAs revealed the effects of age and partner on the frequency of each individual type of touch; these results are reported in Table 4. Table 5 provides the means and standard errors associated with these analyses. Moreover, while an age by partner interaction was not found ($F(6, 18) = 1.44$, $p = .254$, *n.s.*) on the composite of these touching behaviours, univariate ANOVAs revealed an age by partner interaction for Static ($F(1, 23) = 4.29$, $p = .050$, partial $\eta^2 = .16$) was found; mothers ($M = 7.21$, $SE = .99$) and infants ($M = 7.69$, $SE = .95$) did not differ in the frequency of their static touch at 3-months, but mothers ($M = 19.73$, $SE = 5.59$) used this type of touch more frequently than infants ($M = 4.75$, $SE = 5.37$) at 5-months. Furthermore, an

age by partner interaction for Pull ($F(1, 23) = .42$, $p = .012$, partial $\eta^2 = .24$) was found; the frequency of pull increased from 3-months ($M = 4.42$, $SE = .69$) to 5-months ($M = 11.49$, $SE = 1.82$) for mothers, but remained the same from 3-months ($M = .11$, $SE = .66$) to 5-months ($M = .04$, $SE = 1.75$) for infants.

A 2 x 2 (partner x age) mixed MANOVA was performed to investigate the effects of age and partner on 6 dependent variables: the percent duration of static touch, stroke/caress/rub, pat/tap, grasp, poke/prod, and pull/lift/clap. Results revealed a statistically significant main effect of age (F (6, 18) = 3.50, $p = .019$; Wilk's $\Lambda = .464$, partial $\eta^2 = .54$), a statistically significant main effect of partner (F (6, 18) = 27.98, $p = .000$; Wilk's $\Lambda = .097$, partial $\eta^2 = .90$), and a statistically significant age by partner interaction (F (6, 18) = 4.19 $p = .008$; Wilk's $\Lambda = .417$, partial $\eta^2 = .58$) on the composite of these touching behaviours. Univariate ANOVAs revealed the effects of age and partner on the percent durations of Pull and Stroke, as well as all other individual types of touch; these results are reported in Table 6. Table 7 provides the means and standard errors associated with these analyses.

Discussion

The current study was designed to investigate how both mothers and infants utilize touch during early face-to-face interactions, how mothers and infants compare in the quantity (frequency, duration) and quality (type) of their touching behaviours, and how their touching behaviours change over time. Thus, we examined changes in specific touching behaviours among mothers and their infants during face-to-face mother-infant interactions across time at 3- and 5-months.

The results revealed that both mothers and infants engage in a number of touching behaviours, and both partners contribute to their interactions using a variety of types of touch.

However, mothers and infants appear to differ in a few important ways regarding how and how much they use touch to contribute to their social exchanges; such differences also appear to change as a function of the infant's age. In general, mothers were found have spent more time using active touch than their infants. When considering overall touch (i.e., total touch), mothers spent more time touching than their 3-month-old infants. More specifically, mothers spent more time pulling, lifting, and clapping, and patting and tapping than their infants did at this time, and used these type of touch more frequently than 3-month-old infants as well. While mothers and infants used similar amounts of static touch (in terms of both frequency and duration) at 3-months, mothers used more of this touch than infants at 5-months. In contrast, while mothers and infants employed similar levels of grasping at 3-months, infants grasped for longer than mothers at 5-months. These results suggest that given that mothers' fine motor abilities are more developed and refined compared to infants, mothers demonstrated a wider range of touching behaviours than their infants and were more sophisticated when using touch to communicate with their infants.

Taken together, it is clear that both mothers and infants display a wide range of touching behaviours during their interactions, which they display at varying frequencies and durations, depending on the age of their infant at the time of their interaction. This is consistent with findings from previous studies demonstrating the variability of maternal (Jean et al., 2009) and infant (Moszkowski et al., 2009) touch. Our study adds to the present literature by documenting that, although infants are much younger in age than their mothers, infants are capable of demonstrating some of the same kinds of touching behaviours. Furthermore, the amount of touch infants display is not only comparable to that of mothers, but in some cases supersedes the amount of touch their mothers display (i.e., infants' grasping at 5-months). It is thus apparent

that infants are extremely competent in their ability to use touch and to communicate through touch. As such, these findings underscore that touch is a well-developed and critical form of communication during infancy.

The findings of the present study also indicated that mothers' and infants' touching behaviours do in fact change over time. For example, mothers demonstrated increases in their uses of static touch (frequency and duration), pulling (frequency and duration) and poke/prod (duration only), whereas infants demonstrated increases in the duration of time spent grasping and decreases in the duration of their static touch over time. Both mothers and infants demonstrated significant increases in the frequency and duration of their active touch from 3- to 5- months postpartum. Correspondingly, infants utilized passive touch less frequently as they aged. In summary, it appears that both mothers and infants become more active in their use of touch over time. This change in infant touch reflects how infants become increasingly engaged and active during their interactions over the course of the first year of life (Evans & Porter, 2009). Such a change in maternal and infant touch may also be reflective of the fact that mother-infant interactions become increasingly more playful as infants age (Field, 2010). Further, while the mutual coordination of mother-infant gaze and vocalizations during early mother-interactions have been established (Harder, Lange, Hansen, Væver, & Køppe, 2015; Feldman & Eidelman, 2007), these findings may provide evidence for increased coordination and symmetry within the tactile modality (Cohn & Tronick, 1988; Evans & Porter, 2009). Better coordination and symmetry are to be expected at this time, given that infants show more refined fine motor coordination and responses moving into the second 6-months of life (Field, 2010), as well as more sophisticated visual motor integration (Lavelli & Fogel, 2005).

The abovementioned findings regarding active touch indicate that there are similarities in terms of the development of maternal and infant touch during mother-infant interactions between 3- and 5-months. Nonetheless, the respective differences in the progression of maternal and infant touch across time should not be overlooked. Indeed, mothers maintained the same percent duration of passive touch, but infants demonstrated a decrease in passive touch during their interactions across time. Alternatively, Ferber, Feldman, and Makhoul (2008) found that mothers decrease all forms of touch, including those more characteristically passive (i.e. affectionate), across the first year of life. To our knowledge, the present study was the first to assess in infants' touch from 3- to 5-months of age, thereby hindering our ability to make comparisons with findings from previous studies regarding infant touch. Our findings therefore represent a significant contribution to the current literature, as the typical trajectory of the development of touch within the context of mother-infant interactions has been vastly overlooked to date. This is an important area of study considering that touch patterns undergo significant development during the first year of life (Feldman, 2011). Finally, these findings highlight the importance of investigating touch from multiple parameters, as the development of the frequency and the duration of touch are not necessarily parallel. Therefore, these results support the notion that touch is a dynamic, complex, and multidimensional construct (Herstenstein, 2002; Stack, 2010; Stack & Jean, 2011; Ferber et al., 2008).

Our study was an important first step in understanding how maternal and infant touch develops over time. The small sample size of the current study, and the fact that touch was assessed at only two time points, however, limits the generalizability of our findings and represents areas in which future investigators may expand upon. Given the predominance of touch during early mother-infant interactions (Moszkowski & Stack, 2007), it is essential to

understand how maternal and infant touch continues to change beyond 5-months. Future research should thus seek to replicate our findings with a larger sample size, and with an expanded age range that spans the first year of life (Jean et al., 2009). Despite these limitations, in all of the ways discussed above, this study makes a unique contribution to the touch literature. It was the first to consider the full range of maternal and infant touching behaviour displayed by mothers and infants simultaneously and across time, thereby providing valuable insight into how both mothers and infants actively contribute to and shape their social exchanges. Consequently, our findings have important implications for the design of preventative interventions and parenting programs with early touch stimulation.

References

Acosta, A. C. A. (2016). *Impact de trois interventions: Méthode Mère Kangourou, Massage en Incubateur et Massage en Position Kangourou sur la croissance et le développement des enfants prématurés nés à moins de 33 semaines d'âge gestationnel* (Unpublished doctoral dissertation). Université Laval, Québec, QC.

Anisfeld, E., & Lipper, E. (1983). Early contact, social support, and mother-infant bonding. *Pediatrics, 72*(1), 79–83. doi:10.1097/00004583-198311000-00021

Beebe, B., Messinger, D., Bahrick, L. E., Margolis, A., Buck, K. A., & Chen, H. (2016). A systems view of mother–infant face-to-face communication. *Developmental Psychology, 52*(4), 556–571. doi:10.1037/a0040085

Biringen, Z., Derscheid, D., Vliegen, N., Closson, L., & Easterbrooks, M. A. (2014). Emotional availability (EA): Theoretical background, empirical research using the EA Scales, and clinical applications. *Developmental Review, 34*(2), 114–167. doi:10.1016/j.dr.2014.01.002

Cohn, J. F., & Tronick, E. Z. (1988). Mother-infant face-to-face interaction: Influence is bidirectional and unrelated to periodic cycles in either partner's behavior. *Developmental Psychology, 24*(3), 386–392.

Doiron, K. M., & Stack, D. M. (In press). Coregulation and the quality of the relationship in full-term and very low-birthweight preterm infant-mother dyads during face-to-face interactions. *Infancy,* 1-17. doi:10.1111/infa.12187

Elliott, M. R., Reilly, S. M., Drummond, J., & Letourneau, N. (2002). The effect of different soothing interventions on infant crying and on parent–infant interaction. *Infant Mental Health Journal*, *23*(3), 310–328. doi:10.1002/imhj.10018

Evans, C. A., & Porter, C. L. (2009). The emergence of mother–infant co-regulation during the first year: Links to infants' developmental status and attachment. *Infant Behavior and Development, 32*(2), 147–158. doi:10.1016/j.infbeh.2008.12.005

Feldman, R. (2011). Maternal touch and the developing infant. In M. J. Hertenstein & S. J. Weiss (Eds.), *The Handbook of Touch: Neuroscience, Behavioral, and Health Perspectives* (pp. 373–407). New York: Springer Publishing.

Feldman, R., & Eidelman, A. I. (2007). Maternal postpartum behavior and the emergence of infant-mother and infant-father synchrony in preterm and full-term infants: The role of neonatal vagal tone. *Developmental Psychobiology, 49*(3), 290–302. doi:10.1002/dev.20220

Feldman, R., Rosenthal, Z., & Eidelman, A. I. (2014). Maternal-preterm skin-to-skin contact enhances child physiologic organization and cognitive control across the first 10 years of life. *Biological Psychiatry, 75*(1), 56–64. doi:10.1016/j.biopsych.2013.08.012

Feldman, R., Singer, M., & Zagoory, O. (2010). Touch attenuates infants' physiological reactivity to stress. *Developmental Science, 13*(2), 271–278. doi:10.1111/j.1467-7687.2009.00890.x

Ferber, S. G., Feldman, R., & Makhoul, I. R. (2008). The development of maternal touch across the first year of life. *Early Human Development, 84*(6), 363–370. doi:10.1016/j.earlhumdev.2007.09.019

Field, T. (2010). Touch for socioemotional and physical well-being: A review. *Developmental Review, 30*(4), 367–383. doi:10.1016/j.dr.2011.01.001

Field, T. M., Ed. (2014). *Touch in early development*. New York (NY): Psychology Press

Fogel, A. (1992). Movement and communication in human infancy: The social dynamics of development. *Human Movement Science, 11*, 387–423.

Fogel, A. (1993). *Developing through relationships: Origins of communication, self, and culture*. Chicago, IL: University of Chicago Press.

Gallace, A., & Spence, C. (2016). Social touch. In H. Olausson, J. Wessberg, I. Morrison, & F. McGlone (Eds.), *Affective Touch and the Neurophysiology of CT Afferents* (pp. 227–238). New York: Springer.

Greenberg, M., & Morris, N. (1974). Engrossment: The newborn's impact upon the father. *American Journal of Orthopsychiatry, 44*(4), 520–531. doi:10.1111/j.1939-0025.1974.tb00906.x

Harder, S., Lange, T., Hansen, G. F., Væver, M., & Køppe, S. (2015). A longitudinal study of coordination in mother–infant vocal interaction from age 4 to 10 months. *Developmental Psychology, 51*(12), 1778–1790. doi:10.1037/a0039834

Herrera, E., Reissland, N., & Shepherd, J. (2004). Maternal touch and maternal child-directed speech: Effects of depressed mood in the postnatal period. *Journal of Affective Disorders, 81*(1), 29–39. doi:10.1016/j.jad.2003.07.001

Hertenstein, M. J. (2002). Touch: Its communicative functions in infancy. *Human Development*, *45*(2), 70–94. doi:10.1159/000048154

Hsu, H. C., & Fogel, A. (2001). Infant vocal development in a dynamic mother-infant communication system. *Infancy, 2*(1), 87–109.

Hsu, H. C., & Fogel, A. (2003). Stability and transitions in mother-infant face-to-face communication during the first 6 months: A microhistorical approach. *Developmental psychology, 39*(6), 1061–1082.

Jean, A. D., Stack, D. M., & Arnold, S. (2014). Investigating maternal touch and infants' self-regulatory behaviours during a modified face-to-face Still-Face with touch procedure. *Infant and Child Development, 23*(6), 557–574. doi:10.1002/icd.1870

Jean, A. D., Stack, D. M., & Fogel, A. (2009). A longitudinal investigation of maternal touching across the first 6 months of life: Age and context effects. *Infant Behavior and Development*, *32*(3), 344–349. doi:10.1002/icd.1870

Kaye, K., & Fogel, A. (1980). The temporal structure of face-to-face communication between mothers and infants. *Developmental Psychology, 16*(5), 454–464. doi:10.1037/0012-1649.16.5.454

Kline, R. B. (2009). *Becoming a behavioural researcher: A guide to producing research that matters.* New York, NY: Guilford Press.

Lavelli, M., & Fogel, A. (2005). Developmental changes in the relationship between the infant's attention and emotion during early face-to-face communication: The 2-month transition. Developmental psychology, 41(1), 265–280. doi: 10.1037/0012-1649.41.1.265

Lund, C. (2016). Issues in Newborn Skin Care. *Advances in Neonatal Care: Official Journal of the National Association of Neonatal Nurses,* 16*(5S)*, S1-S2. doi:10.1097/ANC.0000000000000346

Mantis, I., Mercuri, M., Stack, D. M., & Field, T. M. (Submitted). Depressed and non-depressed mothers' touching during social interactions with their infants. *Developmental Cognitive Neuroscience, Social Touch: A new vista for developmental cognitive neuroscience?*

Mantis, I., Stack, D. M., Ng, L., Serbin, L. A., & Schwartzman, A. E. (2014). Mutual touch

during mother–infant face-to-face still-face interactions: Influences of interaction period and infant birth status. *Infant Behavior and Development*, *37*(3), 258–267. doi:10.1016/j.infbeh.2014.04.005

Menashe, A., & Atzaba-Poria, N. (2016). Parent-child interaction: Does parental language matter? *British Journal of Developmental Psychology, 34*(4), 518–537. doi:10.1111/bjdp.12147

Moore, E. R., Anderson, G. C., Bergman, N., & Dowswell, T. (2007). Early skin-to-skin contact for mothers and their healthy newborn infants. *Cochrane Database System Rev, 3*(3), 1–75. doi:10.1002/14651858.CD003519.pub3.

Moszkowski, R. J., & Stack, D. M. (2007). Infant touching behaviour during mother–infant face-to-face interactions. *Infant and Child Development*, *16*(3), 307–319. doi:10.1038/srep09177

Moszkowski, R. J., Stack, D. M., Girouard, N., Field, T. M., Hernandez-Reif, M., & Diego, M. (2009). Touching behaviors of infants of depressed mothers during normal and perturbed interactions. *Infant Behavior and Development, 32*(2), 183-194. doi:10.1016/j.infbeh.2008.12.009

Neu, M., Laudenslager, M. L., & Robinson, J. (2008). Coregulation in salivary cortisol during maternal holding of premature infants. *Biological Research for Nursing*, *10*(3), 226–240. doi:10.1177/1099800408327789

Peláez-Nogueras, M., Field, T. M., Hossain, Z., & Pickens, J. (1996). Depressed mothers' touching increases infants' positive affect and attention in Still-Face interactions. *Child Development, 67*(4), 1780–1792.

Perez, H., & Gewirtz, J. (2004). Maternal touch effects on infant behaviour. In T. Field (Ed.), *Touch and massage in early child development* (1st ed., pp. 39–48). Miami: Johnson & Johnson Pediatric Institute LLC.

Pettit, G. S., & Arsiwalla, D. D. (2008). Commentary on special section on "Bidirectional parent-child relationships: The continuing evolution of dynamic, transactional models of parenting and youth behavior problems". *Journal of Abnormal Child Psychology, 36*(5), 711–718. doi:10.1007/s10802-008-9242-8

Stack, D. M. (2010). Touch and physical contact during infancy: Discovering the richness of the forgotten sense. In G. Bremner, & T. D. Wachs (Eds.), *The Wiley-Blackwell Handbook of Infant Development* (Vol. 1, pp. 532-567). Oxford, UK: Blackwell Publishing.

Stack, D. M., & Jean, A. D. (2011). Communicating through touch: Touching during parent-infant interactions. In M. J. Hertenstein & S. Weiss (Eds.), *The Handbook of Touch: Neuroscience, Behavioral, and Health Perspectives* (pp. 273–298).

Stack, D. M., LePage, D. E., Hains, S., & Muir, D. W. (1996). Qualitative changes in maternal touch as a function of instructional condition during face-to-face social interactions. *Infant Behavior and Development*, 19, 761.

Stack, D. M., & Muir, D. W. (1990). Tactile stimulation as a component of social interchange: New interpretations for the still-face effect. *British Journal of Developmental Psychology, 8*(2), 131–145.

Stack, D. M., & Muir, D. W. (1992). Adult tactile stimulation during face-to-face interactions modulates 5-months-olds' affect and attention. *Child Development, 63*, 1509–1525. doi: 10.1111/j.1467-8624.1992.tb01711.x

Tabachnick, B. G., & Fidell, L. S. (2001). Using multivariate analysis. California State University Northridge: Harper Collins College Publishers.

Underdown, A., Barlow, J., & Stewart-Brown, S. (2010). Tactile stimulation in physically healthy infants: Results of a systematic review. *Journal of Reproductive and Infant Psychology, 28*(1), 11–29. doi:10.1080/02646830903247209

Widom, C. S., Raphael, K. G., & DuMont, K. A. (2004). The case for prospective longitudinal studies in child maltreatment research: Commentary on Dube, Williamson, Thompson, Felitti, and Anda (2004). *Child Abuse & Neglect, 28*(7), 715-722.

Wiberg, B. (1990). *The first hour of life and mother-infant behaviour and development of their mutual relationship* (Doctoral dissertation). Retrieved from Google Scholar. (ISBN 91-7174-503-3).

Winberg, J. (2005). Mother and newborn baby: mutual regulation of physiology and behavior—a selective review. *Developmental Psychobiology, 47*(3), 217-229.

Table 1

Overlapping CITS and ITS Categories

CITS Categories	ITS Categories
Static	Static
Stroke/Caress/Rub/Massage	Rub/Caress/Wipe/Stroke
Pat/Tap	Pat/Tap
Squeeze/Pinch/Grasp	Grasping/Clutching/Clasping
Tickle/Fingerwalk/Prod/Poke/Push	Manipulating/Fingering/Scrumble/Poke/Prod
Shake/Wiggle	
Pull/Lift/Extension/Clap	Pull/Push/Clap/Lift
Other	
	Mouthing

Note. CITS, Caregiver-Infant Touch Scale; ITS, Infant Touch Scale.

Table 2

Passive and Active Touch Categories

Passive		Active	
CITS Categories	ITS Categories	CITS Categories	ITS Categories
Static	Static	Squeeze/ Pinch/ Grasp	Grasp/ Clutch/ Clasp
Stroke/ Caress/ Rub/ Massage	Rub/ Caress/ Wipe/ Stroke	Tickle/ Fingerwalk/ Prod/ Poke/ Push	Manipulate/ Fingering/ Scrumble / Poke/ Prod
Pat/ Tap	Pat/ Tap	Pull/ Lift/ Extension/ Clap	Pull/ Push/ Clap/ Lift

Note. CITS, Caregiver-Infant Touch Scale; ITS, Infant Touch Scale.

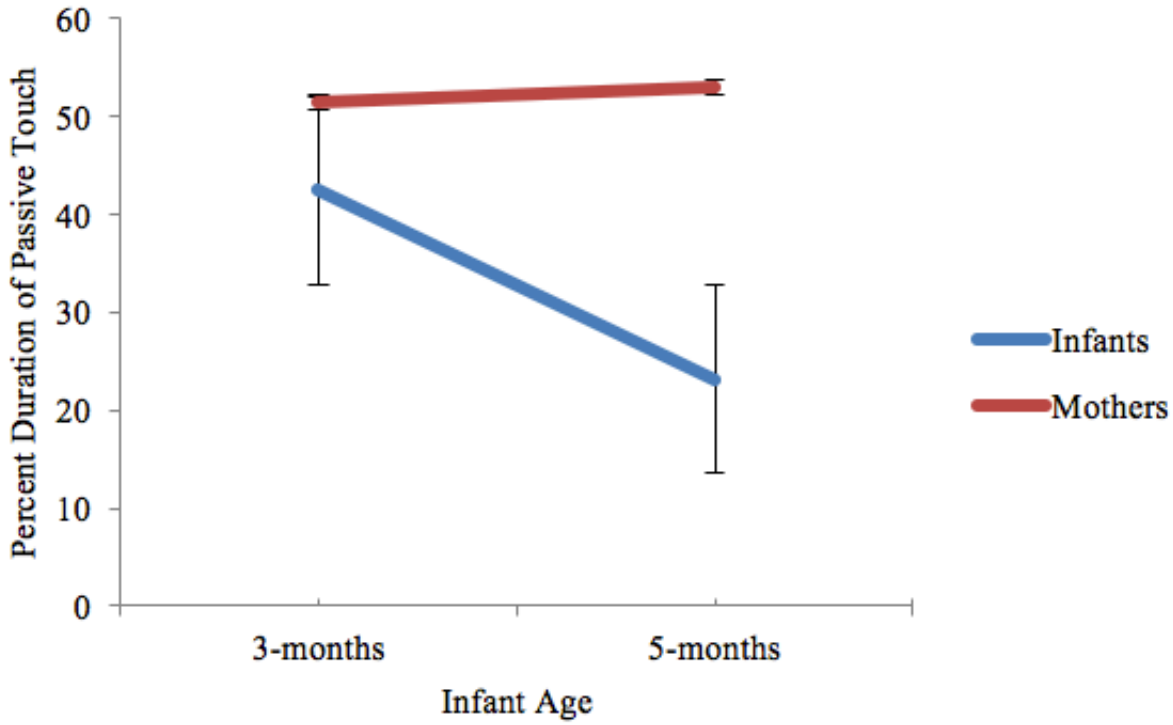

Figure 1. A statistically significant age (3-months, -months) by partner (infant, mother) interaction for the percent duration of Passive Touch. Infants used passive touch for longer durations of time than their mothers at 3-months, but not at 5-months.

Table 3

Means and standard errors for the relative frequency and percent duration of overall, passive, and active touch for mothers and infants.

	Relative Frequency			
	Mothers		Infants	
	M	*SE*	*M*	*SE*
Overall				
3-months	21.89	2.41	21.86	2.32
5-months	51.57	13.03	18.09	12.52
Total	36.72	6.89	19.97	6.62
Passive				
3-months	9.91	1.81	17.07	1.74
5-months	24.65	7.81	12.76	7.50
Total	17.28	4.19	14.92	4.03
Active				
3-months	7.74	.99	3.58	.95
5-months	19.94	4.24	4.57	4.07
Total	13.84	2.29	4.07	2.20
	Percent Duration			
	Mothers		Infants	
	M	*SE*	*M*	*SE*
Overall				
3-months	98.36	4.53	69.99	4.36
5-months	99.80	5.32	60.31	5.11
Total	99.08	3.69	65.15	3.55
Passive				
3-months	51.47	5.75	42.41	5.52
5-months	53.04	3.50	23.19	3.37
Total	52.26	3.54	32.80	3.40
Active				
3-months	23.32	3.75	10.71	3.60
5-months	34.67	4.53	26.33	4.36
Total	29.00	3.27	18.52	3.14

Table 4

Source table for the relative frequency of Static, Stroke/Caress/Rub, Pat/Tap, Grasp, Poke/Prod, and Pull/Lift/Clap.

Source	*SS*	*df*	*MS*	*F*	*p*	*partial* η^2
			Static			
Partner	655.56	1	655.56	3.07	.093	.12
Error	4914.91	23	213.69			
Total	5570.47	24				
Age	286.55	1	286.55	1.65	.212	.07
Age x Partner	744.81	1	744.81	4.29	.050	.16
Error	3997.32	23	173.80			
Total	5028.68	25				
			Stroke/Caress/Rub			
Partner	195.67	1	195.67	11.51	.003	.33
Error	391.11	23	17.00			
Total	586.78	24	212.67			
Age	1.45	1	1.45	.09	.767	.00
Age x Partner	15.27	1	15.27	.95	.341	.04
Error	370.96	23	16.13			
Total	387.68	25				
			Pat/Tap			
Partner	10.60	1	10.60	1.32	.263	.05
Error	185.15	23	8.05			
Total	195.75	24				
Age	.10	1	.10	.01	.913	.00
Age x Partner	5.93	1	5.93	.75	.394	.03
Error	180.81	23	7.86			

Total	186.84	25				
			Grasp			
Partner	2.52	1	2.52	.83	.373	.03
Error	70.16	23	3.05			
Total	72.68	24				
Age	8.91	1	8.91	3.72	.066	.14
Age x Partner	1.00	1	1.00	.42	.524	.02
Error	55.03	23	2.39			
Total	64.91	25				
			Poke/Prod			
Partner	1.63	1	1.63	.201	.658	.009
Error	186.68	23	8.12			
Total	188.31	24	9.75			
Age	17.03	1	17.03	2.95	.100	.11
Age x Partner	18.99	1	18.99	3.28	.083	.12
Error	132.97	23	5.78			
Total	168.99	25	41.80			
			Pull/Lift/Clap			
Partner	774.28	1	774.28	32.00	.000	.58
Error	556.56	23	24.20			
Total	1330.84	24	798.48			
Age	152.94	1	152.94	7.14	.014	.24
Age x Partner	159.21	1	159.21	7.43	.012	.24
Error	492.48	23	21.412			
Total	804.63	24				

Table 5

Means and standard errors for the relative frequency of Static, Stroke/Caress/Rub, Pat/Tap, Grasp, Poke/Prod, and Pull/Lift/Clap for mothers and infants.

		Mothers		Infants	
		M	*SE*	*M*	*SE*
Static					
	3-months	7.21	.99	7.69	.95
	5-months	19.73	5.59	4.75	5.37
	Total	13.47	2.98	6.22	2.88
Stroke/Caress/Rub					
	3-months	1.74	.88	6.81	.84
	5-months	3.19	1.41	6.04	1.36
	Total	2.47	.84	6.43	.81
Pat/Tap					
	3-months	.96	.53	2.57	.51
	5-months	1.7333	1.02	1.96	.98
	Total	1.34	.58	2.27	.56
Grasp					
	3-months	2.87	.43	2.13	.41
	5-months	3.43	.52	3.26	.50
	Total	3.15	.36	2.70	.34
Poke/Prod					
	3-months	.46	.24	1.33	.23
	5-months	2.86	1.05	1.26	1.01
	Total	1.66	.58	1.29	.56
Pull/Lift/Clap					
	3-months	4.42	.69	.12	.66
	5-months	11.49	1.82	.04	1.75
	Total	7.96	1.00	.08	.96

Table 6

Source table for the percent duration of Static, Stroke/Caress/Rub, Pat/Tap, Grasp, Poke/Prod, and Pull/Lift/Clap

Source	*SS*	*df*	*MS*	*F*	*p*	*partial* η^2
			Static			
Partner	4196.32	1	4196.32	18.00	.000	.44
Error	5362.41	23	233.15			
Total	9558.73	24				
Age	197.82	1	197.82	.79	.38	.03
Age x Partner	2152.57	1	2152.57	8.56	.01	.27
Error	5786.06	23	251.57			
Total	8136.45	25				
			Stroke			
Partner	14.12	1	14.12	.78	.387	.03
Error	417.82	23	18.17			
Total	431.94	24				
Age	65.45	1	65.45	3.16	.09	.12
Age x Partner	2.10	1	2.10	.10	.75	.00
Error	476.89	23	20.73			
Total	544.44	25				
			Pat/Tap			
Partner	59.64	1	59.64	3.08	.092	.12
Error	444.86	23	19.34			
Total	501.50	24				
Age	81.23	1	81.23	3.81	.063	.14
Age x Partner	68.00	1	68.00	3.19	.087	.12

Error	490.76	23	21.34			
Total	639.99	25				
			Grasp			
Partner	1806.95	1	1806.95	11.15	.003	.33
Error	3728.61	23	162.11			
Total	5535.56	24				
Age	785.79	1	785.79	9.14	.006	.28
Age x Partner	871.99	1	871.99	10.14	.004	.31
Error	1976.87	23	85.95			
Total	3634.65	25				
			Poke/Prod			
Partner	7.89	1	7.89	2.02	.169	.08
Error	89.79	23	3.90			
Total	97.68	24				
Age	5.69	1	5.69	1.34	.259	.05
Age x Partner	21.66	1	21.66	5.11	.034	.18
Error	97.56	23	4.24			
Total	124.91	25				
			Pull/Lift/Clap			
Partner	5882.77	1	5882.77	50.57	.000	.69
Error	2675.49	23	116.33			
Total	8558.26	24				
Age	296.71	1	296.71	4.80	.039	.17
Age x Partner	300.28	1	300.28	4.86	.038	.17
Error	1421.17	23	61.79			
Total	2018.16	25				

Table 7
Means and standard errors for the percent duration of Static, Stroke/Caress/Rub, Pat/Tap, Grasp, Poke/Prod, and Pull/Lift/Clap.

		Mothers		Infants	
		M	*SE*	*M*	*SE*
Static					
	3-months	40.11	5.51	34.90	5.30
	5-months	49.25	3.16	17.78	3.04
	Total	44.68	3.12	26.34	2.99
Stroke/Caress/Rub					
	3-months	5.66	1.63	6.32	1.57
	5-months	2.96	.76	4.44	.73
	Total	4.31	.87	5.38	.84
Pat/Tap					
	3-months	5.71	1.81	1.19	1.74
	5-months	.83	.34	.98	.33
	Total	3.27	.90	1.08	.86
Grasp					
	3-months	5.17	1.75	8.84	1.68
	5-months	4.75	4.20	25.14	4.03
	Total	4.96	2.60	16.99	2.50
Poke/Prod					
	3-months	1.24	.46	1.76	.44
	5-months	3.23	.68	1.12	.66
	Total	2.24	.40	1.44	.39
Pull/Lift/Clap					
	3-months	16.91	3.23	.10	3.10
	5-months	26.69	2.10	.07	2.02
	Total	21.80	2.20	.09	2.11

Chapter 4: General Discussion

The present thesis comprised a series of two studies designed to explore parents' and infants' touching behaviours during early parent-infant interactions, and how these touching behaviours develop over time. Study 1 investigated mothers' and fathers' specific touching behaviours during their very first interaction with their newborn infants, as well as mothers' and infants' touch 3 months later both before and after a perturbed interaction (i.e. the SF period). Results indicated that mothers and fathers differed in the amount, but not in the type, of touching behaviours they displayed during their first interaction with their infants. That is, mothers touched their infants more frequently and for longer durations of time. Findings also revealed that maternal touch occurring immediately after birth was predictive of maternal touch after the SF period 3-months later. These findings contribute to our understanding of the predictive components of maternal touch, especially when considering interactive contexts that follow a period of perturbation. Furthermore, an examination of maternal and infant touch at 3-months postpartum revealed that infants and their mothers utilize certain touching behaviours (pulling, lifting, and clapping, and grasping) in a similar manner during face-to-face interactions, underscoring the reciprocity that is characteristic of face-to-face mother-infant interactions (Mastergeorge et al., 2014; Doiron & Stack, in press). Infants were also observed to decrease their use of more passive kinds of touch (rubbing, stroking, caressing, and wiping), whereas mothers increased their use of these types of touch, across the still-face procedure. Together, results from Study 1 provide insight into the progression of maternal touch across time and interactions, and how variations in maternal touch are associated with changes in infant touch.

Expanding on Study 1, Study 2 explored how both mothers and infants utilize touch during naturalistic face-to-face interactions from 3- to 5-months, and considered how mothers

and infants compare in their use of specific touching behaviours. Thus, unlike Study 1, Study 2 investigated infants' (in addition to mothers') progression of touch over time. In addition, this second study provided a different setting in which mothers and infants interacted. That is, mothers and infants freely engaged with one another, and did not undergo a SF period. Considering a different kind of mother-infant interaction than Study 1 was important given that the amount and type of touch employed by mothers and infants is dependent on the particular interactive context (Hertenstein, 2002). Congruent with the findings from Study 1, results revealed that infants demonstrated a decrease, whereas mothers demonstrated an increase, in passive touch across their interactions. In addition, results revealed that mothers increased their *frequency* of passive touch over time, whereas infants increased their *duration* of passive touch over time. Consequently, similarities in the progression of the quality (i.e., the type) of mothers' and infants' touch do not necessarily generalize to similarities in the progression of the quantity of their touch. These findings reflect the complexity of touch, and highlight the importance of considering the multiple parameters of touch within future investigations of maternal and infant touch (Hertenstein, 2002; Stack, 2010; Stack & Jean, 201; Ferber, Feldman, & Makhoul, 2008).

In addition, results from both studies revealed that infants utilize a range of touching behaviours, including both passive and active types of touch, at high frequencies and durations, as early as 3-months-old. Further, the results of both studies combined indicate that infants' use of touch is comparable to that of their mothers; this was found to be true both at 3- and 5-months of age, and across the different types of interactive contexts infants engaged in with their mothers. Consistent with our existing knowledge of infant touch, Studies 1 and 2 thus highlight touch as a well-developed and critical form of communication within infant development (Gallace & Spence, 2016; Heller, 2014; Stack, 2010). However, given that our studies did not

assess infant touch during the immediate postpartum period, it is not yet clear how infants utilize touch during their very first interaction with their parents. Touch is the earliest and oldest of all sensorial systems to develop within the human infant (Field, 2010; Montagu, 1986) and likely represents infants' first and preferred line of communication when interacting with their parents. As such, an exploration of the full range of infant touch during the immediate postpartum period would add to our knowledge about how infants and their parents interact for the first time; this represents a necessary future avenue in the touch literature.

Taken together, the current research made a number of important and unique contributions to the limited literature on touch. The present work was the first to consider the range and progression of maternal touch as early as the first hour after birth until 5-months postpartum. Most investigations of maternal touch thus far have been cross-sectional rather than longitudinal (Stack & Jean, 2011), and have thus conveyed little about how maternal touch evolves over time. In addition, previous investigations have failed to demonstrate how infant touch evolves over time, despite knowledge that touch is the most developed communicative modality in the infant at this time and thus the infant's primary channel of communication (Kaye & Fogel, 1980; Field, 2010). While the current study investigated touch over the course of the first few months of life, infants' touch is expected to continue to evolve as their motor abilities continue to develop (Field, 2010). Longitudinal investigations of touch spanning over longer periods of time are therefore warranted. Nonetheless, the present research expanded and enriched our understanding of how infants develop with regards to touch, and how they use it to contribute to their social exchanges with their mothers.

Consistent with the dynamic systems perspective and transactional models of development, which view mothers and their infants as a mutually regulated bidirectional system

and posit that behavioural changes among one interaction partner relate to changes in the other (Beebe, Messinger, Bahrick, Margolis, Buck, & Chen, 2016; Fogel, 1992; McQuaid, Bibok, & Carpendale, 2009; Pesonen, Räikkönen, Heinonen, Komsi, Järvenpää, & Strandberg, 2008; Provenzi, Borgatti, Menozzi, & Montirosso, 2015; Sameroff, 2009; 2010), the current research considered maternal and infant touch concurrently. This was in contrast to most investigations to date that have considered either maternal *or* infant touch rather than both. Finally, Study 1 adds to the scant, yet growing literature, on father-infant interactions (Mantis, Stack, Ng, Serbin, & Schwartzman, 2014), as it considered fathers' touching behaviours during the first hour after birth. However, future researchers should also consider how fathers' touching behaviours progress over time, and how they compare to that of both mothers and infants. This is an essential future direction as infant development occurs within a familial context (Hall, Hoffenkamp, Tooten, Braeken, Vingerhoets, & van Bakel, 2015), and fathers, too, are among infants' most common and significant social partners. Future researchers may consider accompanying their investigations of fathers', as well as mothers' and infants', touch with other behaviours, such as those within the visual and vocal modalities; such investigations would provide a more complete understanding of how parents and their infants interact.

In conclusion, touch is a central component of caregiving and infant behaviour. The present research provided an exploration of touch in both the context of the parent-infant relationship as a whole and at a micro-behavioral level, examining specific differences in touch from immediately after birth to 5-months postpartum. The present findings contribute to our understanding of how parents and their infants use touch to communicate, which has definite implications for our understanding of children's development of social, emotional, and communicative skills (Stack & Muir, 1992; Stack & Jean, 2011) and for the formulation of

parenting interventions involving early touch stimulation for at-risk and typically developing infants.

References

Asadollahi, M., Jabraeili, M., Mahallei, M., Jafarabadi, M. A., & Ebrahimi, S. (2016). Effects of gentle human touch and field massage on urine cortisol level in premature infants: A randomized, controlled clinical trial. *Journal of Caring Sciences, 5*(3), 187–194. doi:10.15171/jcs.2016.020

Atkinson, J., & Braddick, O. (1982). Sensory and perceptual capacities of the neonate. In P. Stratton (Ed.), *Psychobiology of the Human Newborn* (pp. 191–220). Chichester: Wiley.

Barnett, K. (1972). A theoretical construct of the concepts of touch as they relate to nursing. *Nursing Research, 21*(2), 102–110.

Beebe, B., Messinger, D., Bahrick, L. E., Margolis, A., Buck, K. A., & Chen, H. (2016). A systems view of mother–infant face-to-face communication. *Developmental Psychology, 52*(4), 556–571. doi:10.1037/a0040085

Chen, Q., Li, H., Abu-Zhaya, R., Seidl, A., Zhu, F., & Delp, E. J. (2016). Touch event recognition for human interaction. *Electronic Imaging, 2016*(11), 1–6. doi:10.2352/ISSN.2470-1173.2016.11.IMAWM-465

Cohn, J. F., & Tronick, E. Z. (1988). Mother-infant face-to-face interaction: Influence is bidirectional and unrelated to periodic cycles in either partner's behavior. *Developmental Psychology, 24*(3), 386–392.

Ferber, S. G., & Makhoul, I. R. (2004). The effect of skin-to-skin contact (kangaroo care) shortly after birth on the neurobehavioral responses of the term newborn: a randomized, controlled trial. *Pediatrics, 113*(4), 858–865. doi:10.1016/j.jpeds.2004.08.039

Field, T. (2010). Touch for socioemotional and physical well-being: A review. *Developmental Review*, *30*(4), 367–383. doi:10.1016/j.dr.2011.01.001

Field, T. M., Ed. (2014). *Touch in early development*. New York (NY): Psychology Press

Fogel, A. (1992). Movement and communication in human infancy: The social dynamics of development. *Human Movement Science, 11*, 387–423.

Fogel, A. (1993). *Developing through relationships: Origins of communication, self, and culture*. Chicago, IL: University of Chicago Press.

Gallace, A., & Spence, C. (2016). Social touch. In H. Olausson, J. Wessberg, I. Morrison, & F. McGlone (Eds.), *Affective Touch and the Neurophysiology of CT Afferents* (pp. 227–238). New York: Springer.

Grobbel, R., Cooke, K., & Bonet, N. (2017). Ethical use of touch and nurturing-restraint in play therapy with aggressive young children, as illustrated through a reflective supervision session. In J. A. Courtney & R. D. Nolan (Eds.), *Touch in Child Counseling and Play Therapy: An Ethical and Clinical Guide*. London, UK: Taylor & Francis.

Hall, R. A. S., Hoffenkamp, H. N., Tooten, A., Braeken, J., Vingerhoets, A. J. J. M., & van Bakel, H. J. A. (2015). The quality of parent–infant interaction in the first 2 years after full-term and preterm birth. *Parenting, 15*(4), 247-268, doi:10.1080/15295192.2015.1053333

Heller, S. (2014). *The vital touch: How intimate contact with your baby leads to happier, healthier development.* New York, NY: Holt Paperbacks.

Hertenstein, M. J. (2002). Touch: Its communicative functions in infancy. *Human Development*, *45*(2), 70–94. doi:10.1159/000048154

Hertenstein, M. J., & Campos, J. J. (2001). Emotion regulation via maternal touch. *Infancy, 2*(4), 549-566.

Jean, A. D., & Stack, D. M. (2009). Functions of maternal touch and infants' affect during face-

to-face interactions: New directions for the still-face. *Infant Behavior and Development*, *32*(1), 123–128. doi:10.1016/j.infbeh.2008.09.008

Jean, A. D., Stack, D. M., & Arnold, S. (2014). Investigating maternal touch and infants' self-regulatory behaviours during a modified face-to-face Still-Face with touch procedure. *Infant and Child Development, 23*(6), 557–574. doi:10.1002/icd.1870

Jean, A. D., Stack, D. M., & Fogel, A. (2009). A longitudinal investigation of maternal touching across the first 6 months of life: Age and context effects. *Infant Behavior and Development*, *32*(3), 344–349. doi:10.1002/icd.1870

Kuczynski, L., & De Mol, J. (2015). *Dialectical models of socialization*. In W. F. Overton & P. C. M. Molenaar (Eds.), *Theory and Method (*Vol. 1*): Handbook of Child Psychology and Developmental Science* (7th ed.). Hoboken, NJ: Wiley. doi:10.1002/9781118963418.childpsy109

Lowe, J. R., Coulombe, P., Moss, N. C., Rieger, R. E., Aragón, C., MacLean, P. C., Caprihan, A., … & Handal, A. J. (2016). Maternal touch and infant affect in the Still Face Paradigm: A cross-cultural examination. *Infant Behavior and Development, 44*, 110–120. doi:10.1016/j.infbeh.2016.06.009

Mantis, I., Stack, D. M., Ng, L., Serbin, L. A., & Schwartzman, A. E. (2014). Mutual touch during mother–infant face-to-face still-face interactions: Influences of interaction period and infant birth status. *Infant Behavior and Development*, *37*(3), 258–267. doi:10.1016/j.infbeh.2014.04.005

Menashe, A., & Atzaba-Poria, N. (2016). Parent-child interaction: Does parental language matter? *British Journal of Developmental Psychology, 34*(4), 518–537. doi:10.1111/bjdp.12147

Mercer, J. (2006). *Understanding attachment: Parenting, childcare, and emotional development.* Westport, CT: Praeger Publishers.

Montagu, A. (1971). *Touching: The human significance of the skin.* New York: Columbia University Press.

Montagu, A. (1986). *Touching: The human significance of the skin* (3rd ed.). New York: Harper & Row.

Moszkowski, R. J., & Stack, D. M. (2007). Infant touching behaviour during mother–infant face-to-face interactions. *Infant and Child Development*, *16*(3), 307–319. doi:10.1038/srep09177

Neu, M., Laudenslager, M. L., & Robinson, J. (2008). Coregulation in salivary cortisol during maternal holding of premature infants. *Biological Research for Nursing*, *10*(3), 226–240. doi:10.1177/1099800408327789

Peláez-Nogueras, M., Gewirtz, J. L., Field, T., Cigales, M., Malphurs, J., Clasky, S., & Sanchez, A. (1996). Infants' preference for touch stimulation in face-to-face interactions. *Journal of Applied Developmental Psychology*, *17*(2), 199–213. doi:10.1016/S0193-3973(96)90025-8

Pesonen, A. K., Räikkönen, K., Heinonen, K., Komsi, N., Järvenpää, A. L., & Strandberg, T. (2008). A transactional model of temperamental development: Evidence of a relationship between child temperament and maternal stress over five years. *Social Development, 17*(2), 326–340. doi:10.1111/j.1467-9507.2007.00427.x

Pettit, G. S., & Arsiwalla, D. D. (2008). Commentary on special section on "Bidirectional parent-child relationships: The continuing evolution of dynamic, transactional models of

parenting and youth behavior problems". *Journal of Abnormal Child Psychology, 36*(5), 711–718. doi:10.1007/s10802-008-9242-8

Rhoades, E. A. (2017). Parent-child interactions. In E. A. Rhoades & J. Duncan, *Auditory-Verbal Practice: Family-Centered Early Intervention* (pp. 182–208).

Sameroff, A. (2009). *The transactional model of development: How children and contexts shape each other*. Washington, DC: American Psychological Association.

Sameroff, A. (2010). A unified theory of development: A dialectic integration of nature and nurture. *Child Development, 81*(1), 6–22. doi:10.1111/j.1467-8624.2009.01378.x

Stack, D. M. (2001). The salience of touch and physical contact during infancy: Unraveling some of the mysteries of the somesthetic sense. In J. G. Bremner & A. Fogel (Eds.), *Blackwell Handbook of Infant Development* (pp. 351 – 378). Malden, MA: Blackwell.

Stack, D. M. (2004). Touching during mother-infant interactions. In T. Field (Ed.), *Touch and massage in early child development* (1st ed., pp. 49–81). Miami: Johnson & Johnson Pediatric Institute LLC.

Stack, D. M. (2010). Touch and physical contact during infancy: Discovering the richness of the forgotten sense. In G. Bremner, & T. D. Wachs (Eds.), *The Wiley-Blackwell Handbook of Infant Development* (Vol. 1, pp. 532-567). Oxford, UK: Blackwell Publishing.

Stack, D. M., & Jean, A. D. (2011). Communicating through touch: Touching during parent-infant interactions. In M. J. Hertenstein & S. Weiss (Eds.), *The Handbook of Touch: Neuroscience, Behavioral, and Health Perspectives* (pp. 273–298).

Wiberg, B. (1990). *The first hour of life and mother-infant behaviour and development of their mutual relationship* (Doctoral dissertation). Umeå: Umeå Universitet.

Appendix A: Consent Forms

ID _____

Ricerca dal titolo:

Il ruolo del tocco materno nell'interazione madre-bambino alla nascita e a tre mesi di vita

CONSENSO INFORMATO ALLA RICERCA

I sottoscritti:
(Cognome, Nome della madre) _____

(Cognome, Nome del padre) _____

in qualità di genitori/legali rappresentanti di
(Cognome, Nome del bambino) _____

dichiarano

di aver letto la lettera informativa relativa allo studio in oggetto, e di essere stati informati in modo chiaro e comprensibile da _____, collaboratore del Dott. Montirosso (Responsabile Scientifico dello Studio), sulle finalità della ricerca in oggetto e sulle modalità attraverso le quali verrà effettuata, nonché di avere avuto modo di chiedere ogni delucidazione.

Accettano

volontariamente di prendere parte alla ricerca e inoltre

Autorizzano

volontariamente che il/la proprio/a figlio/a
(Cognome, Nome in stampatello) _____

prenda parte a questo studio.

Data _____ Firma leggibile (della madre) _____

Data _____ Firma leggibile (del padre) _____

L'informatore (Cognome e Nome) _____

Data _____ Firma dell'informatore _____

The Development of Communicative Behavior in Infancy

INFORMED CONSENT DOCUMENT
PLEASE READ THIS CAREFULLY BEFORE SIGNING

You and your baby are being asked to participate in an in-depth research study on the process of social development in early infancy. Although a good deal of research has already been done in this area, a lot is still unknown. One of the missing pieces in our knowledge is how individual infants grow and change. We know the basic stages of social development -- such things as when babies learn to communicate their feelings by crying or smiling, when they learn to use gesture and expressions and when they learn to start using words and language.

What is lacking is knowledge about how these changes occur. We want to find out how individual baby learns to control his or her behavior for the purpose of social play and communication. We can only to this by watching the subtle and small changes that take place over time when the baby is observed repeatedly in the same social situation.

The study in which we are asking you to participate is unique in the history of child development research, and it requires as a unique commitment on your part. Only a handful of babies have been observed intensively for an intended period. Those studies were done 10 or more years ago, long before we had powerful tools of behavior analysis embodied in the videotape and computer of today. We are hoping you will have the time, energy and motivation to join us in this pioneering research effort.

We want to be as clear as possible about what we will be expecting from your participation in this research project. Please read carefully each of the procedures listed below, and ask us any questions that you may have about them, First, we'll describe each procedures, and then we'll explain why it is used and what the potential risks are to you and your baby.

(1) Laboratory Playroom Observations: This is the core part of the research study. We will be asking you to come to our laboratory once each week, at a mutually convenient time, to spend about 30 minutes interacting spontaneously with your baby in a comfortable playroom setting. We will try to be flexible in the scheduling of the visits. Although we prefer a regular visitation schedule, we can adjust for illness, doctor's visits, other conflicting commitments, etc. So long as you try to maintain a regular schedule, there is no problem skipping weeks occasionally for vacations, etc. We hope these visits become an enjoyable part of your week, a time for you and you baby to spend some special moments together. During this time you will interact with your baby while he / she is on your lap, on the floor, or at a table. The particular setting will depend on your baby's age.

(2) Observations in your home: Although the core of our research is the laboratory playroom observations, it is important for all research studies on human development to be generalizable beyond the scope of the laboratory. For this reason, we feel it is important to test the validity of our laboratory observations against you baby's normal behavior at

home. In order to do this, we plan to come to your home beginning when your baby is three months of age, and for every three months after that. We will stay for a period of about 2 hours on each visits, and we would like to come at a time when all of the family members are present in order to see how your baby responds socially to his/her father and sibling, as well as to you. If this is not possible, we can come at anytime when its convenient for you.

Because of the complexity of social interaction, we will be videotaping your baby in the home, in the same way we did in the laboratory playroom. Although it is hard to ''act natural'' with several extra people, trailing video cameras and wires around your home, we ask you to pretend we're not there.

None of these procedure are experimental. They have all been used in our research with other families in the Lafayette/West Lafayette area. What is different is that we wish to have your collaboration over a longer term than most research studies require. We have found that families enjoy participation in our research studies. Since we are interested in your baby's natural and spontaneous social behavior, we do not do any invasive or experimental procedures. Your baby is likely to become familiar with our playroom and with our staff, and will probably look forward to his/her visits here. Our standardized assessments are often interesting and challenging to babies, and informative for parents.

Your participation in this research study is protected by standard confidentiality guidelines used in most research done with human subjects in this country. This means that all identifying information about you and your family is kept in a locked file under the supervision of the project director, Dr. Alan Fogel. Videotapes and standardized assessments will only be identified by a number, and the correspondence between the number and your name is known only by the project staff. Your name of your baby's name will not be released in any publication or presentation of these results to the public.

Due to extensive commitment we are requesting, and to cover any inconveniences and transportations costs, we will offer you a small honorarium of $300.00 per year, $150 payable at the end of each six months of complete participation.

If you have any other questions, now or at anytime during the period of the research study, feel free to contact Dr. Alan Fogel, Department of Child Development and Family Studies, Purdue University, 494-5744

_____ _____

Parent signature Date

Appendix B: Coding Criteria for Behavioural Observation Coding Systems

Table 1A. Brief coding criteria for the Caregiver-Infant Touch Scale (CITS) (Stack et al., 1996; Jean, Stack, & Fogel, 2009)

Touching behaviour	Brief description
Static	Touch without movement
Stroke/Caress/Rub/Massage	Lateral soft and gentle movements or rubbing motion involving strong back and fourth or circular movements
Pat/Tap	Quick up and down motions using either palm or fingertips
Squeeze/Pinch/Grasp	Taking hold of infant's body or limb, or part of infant's body or limb, using a firmer hold or grip
Tickle/Finger Walk/Prod/Poke/Push	Usually involves bent finger(s) and often repetitive small movements
Shake/Wiggle	Moving part of the infant in short quick motions from side-to-side or up and down
Pull/Lift/Extension/Clap	Stretching or raising infant's limb away from infant's body
Other	Any other type of touch that cannot be classified in any of the other 7 categories. Typically includes kissing, blowing, and rocking

Table 2A. Brief coding criteria for the Caregiver-Infant Touch Scale - Adapted (CITS - Adapted) (Stack et al., 2014)

Touching behaviour	Brief description
Static	Touch without movement
Stroke/Caress	Lateral soft and gentle movements
Massage/Rub	Rubbing motion involving strong back and fourth or circular movements
Holding	Taking hold of infant's body or limb, or part of infant's body or limb
Kissing	Touch through lips
Palmar Grasp Reflex	Finger(s) enclosed within infant's hand
Utilitarian/Instrumental	Includes adjusting infant's clothing, wiping infant's mouth, moving infant's positioning, etc.
Rocking	Moving of infant's body in back and forth movements. Coded for mothers only
Blowing	Expelling air through pursed lips toward infant. Coded for fathers only.
Other	Any other type of touch that cannot be classified in any of the above categories.

Table 3A. Brief coding criteria for the Infant Touch Scale (ITS) (Moszkowski & Stack, 2007)

Touching behaviour	Brief description
Static	Touch without movement
Rub/Caress/Wipe/Stroke	Lateral soft and gentle movements or rubbing motion involving strong back and fourth or circular movements
Grasping/Clutching/Clasping	All or some of infant's fingers are curled around a stimulus
Manipulating/Fingering/Scrumble/Poke/Prod	The infant runs the tip of his/her finger(s) over a surface, generally in a random fashion. Includes handling, flexing, or extending finger(s), sometimes in a repetitive manner
Mouthing	Infant's hand comes into contact with his or her mouth, including the lips and outside of mouth
Tap/Pat	Quick up and down motions using either palm or fingertips
Pull/Push/Clap/Lift	Pulling or pressing all or part of a stimulus; striking hands against each other; raising a stimulus higher than its original position