THE PHYSIOLOGICAL MECHANISMS OF EMOTION REGULATION DURING INFANCY: THE ROLE OF MATERNAL AND PATERNAL BEHAVIORS

by

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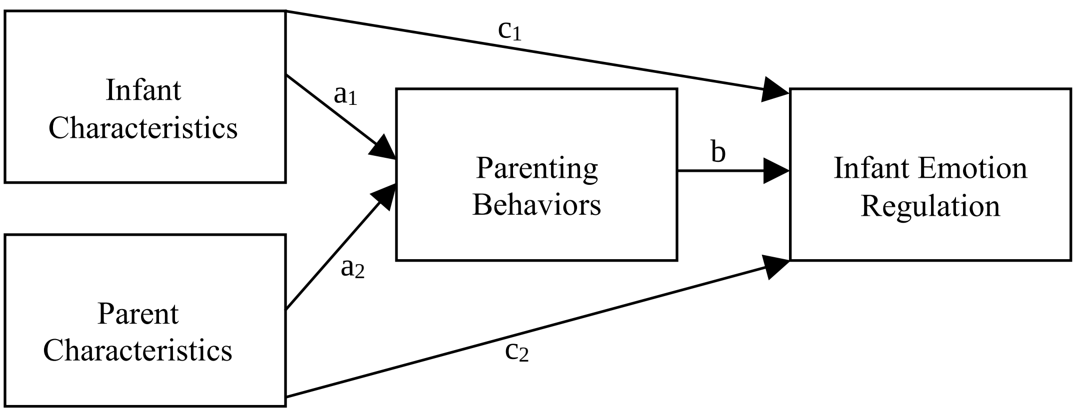
The ability to effectively regulate emotions is the cornerstone of children's social and emotional development and has implications for various domains of functioning. For example, the ability to regulate negative emotions during infancy is associated with better compliance during the preschool years (Hill & Braungart-Rieker, 2002), and infants who have difficulty regulating emotions are at greater risk for externalizing behavior problems as toddlers (Moore, Cohn, & Campbell, 2001). Better emotion regulation skills are also related to social competence during childhood (Eisenberg, Hofer, & Vaughn, 2007). Because of the importance of emotion regulation, it is imperative for researchers to understand the specific components of emotion regulation. The regulatory process during infancy consists of two components: arousal and regulation (Fox & Calkins, 2003; Rothbart & Derryberry, 1981). Historically, studies of infant emotion regulation have concentrated on examining behavioral indices of arousal (facial expressions) and regulation (behavioral strategies). However, the autonomic nervous system is responsible for both preparing the body for fight or flight and aiding the body in recovering from said arousal (Kahle, Miller, Lopez, & Hastings, 2016) and physiological indices of arousal and regulation have also been shown to be important predictors of children's outcomes, including better emotion regulation abilities during childhood (Stifter, Dollar, & Cipriano, 2011). Unfortunately, when studying emotion regulation during the first year of life, researchers often fail to include both physiological and behavioral indicators or they focus only on one component of the regulatory process. The present study addresses this critical gap by examining both behavioral and physiological measures of arousal and regulation in order to gain a comprehensive understanding infant emotion regulation during the first year of life.

The ability to regulate emotions begins to develop during the first year of life and is largely shaped by characteristics of the infant and the larger environment (Fox & Calkins, 2003). Infant temperament is one characteristic that reliably predicts emotion regulation abilities. Infants who are more temperamentally negative are generally found to be more reactive and have difficulties regulating emotions (Braungart-Rieker, Garwood, Powers, & Notaro, 1998; Yoo & Reeb-Sutherland, 2013). With respect to the environment, research has consistently found that parenting behaviors are associated with infant emotion regulation. For example, parents who respond to their infants in a sensitive manner have infants who show less negative emotion and utilize effective emotion regulation strategies (Braungart-Rieker et al., 1998). Infant negative temperament also impacts parenting behaviors, and when infants have a more negative temperament parents respond to them in a less sensitive manner (Ghera, Hane, Malesa, & Fox, 2006). This indicates the direct and indirect impact infant negative temperament has on infant emotion regulation. There has been less research, however, examining the impact of discrete parenting behaviors, such as touch. Although researchers have commonly manipulated the presence of touch during stressful situations for infants (e.g., Stack & Muir, 1992), few studies have examined the impact of more naturally occurring touch on emotion regulation before and after an infant experiences distress. In addition to the influence of parenting behavior, infants' emotion regulation abilities may be directly, and indirectly, impacted by characteristics of the parent. A considerable body of research has found that increased levels of parental depressive symptoms are associated with heightened infant reactivity and difficulties regulating emotions (Suurland et al., 2016; Tronick & Corrina, 2009). This effect may be indirect via the influence of depressive symptoms on parenting behaviors. For example, mothers with higher levels of depressive symptoms have lower quality interactions with their infants (McFadden & Tamis-

Lemonda, 2013). The purpose of the current study was to examine the impact of infant characteristics and parent characteristics on infant emotion regulation. However, it was hypothesized that this relationship would be mediated by parenting behaviors (i.e., touch; see Figure 1). Further, this study examines these processes in mother-infant and father-infant dyads as fathers have been relatively understudied.

Figure 1

The Conceptual Model.



Experience and Regulation of Emotion in Infancy

Infant emotional experiences consist of two processes: emotional reactivity (i.e., arousal) and the regulation of that reactivity. Reactivity is the latency to respond to a stimulus, the intensity of the reaction, and the stimulus threshold required to elicit a response (Fox & Calkins, 2003; Rothbart & Deyberry, 1981). Infants typically experience an event that changes motor behavior (e.g., facial expression) and physiology is evaluated and leads to subjective feelings (Kagan, 1994). By 2 years of age, most infants experience the universal emotions of anger, joy, sadness, fear, disgust, and surprise (Cole, Michel, & Teti, 1994), but the development of each emotion differs. For example, infants begin to experience joy by 2 months of age (Camras, 2011). With respect to negative emotions, newborns generally experience generalized distress (e.g., pain, discomfort, etc.) that becomes differentiated into anger, sadness, and fear by 18 months of age (Camras, 2011). Infants display unique facial and vocal expressions that indicate distress (i.e., negative affect), which are considered behavioral indices of arousal (Fox & Calkins, 2003). Although the experience of emotion develops across the lifespan, it is particularly important for infants to learn not only how to experience negative emotions but also how to manage them (e.g., regulate the emotion) due to the inevitability of experiencing negative emotions throughout the lifespan (Kopp, 1989).

Although various definitions have been put forth, emotion regulation consists of both internal (e.g., innate capacities of the individual such as temperament and physiology) and external (e.g., caregiving experiences) processes that monitor, evaluate, and modify the intensity and timing of emotional reactivity in order to accomplish a particular goal (Fox & Calkins, 2003; Thompson, 1994). Both positive and negative emotions can be regulated in order to meet situational demands (Gross & Thompson, 2007). Therefore, when an individual is experiencing a discrete emotion, emotion regulation constitutes the process of changing that emotion once it has been experienced and contains the following features: (a) it is necessary when an individual expects to experience an emotional state that might deviate from the preferred state or goals of the individual; (b) it forces the emotional system back to the desired state; and (c) in order to change to that preferred state, input to the system must be changed via different strategies (Cole, Martin, & Dennis, 2004; Hoeksma, Oosterlaan, & Schipper, 2004).

There are five categories related to emotion regulation strategies: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. These strategies involve selecting situations based on the expected emotions that they provoke, changing situations to be more or less likely to experience particular emotions, attending to different elements of a situation, changing the interpretation of situations, and directly influencing the response to a situation in terms of both behavior and physiology. (Gross & Thompson, 2007). However, during the early part of the first year of life infants are dependent on caregivers to help them regulate their experiences of distress. The first regulatory strategies infants utilize develop from basic reflexes that aid in the regulation of states of discomfort. These include, but are not limited to, gaze aversion that serves to distract oneself from discomfort and self-comforting behaviors that often include thumb-sucking (Kopp, 1989; Stifter & Braungart, 1995). Aided by caregiver modeling and assistance in regulation, infants rapidly develop more sophisticated and intentional strategies by the end of the first year of life (Calkins, 1994; Cole et al., 1994; Kopp, 1989). For example, by 6 months of age, infants are more purposeful in directing their attention and their motor activities due to the rapid development of the visual and motor systems (Calkins & Hill, 2007). In addition, the regulatory behaviors of distraction and self-soothing, that are used to reduce distress in infants as young as 6 months of age, start to be employed in a context-dependent manner (Crockenberg & Leerkes, 2004; Field, 1994). Overall, the regulatory behaviors that emerge from early infant reflexes are increasingly used in a more purposeful and sophisticated manner.

To study infant arousal and regulation, researchers have traditionally relied upon observable characteristics, such as facial expressions. For example, positive emotion is typically inferred when an infant displays a smile and negative emotions are typically captured by distressed, crying faces (Braungart-Rieker et al., 1998). Observable, behavioral indicators of emotion regulation strategies in infants include attention shifting (e.g., gazing at or away from a stimulus), self-soothing (e.g., rubbing face or thumb-sucking), and engagement with objects.

There are also internal, physiological indices of both arousal and regulation, which are present in infancy (Suurland et al., 2016). In a seminal monograph, Fox, Kirwan, and Reeb-Sutherland (2012) discussed the necessity of examining behavior and physiology together in the study of arousal and emotion regulation. Further, Porges, Doussard-Roosevelt, and Maiti (1994) further asserted that the autonomic nervous system (ANS) is integral in the experience and regulation of emotion. Overall, many theories of emotion assert that ANS activity is crucial in an individual's response to emotion (Kreibig, 2010).

The ANS helps an individual to maintain homeostasis (Porges et al., 1994). Within the ANS, there are two subsystems: (a) the parasympathetic nervous system (PNS) and (b) the sympathetic nervous system (SNS), which regulate various organs for either growth and restoration or mobilization to face external challenges respectively (Porges et al., 1994). The SNS is often conceptualized as preparing the body for fight or flight by inducing an arousal response. In contrast, the PNS aids in recovering from arousal (i.e., regulation; Kahle et al., 2016). The SNS and the PNS co-vary and each system can change in a manner that is considered reciprocal, coactive, or independent (Berntson, Quigley, & Lozano, 2007). Most research suggests that during times of stress reciprocal sympathetic activation is key, where increases in SNS activity, that governs arousal, coincide with decreases in PNS activity, which reflects regulation (Berntson et al., 1994; El-Sheikh et al., 2009; Stifter et al., 2011). It appears that it is adaptive for the SNS to be predominant during initial arousal, the PNS during regulation from arousal, and that the two systems operate in opposing directions (i.e., as one increases the other must decrease). This pattern is considered adaptive because it coincides with indices of better emotion regulation in young children (Stifter et al., 2011).

Within each of these systems there are two well-known measures of SNS and PNS activity: pre-ejection period (PEP) and respiratory sinus arrhythmia (RSA). Pre-ejection period measures cardiac control by the SNS and is indicative of arousal. It refers to the generation of force by the left ventricle and, specifically, the period between depolarization of the ventricle to ejection (Fox, Schmidt, Henderson, & Marshall, 2007). Therefore, PEP is the time that elapses between when the heart beats and when blood is ejected into the aorta (Stifter et al., 2011). Greater SNS influence (i.e., arousal) is indicated by PEP shortening because it corresponds with both greater contractility and more rapid blood flow (Berntson et al., 2007; Kahle et al., 2016)).

Respiratory sinus arrhythmia, on the other hand, is a measure of PNS vagal control. As detailed by Porges and colleagues (1994), the vagus, the tenth cranial nerve, emerges from the brain stem and innervates many organs, including the heart. Containing both motor and sensory fibers, the vagus nerve promotes homeostatic regulation of the organs it innervates via communication with the brain. The vagus nerve has two branches, each of which contains two nuclei. The nucleus ambiguus is the nuclei associated with the heart. Specifically, the nucleus ambiguus provides input to the sino-atrial node (S-A node), which regulates heart rate. When the S-A node is stimulated by the vagus, the result is a slowed heart rate. Vagal withdrawal, on the other hand, is associated with an increased, or faster, rate and indicates regulation. Patterns of changing heart rate signify RSA, where increases in heart rate are associated with inspiration and decreases in heart rate are associated with expiration (Porges et al., 1994). Electrocardiography (ECG) allows for the detection of heart rate and, relevant for RSA, allows for the calculation of heart period, the time between adjacent heart beats ((Berntson et al., 2007). The heart rate period portrays a particular pattern that contains a period and amplitude, of which the RSA amplitude represents cardiac vagal tone (Porges et al., 1994).

From 6 to 12 months of life, RSA and PEP are valid measures of PNS and ANS activity (Suurland et al., 2016). There are significant developmental changes in the PNS that occur during this 6-month period whereby infants exhibit increasing vagal control in response to reactivity. However, individual patterns of responding appear to be stable at 6 months of age (Alkon et al., 2006). This coincides with the developing behavioral emotion regulation strategies (i.e., gaze aversion and self-soothing) that, although present at 6 months of age, develop and are mastered by the first year of life (Crockenberg & Leerkes, 2004; Field, 1994). Unlike RSA, PEP is not as frequently studied in infancy, so there is limited information on PEP changes during the first year of life. Therefore, more studies are needed to incorporate measures of PEP to better understand arousal in infancy.

Infant Emotion Regulation in the Still-Face Paradigm

Although there are several methods used to examine emotion regulation throughout the lifespan, the Still-Face Paradigm (SFP) is commonly used in infancy (e.g., Braungart-Rieker, Garwood, Powers, & Wang, 2001). The SFP was originally utilized by Tronick and colleagues (1978) to examine the role of infants in social interactions, as well as infant response to simulation of depression, and commonly consists of three episodes of face-to-face interaction between an adult and infant: (a) a normative free play between a parent and an infant; (b) the "still-face (SF)" episode where the parent is instructed to be unresponsive to the infant; and (c) a reunion episode where the parent resumes interaction with the infant (Mesman, van Ijzendoorn, & Bakermans-Kranenburg, 2009). The still-face effect is characterized by an increase in negative affect and a decrease in positive affect and infant gaze toward the parent during the SF episode, compared to the free play episode, followed by a mix of positive and negative affect that continues into the subsequent reunion episode (Mesman et al., 2009; Weinberg & Tronick, 1996). During the SFP, infants are no longer able to use their parent to aid in regulation so that when they become distressed during the SF episode it becomes necessary to use internal and independent regulatory strategies (Braungart-Rieker et al., 1998; Tronick & Gianino, 1986). Therefore, the SFP provides researchers with the opportunity to observe patterns of infant arousal and subsequent regulation.

During the SFP, several studies have examined the behavioral strategies that infants utilize to regulate the distress induced from experiencing an unresponsive parent. The regulatory behaviors most commonly used during infancy are self-distraction (i.e., averting gaze away from the source of frustration) and self-comforting (e.g., thumb sucking; Manian & Bornstein, 2009; Planalp & Braungart-Rieker, 2015; Stifter & Braungart, 1995). During the SF episode of the SFP, infants reduce their gaze toward their unresponsive parent and engage in self-comforting behaviors (e.g., thumb sucking), which is associated with subsequent declines in negative affect both across episodes and within episodes of the SFP (Ekas, Lickenbrock, & Braungart-Rieker, 2013a; Ekas, Haltigan, & Messinger, 2013b).

It is also possible to examine physiological changes associated with arousal and regulation during the SFP (Mesman et al., 2009). When studying arousal many studies have relied exclusively on infant heart rate (e.g., Conradt & Ablow, 2010; Gunning, Halligan, & Murray, 2013). Few studies have utilized measures of PEP during infancy, despite research showing that PEP can be measured at 6 months of age and autonomic changes can be observed (Alkon et al., 2006). This is a weakness of existing research given that heart rate is not a pure measure of SNS activity but rather a measure of ANS functioning as a whole (Stifter et al., 2011). When PEP shortening is observed, this indicates arousal (Berntson et al., 2007; Kahle et al., 2016). In the context of emotion regulation with toddlers and preschoolers, PEP has often been measured, thus, it is feasible to incorporate measures of PEP in the study of emotion regulation (e.g., Kahle et al., 2016; Stifter et al., 2011). For example, PEP shortening (arousal) was marginally associated with observed negative affect in 24-month-old children during different distressing tasks (Buss, Goldsmith, & Davidson, 2005). In a separate study of 3.5-year-olds, PEP shortening was also observed during a task that provoked anger, and individuals rated higher in emotion regulation showed better recovery (PEP lengthening) following distress, indicating the importance of including measures of PEP in tasks involving emotional arousal and regulation (Kahle et al., 2016; Stifter et al., 2011). To our knowledge, only one study has utilized measures of PEP in the context of the SFP and found PEP shortening during the SF episode in 6-month-old infants (Suurland et al., 2016). Given the paucity of research using PEP as an index of arousal in young infants, the current study aims to incorporate PEP to measure and arousal.

In contexts that involve interactions with another person, when infants experienced negative affect, they showed evidence of regulation via vagal withdrawal (lower RSA values that indicate regulation; Bazhenova, Plonskaia, & Porges, 2001). Pertinent to the current study, during the SFP, infants also display a pattern of vagal withdrawal during the SF episode (Conradt & Ablow, 2010). Therefore, it appears that vagal withdrawal can be used as a physiological marker of emotion regulation during the SFP. In addition, researchers have asserted that certain patterns of infant physiology, particularly vagal withdrawal, are indicative of emotion regulation due to their association with affective experiences of emotion. For example, during the SF episode when infants display more negative affect, this coincides with vagal withdrawal, which signifies arousal followed by regulation (Moore & Calkins, 2004; Weinberg & Tronick, 1996). These physiological patterns align well with the still-face effect since the reunion episode is characterized by a return to baseline levels of both heart rate and vagal tone (Weinberg & Tronick, 1996). Although researchers have established a still-face effect modeled by patterns of vagal withdrawal, physiological indices are not as commonly incorporated into studies of infant emotion regulation, particularly in the context of the SFP. In addition, although studies have established that infants experience physiological arousal followed by regulation during the SFP, most studies only examine arousal or regulation. The current proposal thus aimed to extend knowledge of infant emotional experiences by measuring arousal and regulation in terms of both behavior and physiology to fully represent all components of infant emotion regulation and to understand the patterns for each specific component.

Although it is important to examine arousal and regulation together, as they are the main components of an infant's physiological response, there are few studies that have incorporated both divisions of the ANS. Some studies have examined the integration of arousal and regulation, but have used heart rate as the measure of arousal (e.g., Bazhenova et al., 2001; Condradt & Ablow, 2010). Heart rate is not purely controlled by the SNS or the PNS but rather by both divisions of the ANS (Stifter et al., 2011). Therefore, more studies should utilize PEP as a measure of arousal since it solely reflects the influence of the SNS. When infants display a pattern of vagal withdrawal and heart rate increases during the SFP, infants are then able to employ behaviors that allow the infant to disengage (Bazhenova et al., 2001). It thus appears it is important to understand ANS functioning because of the direct association with regulation behaviors. Reciprocal activation of both branches (i.e., PEP shortening increase and suppression of vagal withdrawal) is associated with better emotion regulation in older children during challenging situations (Stifter et al., 2011). Because the SFP contains periods that are challenging (i.e., the SF episode), induce arousal and necessitate the need to regulate, it would be expected that during the SF episode infants would show PEP shortening (arousal) as well as vagal withdrawal (regulation). Both PEP and RSA should then approach or return to baseline levels in the reunion episode if infants have appropriately regulated the arousal they experienced in the SF episode. More research is needed to understand the patterns that emerge for not only arousal but also regulation between different episodes of the SFP. This proposal aims to examine both aspects of emotion regulation in order to gain a deeper understanding of the physiological responses that infants experience in the SFP.

Direct Effects on Infant Emotion Regulation

The development of emotion regulation is influenced by intrinsic and extrinsic factors (Fox & Calkins, 2003). One of the intrinsic factors that influences infant emotion regulation is temperament (Fox & Calkins, 2003; see Figure 1, path c_1). Infant temperament refers to reactivity and self-regulation differences between individuals and consists of three different domains: affect, activity, and attention (Rothbart & Bates, 2006; Rothbart & Sheese, 2007). Therefore, infant temperament is directly associated with arousal and regulation. High levels of distress to limitations, fear, and sadness characterize negative temperament. Infants with a negative temperament have difficulty recovering from distress (Braungart-Rieker et al., 2014; Putnam, Rothbart, & Gartstein, 2008). It has been suggested that negative infant temperament is partially responsible for the carry-over of negative affect from the SF episode into the reunion episode seen during the SFP (Yoo & Reeb-Sutherland, 2013). Although infants who are high and low in negative temperament show the typical still-face effect, only infants high in negative temperament have a more difficult time decreasing levels of negative engagement following the SF episode, which indicates they are not able to regulate their distress and return to baseline levels once the stressor of the SF episode (i.e., parental unresponsiveness) is no longer present

(Yoo & Reeb-Sutherland, 2013). In the SFP, infants who have more negative temperaments also engage in less self-comforting and gaze aversion behaviors with their mothers during the SF episode (Braungart-Rieker et al., 1998). Therefore, infants who have a more negative temperament not only show higher levels of arousal but also lower levels of regulatory behaviors. Infant temperament is also directly related to physiological regulation, and baseline levels of vagal tone are a good indicator of lower levels of infant negativity as young as 12 weeks old (Huffman et al., 1998). During stressful and frustrating tasks, infants who have a more negative temperament and become frustrated more easily, show less vagal withdrawal, indicating that they are not able to properly regulate their arousal (Calkins, Dedmon, Gill, Lomax, & Johnson, 2002). Unfortunately, measures of PEP have yet to be studied in conjunction with infant negative temperament. The current proposal aims to fill this gap by examining the direct, and indirect, effects of infant negative temperament on all components of infant arousal and regulation, including measures of PEP.

One of the extrinsic factors that influence emotion regulation during infancy is parents and the characteristics of a given parent (Fox & Calkins, 2003; see Figure 1, path c_2). During the first year of life, infants are still reliant on their caregivers to regulate distress, so it is especially important to examine the caregiver's role in infant emotion regulation (Calkins, 1994; Cole et al., 1994; Kopp, 1989). One characteristic of the parent that may influence emotion regulation in infancy is depression. Maternal depressive symptoms result in maternal emotional unavailability for the infant, which leads to disorganized patterns of behavior and physiology (Field, 1994). Indeed, infants that interact with mothers with depression have a more negative affective state and express more anger and negative affect in general (Tronick & Corrina, 2009). In a high-risk group of infants, some of whom had mothers with psychopathology, PEP shortening was enhanced in the SF episode indicating greater levels of arousal as well as less recovery from vagal withdrawal from the SF to the reunion episodes. This indicates these infants were not only more aroused but continued to have difficulty regulating after the SF episode was over (Suurland et al., 2016). Depression also impacts regulation as seen when infants whose mothers were depressed displayed different regulatory strategies such as higher levels of self-soothing as opposed to gaze aversion during the SFP (Manian & Bornstein, 2009). This may be because the infant has learned that they cannot rely on the parent to help regulate arousal and distress from the SF episode to the reunion (Suurland et al., 2016). In sum, stable infant and parent characteristics directly impact the different components of infant emotion regulation.

Indirect Effects on Infant Emotion Regulation

Although it appears that there is a direct impact of infant and parent characteristics on infant emotion regulation, it is also important to examine the mechanisms through which infant and parent characteristics impact this capability. One mechanism to consider is parenting, and during infancy, one of the most commonly studied parenting behaviors is maternal sensitivity (e.g., Ainsworth, 1979; Leerkes, 2011). In the context of the SFP, sensitivity refers to the engagement level of the parent, matching the child's gaze, physically putting themselves at the child's same level, being able to soothe the child in times of discomfort, and interacting with the child in a manner that matches the affective state of the child (Braungart-Rieker et al., 2001). Maternal sensitivity is especially important in the context of distress, during which infants turn to their caregivers for comfort (Leerkes, 2011). In the context of the SFP, it is important to examine maternal behaviors, because many researchers have posited that the still-face effect exists because infants are no longer able to use their parents to aid in regulation (e.g., Mesman et al., 2009; Weinberg & Tronick, 1996). In addition, parenting behaviors exhibited either before or after the SF episode may influence arousal and regulation (Braungart-Rieker et al., 2014).

Sensitivity is associated with both behavioral and physiological aspects of arousal and regulation (see Figure 1, path b). Infants whose mothers were more sensitive showed less negative affect, more self-comforting, and more gaze aversion during the SF episode (Braungart-Rieker et al., 1998; Braungart-Rieker et al., 2001). Parent sensitivity is also associated with more self-comforting from the SF episode to the reunion (Braungart-Rieker et al., 2014). Therefore, parental sensitivity impacted arousal by dampening the still-face effect and also enhanced infant regulatory behaviors during the SF episode. Maternal sensitivity aids in recovery following the SF episode, such that when mothers are more sensitive during that reunion episode their infants decrease their use of gaze aversion (Condradt & Ablow, 2010). In addition, maternal sensitivity also impacts physiological arousal and regulation. When mothers were more sensitive following the SF episode, infants showed increases in RSA, indicating that they were able to recover from the SF episode (Condradt & Ablow, 2010). Maternal sensitivity during the reunion episode, but not during the free play episode, impacted infant physiological responses to the SF (Codradt & Ablow, 2010). Infants who had parents that were more sensitive not only regulated better by showing vagal withdrawal in the SF episode, but this pattern continued into the reunion where infants showed lower levels of RSA compared to baseline (Moore et al., 2009). Sensitivity impacts behavioral arousal and regulation and physiological regulation; however, to date, physiological measures of arousal have not been fully incorporated in the research investigating the impact of parenting on infant emotion regulation.

Although studies have often focused on the global parenting behavior of sensitivity, few studies have examined the particular components of sensitivity in a similar manner. One maternal behavior that is of particular interest is touch. Touch, one of the first senses to mature during infancy, is communicative in nature and can convey different feelings from the caregiver to the infant, which in turn regulates the feelings and behaviors of the infant (Hertenstein, 2002; Hertenstein, Verkamp, Kerestes, & Holmes, 2006). Touch is a vital parenting behavior to investigate because it influences an infant's perception and experience of others and the world around him or her by helping to serve as a co-regulatory mechanism between the infant and his or her caregiver, whereby the caregiver aids in the infants' regulation (Feldman, Weller, Sirota, & Eidelman, 2003; Tronick, 1995). Through the communication of emotions via the modality of touch, positive emotions are evoked and negative emotions lessened (Hertenstein, 2002). Touch is also positively reinforcing for infants and their preference for touch can be seen in increased expressions of positivity from receiving touch (Field, 2002). Indeed, infants showed more positive affect in interactions with their mothers following a regimen of infant massage by the caregiver (Field, 1995).

The touch mothers provide may serve differing communicative functions (Tronick, 1995). According to Jean and Stack (2009), there are nine different functions of touch, some of which include a parent touching their infant with the intended goal of being playful, or a parent touching their infant while also engaging in some other mode of communication. These different functions of touch may help infants to better regulate negative emotions (Hertenstein & Campos, 2001). Nurturing touch that involves stroking an infant or touching the infant in a rhythmic manner occurs most frequently by caregivers and may function to increase infant positive affect (Tronick, 1995). In addition, affectionate touch has been associated with better regulatory capacities in infancy (Feldman & Eidelman, 2007). Studies show that mothers use touch for differing functions during the SFP. Playful touch (e.g., tickling) was used most frequently across episodes of the SFP, but nurturing touch (e.g., stroking the infants' cheek) was used marginally more during the reunion period, particularly when infants were more distressed during the SF episode (Jean & Stack, 2009). Studies have also found that different functions of touch are associated with different displays of infant affect and self-regulatory behaviors (Jean, Stack, & Arnold, 2014). When mothers were allowed to touch their infants during the still-face episodes their active touch was associated with more positive affect and more gaze toward the mother (Stack & Muir, 1992).

To date, only two studies have examined touch as it naturally occurs across the SFP and its direct associations with infant regulatory behaviors (Jean & Stack, 2012; Lowe et al., 2016). Overall levels of maternal touch have been associated with certain behavioral strategies in infants, whereby increased maternal touch is associated with less self-comforting and more gaze aversion. Further, this appears to differ based on episode of the SFP, and playful touch was associated with less gaze aversion during the reunion period (Jean & Stack, 2012). Touch that was playful in nature was associated with more positive infant affect both prior to and following the SF episode, and particularly following the SF episode, whereas touch that served to get the child's attention or accompany another modality of communication was associated with a decrease in affect on a second-by-second basis. For touch that accompanied another modality of commination, the decrease in negative affect was only seen prior to the SF episode, whereas attention-seeking touch was associated with affect during both episodes and particularly following the SF episode (Lowe et al., 2016). These are the only studies to our knowledge to investigate the impact of maternal touch on emotion regulation in a similar manner as the global parenting measure of sensitivity. Because these studies only investigated the behavioral indices of arousal and regulation and did not examine both arousal and regulation together, the current study aimed to investigate how maternal touch impacts both infant arousal and regulation during the SF and reunion episodes. This will help to inform how specific parenting behaviors influence physiology, which could help to determine what components of sensitive parenting are most important for infants.

Although a limited number of studies have examined associations between touch and emotion regulation, fewer studies have incorporated physiological measures in the study of maternal touch. Infants who received moderate levels of affectionate touch showed less change in heart rate, indicating less arousal (Fairhurst, M.T., Löken, L., & Grossman, T., 2014). In studies that have manipulated touch during the SFP, when infants received touch during the still-face episode, there was less emotional arousal and, subsequently, less vagal withdrawal, indicating that infants did not need to regulate as much (Feldman, Singer, & Zagoory, 2010). This would suggest that touch may impact the relationship between reactivity and regulation for infants in the SFP. No studies have incorporated measures of PEP in the context of maternal parenting behaviors and infant emotion regulation. The proposed study will comprehensively investigate the impact of parenting on infant emotion regulation by including physiological measures of arousal.

Because infant and parent characteristics directly influence emotion regulation and parental touch indirectly impacts infant emotion regulation, it is important to investigate factors that explain individual variability in the type, and frequency, of touch that parents utilize during interactions with their infants. According to Belsky's (1984) seminal theory on parenting, he asserts that two factors that can influence the quality of parenting are factors related to characteristics of the child and the parent (see Figure 1, paths a_1 and a_2). One of the most notable child characteristics that influences the quality of parenting is infant temperament (Belsky, 1984;

see Figure 1, path a_1). Infant temperament directly influences the quality of parenting, such that infants with a more negative temperament are more likely to receive lower quality parenting, specifically sensitivity (Belsky, 1984; Ghera et al., 2006; Mills-Koonce et al., 2007). In observed interactions, mothers are less sensitive when their infants react more negatively and are also rated by the parent as being more fearful, which is a characteristic of negative temperament (Mills-Koonce, Propper, & Barnett, 2012). Infant negative temperament is also related to a reduced ability for an infant and mother to bond at 6 months after birth (Nolvi et al., 2016). In the context of the SFP, when infants are less difficult, their mothers engage with them in a more sensitive manner (Planalp, Braungart-Rieker, Lickenbrock, & Zentall, 2013). Infants with a more negative temperament, however, engage with their mothers in a more negative manner following the still-face episode as well (Yoo & Reeb-Sutherland, 2013). Therefore, infants with a negative temperament may elicit lower quality interactions with their parent. No studies have investigated the influence of infant negative temperament on maternal touch. Consistent with the research on sensitivity, it is conceivable to hypothesize that aspects of infant temperament may influence the quality or type of touch that mothers utilize in interactions with their infants.

When considering maternal factors, one important and noted characteristic often studied is maternal depression (see Figure 1, path a_2). In general, mothers who endorse depressive symptoms are rated as having poorer quality interactions with their child (Field, Hossain, & Malphurs, 1999). In addition, mothers who endorse a greater number of depressive symptoms are less sensitive in their interactions with their infants (McFadden & Tamis-Lemonda, 2013). When mothers endorse depressive symptoms, they utilize touch less and their touch is more intrusive and negative (Beebe et al., 2008). These intrusive touch behaviors may evoke a negative response from their child, such as negative affect and gaze aversion (Reissland, Shepherd, & Herrera, 2005). Therefore, it is possible that when mothers are experiencing depressive symptoms qualities of their touch may not help the infant regulate but may actually exacerbate distress. However, if utilized properly, touch can be beneficial for mothers who are depressed. During the SFP, when depressed mothers were able to use touch, the infants displayed more positive affect suggesting that touch may compensate for other modalities of communication that may be impaired due to depression (Paláez-Nogueras, Field, Hossain, & Pickens, 1996). However, no studies have examined the direct effects of maternal depression on touch, especially in the context of the SFP. Therefore, this study aims to investigate not only the factors that directly influence infant emotion regulation (infant negative temperament and maternal depressive symptoms), but also the indirect pathway (touch) through which this effect occurs. This could allow researchers to pinpoint specific targets for parenting interventions

Fathers

In the context of infant development, the role of fathers is often ignored. The "essential father" hypothesis asserts that the contribution of fathers to child development is essential and unique (Pleck, 2010). Because fathers often do not spend as much time with their children as mothers do, the time they do spend with them and their behaviors may be even more salient and impactful on children. When examining the unique role of fathers, it appears that paternal parenting behaviors are independent of maternal behaviors and account for child outcomes uniquely, but these effects may not be completely different from the effects of maternal parenting behavior. Good fathering is generally associated with positive child outcomes (Pleck, 2010). Additional evidence for the importance of fathers comes from research on father absence and, together, these studies suggest that children suffer from absent fathers because, without fathers, there are many roles in a family that are not adequately filled (Lamb, 2010). Because of the importance of fathers, it is important to focus on the unique aspects of paternal interactions with children to understand the specific mechanisms behind the influence of the father on child development. Fathers differ in their interactions with their children and often spend more time in play but their interactions with their children are not solely limited to this function (Lamb, 2010). Fathers also sufficiently respond to their infants' needs and interact with their infants (Lamb & Lewis, 2010). Therefore, it appears that although often ignored, fathers play an integral role in their child's development and there may be unique aspects of father's parenting, such as play, that differ from maternal parenting behaviors.

In order to examine the role of fathers in infant development, many studies investigate the differences between father-infant and mother-infant interactions. When comparing mother-infant interactions to father-infant interactions, interactions between different mothers and their infants are more similar than interactions between a mother and a father with the same infant (Moore et al., 2013). While mothers may provide more structure in their interactions with their infants (Moore et al., 2013), fathers arouse their infants in a positive and more emotionally intense way through play, resulting in interactions that have higher intensity levels (Feldman, 2003). Indeed, fathers spend more time engaged in physical play with their children compared to mothers (Forbes, Cohn, Allen, & Lewinsohn, 2004). This play and arousal may not only be more important for child outcomes in the context of the father-child relationship (Grossman et al., 2002), but may also allow infants opportunities to learn how to regulate (Parke, 1994).

Due to the potential differences in father-infant interactions, it is important to examine infant arousal and regulation in interactions with fathers because, similar to mothers, fathers may directly impact their infants' emotion regulation. In interactions with both fathers and mothers, infants display similar levels of negative affect and regulatory behaviors (e.g., heightened negative affect and gaze aversion) during the SF episode (Braungart-Rieker et al., 1998). In addition, infants show the same still-face effect pattern in the SFP with mothers and fathers where negative affect increases in the SF episode and the recovers upon reunion and gaze aversion and self-comforting increase during the SF episode (Braungart-Rieker et al., 2014). Infant negative affect is also higher than positive affect during the SF episode, which demonstrates the distressing effects of the SFP on infants with both mothers and fathers (Braungart-Rieker et al., 1998).

Although the general still-face appears to be consistent across parents, there are some subtle differences in patterns of infant arousal and infant regulation (Bridges, Grolnick, & Connell, 1997; Diener, Mangelsdorf, McHale, & Frosch, 2002). For example, during face-to face play interactions with fathers, infants displayed less positive affect than with mothers (Forbes et al., 2004). During the SFP with fathers, infants also display different amounts of regulatory behaviors than they do with mothers, as seen in orienting towards their father more and orienting towards objects less during the SF episode (Braungart-Rieker et al., 1998). In addition, infants engaged in more self-comforting and gaze aversion during the SFP with mothers during the SF episode, whereas they looked at their father more (Braungart-Rieker et al., 2001). During the father-infant SFP, associations between affect and regulatory strategies also differed. For example, there was a positive association between positive affect and self-comforting behaviors during the father-infant SFP but not during mother-infant SFP (Braungart-Rieker et al., 1998). It appears that there are differences in observable arousal and regulation behaviors in father-infant interactions. To our knowledge, however, no studies have incorporated physiological measures of emotion regulation throughout the SFP with fathers. In order to fully understand father-child interactions, it is necessary to examine similar components in both mothers and fathers to fully compare the interactions and impacts of each parent on emotion regulation.

Similar to mothers, infant regulation in interactions with fathers may be directly impacted by both characteristics of the child and the parent (see Figure 1, paths c_1 and c_2). Infant temperament appears to directly impact infant regulation with their fathers (see Figure 1, path c_1), where infants who are less difficult were able to distract themselves faster with their fathers, and infants who were not well-regulated used more self-comforting with their fathers during the SFP (Planalp & Braungart-Rieker, 2015). Paternal depressive symptoms also appear to impact infant emotion regulation (see Figure 1, path c_2). In face-to-face interactions where there is no SF episode, infants are more awake, orient toward the father more, smile more, fuss less, and vocalize more in interactions with their depressed fathers compared to interactions with depressed mothers (Field et al., 1999). In addition, parent history of depression was not associated with infant affect during the SF episode of the SFP with fathers but was associated with less infant positive affect during the SF episode with mothers (Forbes et al., 2004). Therefore, the impact of depression on infants may differ based on parent, and it is important to investigate how mothers and fathers differentially impact infants' emotion regulation and what characteristics matter in the context of mother-infant and father-infant interactions.

Similar to mothers, paternal parenting behaviors may also have an indirect effect on infant emotion regulation. Because fathers interact with their infants differently, it is possible that there may be differences in parenting behaviors (e.g., sensitivity) as well. While some studies have found that mothers and fathers often display similar amounts of sensitivity and engagement with their child during the SFP (Braungart-Rieker et al., 1998; Braungart-Rieker et al., 2001), other studies have found that mothers were more sensitive and engaged in more play than fathers during the SFP (Planalp et al., 2013). There may also be different implications for parenting behaviors in father-infant interactions (see Figure 1, path b). When fathers were less sensitive, infants display more negative affect during the SFP and this effect was unique to the father-infant interaction, potentially due to fathers being more sensitive to an infants' negative temperament or because less sensitive parenting from fathers evoked more negative responses from infants (Braungart-Rieker et al., 2014). In addition, when fathers were more engaged with their infants during the SFP, infants oriented towards their fathers more. However, only maternal sensitivity was related to infant affective responses during the SFP. It is possible that different nuanced aspects of parenting from mothers and fathers contributes to the different facets of emotion regulation for infants (Braungart-Rieker et al., 1998). Although it is not conclusive from previous research if mothers and fathers differ in their parenting behaviors, it appears that paternal parenting behaviors impact behavioral indices of infant arousal and regulation during the SFP. Although most studies have focused on the behavioral indices of arousal and regulation with fathers, it is also important to examine infant physiological responses. Fathers do appear to impact infant physiology, and fathers who were more intrusive and showed more negative regard towards their infant had infants that showed an increased cortisol response during an emotionally frustrating task (Mills-Koonce et al., 2011). However, researchers have yet to incorporate physiological measures of ANS functioning, such as RSA and PEP during father-infant interactions.

Although a limited number of studies have examined the differences in maternal and paternal sensitivity, even fewer studies have focused on the specific behavior of paternal touch. The studies that do exist, however, show that the type of touch that a father uses is directly related to the quality of play. For example, touch for the purpose of caretaking was associated with lower quality play interactions between fathers and infants (Shields & Sparling, 1993). In the only other study, Feldman and Eidelman (2007) examined the touch that fathers used in their interactions with premature infants. The focus was on how father behavior influenced mother-child outcomes and not on father-child outcomes. To our knowledge, these are the only studies that have examined paternal touch during infancy. It is important to both expand research on the role of paternal touch in infant arousal and regulation in order to determine if it is an important parenting behavior for fathers. .

Similar to the examination of the factors that influence maternal parenting behaviors, there are also several factors that may influence paternal parenting behaviors (see Figure 1, paths a_1 and a_2). Beginning in the prenatal period, and continuing into the postnatal period, fathers experience changes in hormones. For example, fathers experience a decline in testosterone levels, which is associated with greater levels of paternal responsiveness (Storey, Walsh, Quinton, & Wynne-Edwards 2000). As a result of these hormonal changes, fathers are at risk of experiencing postpartum depression after the birth of a child (Don & Mickelson, 2012). Similar to mothers, these depressive symptoms could impact father's parenting behaviors (see Figure 1, path a_2). Indeed, fathers that endorse a higher number of depressive symptoms are not as negatively impacted in interactions with their child compared to mothers that endorse depressive symptoms (Field et al., 1999). Some other studies have found that paternal depression negatively impacts fathers' interactions with their infants, whereby they are less engaged and more withdrawn (Bronte-Tinkew, Moore, Matthews, & Carrano, 2007; Sethna, Murray, Netsi, Psychogiou, & Ramchandani, 2015). It is possible that fathers who experience depressive symptoms may engage in parenting behaviors (e.g., touch) in a different manner, but more research is needed in order to fully establish this association and to understand its impact on child outcomes, since there is a proposed link between maternal depressive symptoms and poor infant outcomes (Belsky, 1984).

Another factor that may influence paternal parenting behaviors is infant temperament (see Figure 1, path a_1). Several infant temperament qualities appear to later impact father-infant insecure attachment as opposed to only one temperamental category for mothers (Planalp & Braungart-Rieker, 2013). Fathers may be more attuned to different qualities of their infant's temperament, which could impact their parenting and, in turn, their child's attachment relationship. It is also possible that when observing direct parenting behaviors, that infant temperament may not impact fathers in the same manner as mothers. For example, infant negative temperament predicted maternal sensitivity across time but not paternal sensitivity (Planalp et al., 2013). In addition, researchers have found an association between low paternal sensitivity and greater infant negative affect during the SFP and posited that these infants may also have a negative temperament and that fathers respond in a more negative manner when interacting with children with a negative temperament (Braungart-Rieker et al., 2014). Further, fathers tend to engage with their children more when they have a less negative temperament (McBride, Schoppe, & Rane, 2002). They also display greater affection when their infants have a less negative temperament (Volling & Belsky, 1991). It appears that fathers are impacted by their infants' temperament and that this impact may be different than that on mothers.

The Current Study

The overall purpose of the current study was to examine the intrinsic and extrinsic factors that influence parental touch and, in turn, how parental touch influences infant arousal and regulation during the SFP. This goal was accomplished through four specific aims:

1. The first specific aim was to replicate the SFP with respect to infant affect, regulatory behaviors, and RSA, and to add a more comprehensive and nuanced understand of physiology by establishing the role of PEP in the still-face effect. It was hypothesized that during the SF episode, infants would display more negative affect, engage in more self-comforting behaviors, shift their gaze away from the parent, show vagal withdrawal, and experience PEP shortening. In addition, the still-face effect was compared between mothers and fathers, and it was expected that, although similar patterns would emerge for both the mother-infant and father-infant SF, there may be subtle differences in infant behavior. Specifically, infants may show more negative affect and show less gaze aversion and self-comforting with fathers compared to mothers. Although currently not established in the literature, it was expected that infants would show similar patterns of physiology with fathers, due to the existence of the still-face effect in both the mother-infant and father-infant SFP.
2. The second aim of the study was to investigate the direct and indirect effects of infant and parent characteristics on infant negative affect, regulation, PEP, and RSA across the SFP through the indirect pathway of parenting behaviors. In order to establish both of the direct and indirect effects in this model, analyses were conducted in a stepwise process.
    a. The first step (Aim 2a) in establishing the direct and indirect effects of infant and parent characteristics on emotion regulation through the indirect pathway of parenting behaviors, was to investigate whether maternal depressive symptoms and infant negative temperament impacted parental touch behaviors. Because of the established direct impact of these characteristics on infant emotion regulation, it was necessary to also investigate their impact on parenting behaviors in order to

test for an indirect effect on emotion regulation. It was expected that infants with a more negative temperament would receive different levels and functions of touch, particularly nurturing touch and overall touch, and the same was expected for mothers that endorse a greater number of depressive symptoms. For fathers, it was expected that only infant negative temperament would impact the use of touch, particularly playful touch, whereas depressive symptoms would not, which is consistent with the literature on sensitivity.

b. Next (Aim 2b), I examined the impact of parental touch on infant regulation. Parental touch may be the mechanism through which infant and parent characteristics impact emotion regulation. Because parental touch has yet to be conceptualized and investigated in this way, it was necessary to explore what functions of touch impact infant arousal and regulation. It was hypothesized that maternal touch during the free play episode may reduce infant negative affect and infant PEP shortening in the SF episode (i.e., reduce arousal) and increase infant gaze aversion, self-comforting, and vagal withdrawal (i.e., enhance regulation) as well. In addition, maternal touch, specifically overall levels of touch and nurturing touch during the reunion, was hypothesized to impact better recovery during the reunion. The specific pattern expected is signified by decreases in infant negative affect, PEP lengthening, less self-comforting, more attention towards the mother, and RSA values that approach baseline levels. No studies to date have investigated these specific features of touch across the context of the SFP. Analyses concerning the importance of the different functions of touch were mostly exploratory. However, it was expected that nurturing touch and overall levels of touch would specifically be related to these patterns. Given the paucity of research with fathers, no specific hypotheses were proposed with respect to differences between mothers and fathers.

c. The final step (Aim 2c), examined the direct and indirect effects of infant and parent characteristics on infant emotion regulation through the indirect pathway of parenting behaviors together in one model. Specifically, this study aimed investigate how infant and parent characteristics impacted touch during both the free play and reunion, and how touch, in turn, impacted change in infant arousal and regulation from both the free play to the SF episode and the SF episode to the reunion. It was expected that touch would mediate the association between infant negative temperament and parental depressive symptoms and infant emotion regulation change scores from the free play to the SF episode and from the SF to the reunion episode. It was unclear whether it would be full or partial mediation. The final model was expected to be different for mothers and fathers and it was expected that infant negative temperament would both directly and indirectly influence infant emotion regulation, but paternal depressive symptoms would not.

Method

Participants

For the present study, 83 infants completed the study with both of their parents. Of the 83 infants, some infants will be excluded from some analyses due to the inability to complete the SFP with one parent due to the distress induced by the first SFP, physiological data that could not be used because of the presence of too much noise, the cessation of the SFP because of distress, or technological issues. The final sample consisted of 68 mother-infant dyads and 61 father-infant dyads, and those excluded did not differ on any demographic variables from those included in the final sample. The sample consisted of two different infant age groups: 6 months old (n = 69) and 9 months old (n = 14). Of the 6-month-old infants, 43.5% were male (n = 30) and 56.5% were female (n = 39). Of the 9-month-old infants, 71.4% were male (n = 10) and 28.6% were female (n = 4). Mothers ranged in age from 20 to 47 years old (M = 31.98, SD = 4.23) and fathers ranged in age from 24 to 46 years old (M = 33.46, SD = 4.84). Of the 83 infants, parents indicated that 17.1% infants were of Hispanic/Latino ethnicity and 82.9% were identified as other. More specifically, 86.96% of infants were White/Caucasian, 9.78% were Black/African American, 2.17% were Asian, and 1.09% were American Indian/Alaska Native. The sample was mostly upper middle class with 801.9% of families indicating a household income of $50,000 or greater, 10.8% a household income between $40,000 and $49,000, 3.6% between $20,000 and $29,000, 2.4% between $10,000 and $19,000, and 1.2% between $5,000, and $9,999. Further, the sample was also well-educated where 98.8% of mothers and 93.8% fathers had at least some level of college education.

Procedure

Participants were recruited locally through resources and organizations that target or provide services to families with young children. After expressing interest, families were contacted via phone or email in order to provide them with more details about the study and to verify that they qualified. Families were scheduled to come into the lab within 2 weeks of their infant reaching either 6 months or 9 months of age. Prior to the in-lab visit, both parents were mailed questionnaires in order to obtain demographic information, and measures of parent depressive symptoms and infant temperament. During the laboratory visit, parents first signed informed consent, a permission form for their infant to participate, a media consent form, and answered questions about their infant's general health and mood on the day of the visit. Then, the infant was connected to sensors in order to obtain physiological measures. The infant was placed on a changing table with one or both parents present who helped undress the infant and aided the researcher in placing the sensors on the infant. All infants were then placed in a white, neutral onesie so that gender would be more ambiguous. Parents were randomly assigned to one of two conditions (mother first versus father first). Both parents completed the same procedure with their infant. For 2 minutes, the parent and infant were seated in a chair with the infant on the parent's lap while they watched a neutral, animated video (e.g., Baby Einstein). Following this baseline assessment, infants were placed in a high chair and the parent was seated in a chair face-to-face with their infant and at eye level. Next, the SFP (Tronick et al., 1978) was completed. The first 2 minutes of the SFP consisted of the free play (FP) episode in which the parent and infant interacted face-to-face without the aid of any toys. The second 2 minutes consisted of the SF episode during which the parent was instructed to stop interacting with the infant and to display a neutral facial expression while maintaining eye contact with the infant. Finally, the parent resumed interaction with the infant for the final 2 minutes, the reunion (RE) episode. The parents were notified to move to the next episode via instructions from the researcher that were issued over a microphone. If at any point the child became distressed and displayed levels of hard crying without cessation for 30 consecutive seconds or if the parent indicated that they would like for the task to be terminated, the episode was ended. If the infant could not complete the FP episode due to distress, then the SFP was terminated and not conducted. During the baseline and SFP, three cameras were used to collect audio and video recording. Two of the cameras obtained a side view of the infant and parent and one camera was solely focused on the infant. Physiological data was also collected throughout the procedure utilizing the sensors that were placed on the infant prior to the SFP.

Measures

Infant affect. Infant affect was coded during all episodes of the SFP with both parents utilizing a valid coding system that has been used during the SFP (Braungart-Rieker et al., 1998). Infant affect was coded on a second-by-second basis on a 7-point scale (-3 = *screaming, extreme crying,* 3 = *intensely laughing, mouth opened widely in a smile*). Infant affect was rated based on facial expression, specifically the infant's mouth and eyebrows. A score of zero indicated that the infant had a neutral expression where no smiling behavior or expression was present. Independent coders were trained via a gold standard criterion and 21% of cases for mother-infant and father-infant SFP were coded for reliability. For the present sample, the internal consistency (Intraclass Correlation) was .94 for the FP episode, .96 for the SF episode, and .96 for the RE episode during the mother-infant SFP. For fathers, the internal consistency was .93 for the FP episode, .94 for the SF episode, and .95 for the RE episode. Proportion scores will be calculated for each episode to determine the proportion of time the infant displayed negative affect.

Infant regulatory strategies. Infant regulatory strategies were coded using a valid and reliable measure of infant regulation (Braungart-Rieker et al., 1998; Ekas et al., 2013a). Two categories of infant regulatory strategies (visual behavior and motor behavior) were coded on a second-by-second basis during the SFP. For visual behaviors, the infant could either be looking at the parent, distracting themselves (i.e., not looking at the parent), or not looking (i.e., the infants' eyes were closed). The visual behaviors were mutually exclusive and the predominant behavior during each second of the interaction was coded. For motor behaviors, the child could be self-soothing (e.g., sucking their thumb), engaging in high-intensity motor behavior, rhythmic movement, or escape behavior. Only self-soothing was utilized for the present project. Motor behaviors were not mutually exclusive. Independent coders were trained using a gold standard criteria and 28% of cases for mother-infant SFP and 30% of cases for father infant SFP were coded for reliability. Internal consistency for the present sample during the maternal SFP was .73, .74, and .75 for visual behaviors across the SFP and .92, .75, and .86 for self-soothing across the SFP. Internal consistency for the present sample during the paternal SFP was .70, .71, and .74 for visual behaviors across the SFP and .93, .92, and .95 for self-soothing across the SFP. Proportion scores will be calculated to determine the amount of time infants utilized each strategy.

Infant physiology. Infant physiological data was collected using MindWare ambulatory monitors (MW1000A). Adhesive electrodes were placed in the following locations: bottom rib on the left and right side, the left clavicle, the xiphisternal junction, at the top of the sternum by the jugular and offset to the right, and then one inch below and above the preceding two locations on the back. Mindware Biolab software was used to obtain the following signals: impedence (Z0), first derivative of impedence (dz/dt), and electrocardiogram (ECG; Kahle et al., 2016). A sampling frequency of 500 Hz was used. The Mindware Impedence Cardio Application was used to calculate PEP values for each infant across each SFP with their mother and father. Measures of PEP were calculated as the average PEP value across each of the episodes. Mindware Heart Rate Variability Analysis was used to obtain measures of RSA for each 60-second interval across all episodes of the SFP. The signal selected for respiration was dz/dt. The bandwidth for the infants was set to .003–.040 for the VLF Band, .040–.240 for the LF Band, and .240–1.040 for the HF/RSA band. Measures of RSA were calculated as the average RSA value across each of the episodes so that each average was calculated from two 60-

second intervals within the corresponding episode. For both RSA and PEP, 20% of cases will be coded for reliability to ensure that values obtained by both coders are within .10 of one another (Scrimgeour, Davis, & Buss, 2016). All inconsistencies were consensus coded.

Parental touch. Parental touch was coded using the Functions of Touch Scale (FTS; Jean & Stack, 2009), which has previously been used to coded touch during the SFP. Touch was coded on a second-by-second basis during the FP and RE episodes of both the mother-infant and father-infant SFP. For each second of the interaction, touch was coded as one of nine functions of touch (see Table 1). Proportion scores were calculated to indicate the proportion of time parents spent utilizing each function of touch during the FP and RE episodes of the SFP. A total touch score was also calculated to indicate the proportion of time the parent spent touching the infant regardless of function. Independent coders were trained using a gold standard criteria and 21% of cases for the mother-infant and father-infant SFP were coded for reliability. The Kappa value during the SFP with the mother was .88 for the FP episode and .81 for the RE episode. The Kappa value during the SFP with the father was .81 for the FP episode and .81 for the RE episode.

Table 1

Functions of Touch Scale (Jean & Stack, 2009)

Function	Definition	Example
1. Passive Accompaniment	Touch is tactile (i.e., not moving) and accompanies another modality of communication	Talking to the infant while the parent's hands are resting on the infant
2. Active Accompaniment	Touch accompanies another modality of communication but is active	Moving the infant's hands while talking

Function	Definition	Example
3. Playful	Touch is active and accompanies a game	Active touch while singing or making noises
4. Nurturing	Touch done in a soothing manner and accompanies concern or acknowledgement of the infant's distress	Rubbing the infant's check while saying, "It's okay."
5. Attention-Getting	Touch that is active and used to direct the infant's attention back to the parent if the infant's attention is currently elsewhere	Grabbing the infant's cheek to direct the infant's gaze back towards the parent
6. Utilitarian	Touch that serves to complete an instrumental task	Removing the high chair straps from the infant's mouth

Parental depressive symptoms. Mothers and fathers independently completed a valid and reliable measure of depressive symptoms, the Center for Epidemiological Studies Depression Scale (CES-D; Radloff 1977). Parents reported how many times they experienced varying symptoms of depression during the past two weeks by answering items on a 4-point scale (0 = *rarely or none of the time (less than one day)*, 3 = *most or all of the time (5–7 days)*). Sample items include "I was bothered by things that usually don't bother me," "I felt depressed," and "I could not get 'going.'" After reverse coding four items, sum scores were calculated where higher scores were indicative of a greater number of depressive symptoms present. A score of 16 or higher indicates potential clinical depression (Radloff, 1977). Cronbach's Alpha for the present sample was .82 and .75 for mothers and fathers respectively.

Infant temperament. Several domains of temperament were rated by both mothers and fathers using a valid and reliable measure of infant temperament, the Infant Behavior

Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003). Parents reported how often their infant displayed several behaviors during the last week on 7-point scale (1 = *never*, 7 = *always*). If an item did not apply, parents were allowed to indicate that the item did not apply and it was excluded in the calculation of scale scores. The 191 items of the measure are divided into 14 subscales that range in length from 10–18 items. The subscales are as follows: activity level, distress to limitations, fear, duration of orienting, smiling and laughter, high pleasure, low pleasure, soothability, falling reactivity/rate of recovery from distress, cuddliness, perceptual sensitivity, sadness, approach, and vocal reactivity. Across the measure, 31 items were reverse coded and for each subscale, a mean score was calculated where higher scores are indicative of a greater presence of the specified behaviors. For the current study, infant negative temperament was calculated in line with previous research (Braungart-Rieker et al., 2014; Putnam, Rothbart, & Gartstein, 2008) by averaging the following four subscales: distress to limitations, fear, sadness, and falling reactivity/rate of recovery from distress (reverse coded). Cronbach's Alpha for the present sample for mothers and fathers was .93 and .96 respectively.

Results

Descriptive Analyses

Prior to conducting the primary analyses, means and standard deviations for each of the variables of interest were calculated (see Table 2). In addition, covariate analyses were conducted to determine if any demographic variables needed to be included in any of the following analyses. The specific covariates tested were infant age, infant ethnicity, infant gender, household income, parent education, and parent order of the SFP.

Table 2

Descriptive statistics

	Mothers			Fathers		
Variable	Range	*Mean*	*SD*	Range	*Mean*	*SD*
1. Depressive Symptoms	.00 – 27.00	7.09	6.20	.00 – 22.00	6.21	4.74
2. Negative Temperament	2.83 – 5.28	3.59	.48	2.43 – 4.75	3.57	.51
3. All Touch (FP)	.00 – 1.00	.62	.26	.03 – 1.00	.63	.29
4. Passive Accompaniment (FP)	.00 – .53	.10	.13	.00 – .43	.04	.08
5. Active Accompaniment (FP)	.00 – .79	.14	.15	.00 – .72	.23	.20
6. Nurturing (FP)	.00 – .90	.004	.01	.00 – .04	.002	.01
7. Playful (FP)	.00 – .85	.33	.23	.00 – .93	.32	.24
8. Attention-Getting (FP)	.00 – .09	.01	.02	.00 – .13	.02	.03
9. Utilitarian (FP)	.00 – .20	.04	.05	.00 – .13	.02	.03
10. All Touch (RE)	.00 – 1.00	.67	.24	.10 – 1.00	.68	.27
11. Passive Accompaniment (RE)	.00 – .61	.08	.11	.00 – .64	.07	.12
12. Active Accompaniment (RE)	.00 – .90	.23	.18	.00 – .83	.26	.21
13. Nurturing (RE)	.00 – .54	.04	.10	.00 – .17	.01	.03
14. Playful (RE)	.00 – .97	.28	.22	.00 – .87	.28	.24
15. Attention-Getting (RE)	.00 – .09	.01	.02	.00 – .17	.02	.04
16. Utilitarian (RE)	.00 – .33	.04	.06	.00 – .33	.04	.06

	Mothers			Fathers		
Variable	Range	*Mean*	*SD*	Range	*Mean*	*SD*
17. Negative Affect (SF)	-.15 – .93	.27	.30	-.43 – .78	.15	.25
18. PEP (SF)	-15.00 – 11.00	-.92	4.72	-14.00 – 6.00	-1.75	3.98
19. Distraction (SF)	-.14 – .82	.32	.23	-.24 – .86	.33	.23
20. Self-Soothing (SF)	-.63 – .65	.01	.19	-.74 – .49	.03	.19
21. RSA (SF)	-3.17 – 2.04	-.36	.90	-2.90 – 4.30	-.14	1.15
22. Negative Affect (RE)	-.70 – .81	-.02	.25	-.83 – .62	-.01	.28
23. PEP (RE)	-20.00 – 12.00	-.62	5.17	-8.00 – 9.00	.54	3.36
24. Distraction (RE)	-.74 – .42	-.30	.23	-.86 – .15	-.36	.24
25. Self-Soothing (RE)	-.78 – .97	.03	.24	-.54 – .58	-.03	.21
26. RSA (RE)	-2.66 – 1.74	.22	.84	-2.56 – 4.08	-.01	1.09

Covariate analyses for maternal sample. Maternal education was associated with depressive symptoms, $F(1, 66) = 6.27$, $p = .02$. Mothers who were not college educated endorsed a higher number of depressive symptoms. Education was also associated with PEP values during the SF, $F(1, 66) = 4.72$, $p = .03$. Infants of mothers who were not college educated had higher PEP values during this episode. Parent order was a significant covariate for the proportion of nurturing touch during the free play, FP, $F(1, 66) = 5.34$, $p = .02$, proportion of overall touch during the RE, $F(1, 66) = 4.49$, $p = .04$, passive accompaniment during the RE, $F(1, 66) = 4.59$, $p = .04$, the change in negative affect during the SF, $F(1, 66) = 22.73$, $p < .001$, and the change in negative affect from SF to RE, $F(1, 66) = 8.92$, $p = .004$. When the infant participated in the SFP with father first, mothers engaged in more nurturing touch during the reunion, and more overall touch as well as passive accompaniment during the reunion. When the infant did the SFP with the father first, he or she displayed a greater increase in negative affect during the SF and more negative affect during the reunion as well. Parent order was also a significant covariate for the raw values of negative affect during the FP, $F(1, 66) = 12.12$, $p < .001$, SF, $F(1, 66) = 31.96$, $p <.001$, and RE, $F(1, 66) = 9.45$, $p = .003$, as well as RSA during the FP, $F(1, 66) = 4.76$, $p = .03$, and SF, $F(1, 66) = 5.86$, $p = .02$. When the mother-child SFP was second, infants displayed more negative affect during all of the episodes and lower RSA levels during the FP and SF. Child ethnicity was a significant covariate for utilitarian touch during the RE, $F(1, 66) = 4.54$, $p = .04$, and the change in self-soothing behavior from the FP to the SF, $F(1, 66) = 4.30$, $p = .04$. Hispanic/Latino infants received more utilitarian touch and displayed more self-soothing during the reunion. Male infants received more playful touch during the reunion, $F(1, 66) = 6.58$, $p = .01$, and had higher RSA levels during the RE, $F(1, 66) = 13.10$, $p <.001$. Male infants showed greater RSA change from the SF to the RE, $F(1, 66) = 5.01$, $p = .03$. Infants from a household with an income below $40,000 received more utilitarian touch during the FP, $F(1, 66) = 5.80$, $p = .02$. Infants whose mothers who were not college educated had a lower change in distraction behaviors from the SF to the RE, $F(1, 66) = 4.32$, $p = .04$.

Covariate analyses for paternal sample. For fathers, parent order impacted playful touch during the FP, $F(1, 59) = 5.80$, $p = .02$, RSA change from FP to SF, $F(1, 59) = 6.03$, $p = .02$, and SF to RE, $F(1, 59) = 5.86$, $p = .02$. When the father-infant SFP came first, fathers engaged in less playful touch during the FP, and their infants had less RSA change from the FP to the SF and the SF to the RE. Parent order also affected the raw distraction, $F(1, 59) = 5.47$, $p = .02$, and RSA, $F(1, 59) = 7.13$, $p = .01$, values from the FP as well as RSA during the RE, $F(1, 59) = 8.43$, $p = .01$. When infants did the SFP with their fathers first, they displayed more distraction during the FP and had lower RSA values during the FP and RE. Child ethnicity also impacted the amount of playful touch during the RE, $F(1, 59) = 5.83$ $p = .02$, and Hispanic/Latino children received more playful touch. Child age was associated with lower RSA levels for 6 month olds during the FP, $F(1, 59) = 4.57$, $p = .04$. Child gender was associated with playful touch during the RE, $F(1, 59) = 6.91$, $p = .01$, as well as the change in distraction from FP to SF, $F(1, 59) = 6.91$, $p = .01$. Males received more playful touch than females during the RE and had less of a change in distraction behaviors. Household income impacted the amount of nurturing touch during the FP, $F(1, 59) = 4.69$, $p = .03$, and infants from a household that made less than $40,000 a year received more nurturing touch from their father. Paternal education was a significant covariate for PEP recovery from the SF to the RE, $F(1, 59) = 5.96$, $p = .02$, and infants with fathers who were not college educated, showed greater recovery. Paternal education affected the raw negative affect values from the SF, $F(1, 59) = 4.25$, $p = .04$, and the RE, $F(1, 59) = 5.05$, $p = .03$. Infants of college educated fathers displayed more negative affect.

Parent differences in touch. Seven separate (episode x parent) repeated measures analysis of variance (ANOVA) were conducted (see Table 3) to examine differences between mothers and fathers for the six different functions of touch as well as overall levels of touch. All post hoc tests were conducted with the Bonferroni adjustment.

Table 3

Group Differences in Touch

Variable	df	*F*	*p*	η_p^2	Power	Bonferonnni
1. All Touch	1,51					
Parent		2.17	.15	.04	.30	
Parent x Order		2.47	.12	.05	.34	
Episode		7.41	.01*	.13	.76	.04*
Episode x Order		3.07	.09	.06	.41	
Parent x Episode		.59	.45	.01	.12	
Parent x Episode x Order		.52	.48	.01	.11	

Variable	df	F	p	η_p^2	Power	Bonferonnni
2. Passive Accompaniment	1, 51					
Parent		10.81	.002**	.18	.90	.03*
Parent x Order		5.50	.02*	.10	.63	
Episode		.09	.76	.00	.06	
Episode x Order		.37	.55	.01	.09	
Parent x Episode		.30	.59	.01	.08	
Parent x Episode x Order		2.94	.09	.05	.39	
3. Active Accompaniment	1,51					
Parent		.47	.50	.01	.10	
Parent x Education (Father)		2.58	.12	.05	.35	
Episode		.98	.33	.02	.16	
Episode x Education (Father)		.57	.45	.01	.12	
Parent x Episode		3.29	.08	.06	.43	
Parent x Episode x Education (Father)		2.35	.13	.04	.33	
4. Nurturing	1, 50					
Parent		2.13	.15	.04	.30	
Parent x Income		.36	.55	.01	.09	
Parent x Order		5.60	.02*	.10	.64	
Episode		1.19	.28	.02	.19	
Episode x Income		.53	.47	.01	.11	
Episode x Order		.16	.69	.00	.07	
Parent x Episode		1.44	.24	.03	.22	
Parent x Episode x Income		.66	.42	.01	.13	
Parent x Episode x Order		.65	.42	.01	.12	
5. Playful	1,49					
Parent		.72	.40	.01	.13	
Parent x Order		.04	.85	.00	.05	
Parent x Ethnicity		4.47	.04*	.08	.55	
Parent x Gender		1.33	.25	.03	.21	
Episode		5.82	.02*	.11	.66	.08
Episode x Order		2.43	.13	.05	.33	
Episode x Ethnicity		3.30	.08	.06	.43	
Episode x Gender		7.64	.01*	.14	.77	
Parent x Episode		4.31	.04*	.08	.53	.15 - .39
Parent x Episode x Order		11.41	.001***	.19	.91	
Parent x Episode x Ethnicity		.61	.44	.01	.12	
Parent x Episode x Gender		1.01	.32	.02	.17	

Variable	df	F	p	η_p^2	Power	Bonferonnni
6. Attention-Getting	1, 52					
Parent		2.77	.10	.05	.37	
Episode		.52	.47	.01	.11	
Parent x Episode		.13	.72	.00	.07	
7. Utilitarian	1, 50					
Parent		3.10	.09	.06	.41	
Parent x Income		2.12	.15	.04	.30	
Parent x Ethnicity		.32	.57	.01	.09	
Episode		1.06	.31	.02	.17	
Episode x Income		.07	.79	.00	.06	
Episode x Ethnicity		1.13	.29	.02	.18	
Parent x Episode		.35	.56	.01	.09	
Parent x Episode x Income		.74	.39	.02	.14	
Parent x Episode x Ethnicity		1.92	.17	.04	.27	

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

For overall touch, there was a significant main effect of episode, $F(1, 51) = 7.41$, $p = .01$, $\eta_p^2 = .13$, but no main effect of parent or episode x parent interaction. Post hoc analyses revealed that infants received significantly more touch during the RE ($M = .66$, $SE = .03$) compared to the FP ($M = .62$, $SE = .03$) episode regardless of parent, $p = .04$ (see Figure 2) For passive accompaniment, there was a significant main effect of parent, $F(1, 51) = 10.81$, $p = .002$, $\eta_p^2 = .18$. Regardless of episode, infants received more passive accompaniment from their mothers ($M = .09$, $SE = .01$) than fathers ($M =.05$, $SE = .01$), $p =.03$ (see Figure 3). There was no main effect of episode or a significant interaction.

Figure 2

Main Effect of Episode on Playful Touch

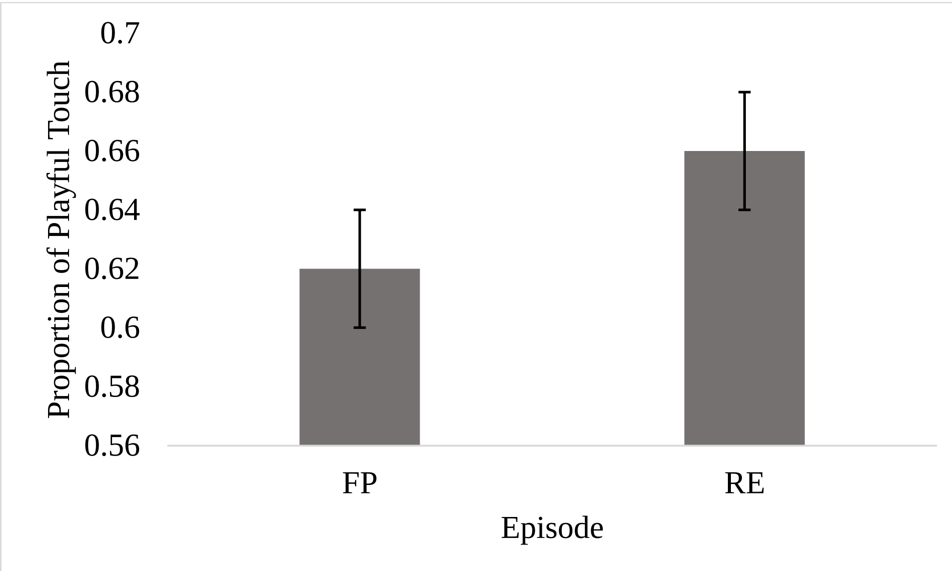
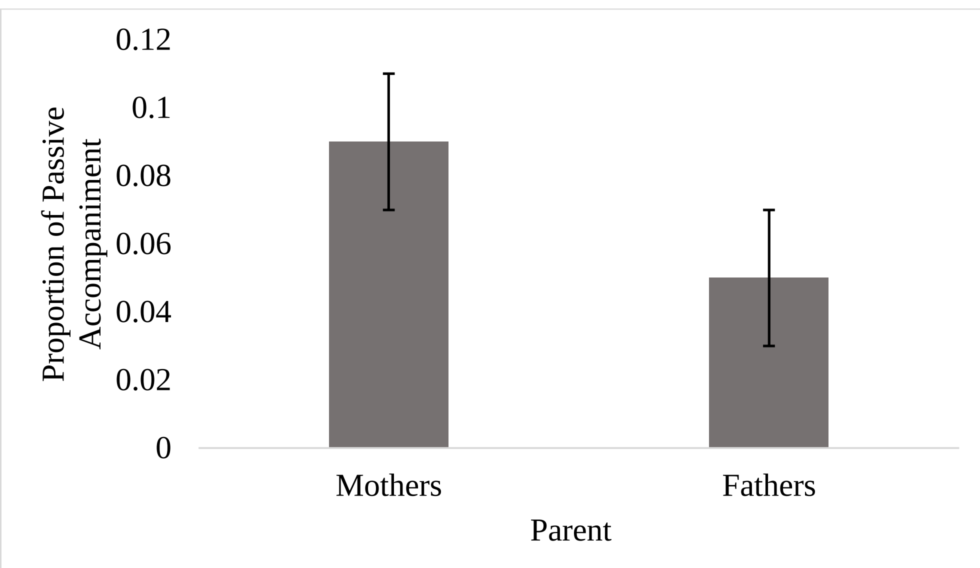


Figure 3

Main Effect of Parent on Passive Accompaniment

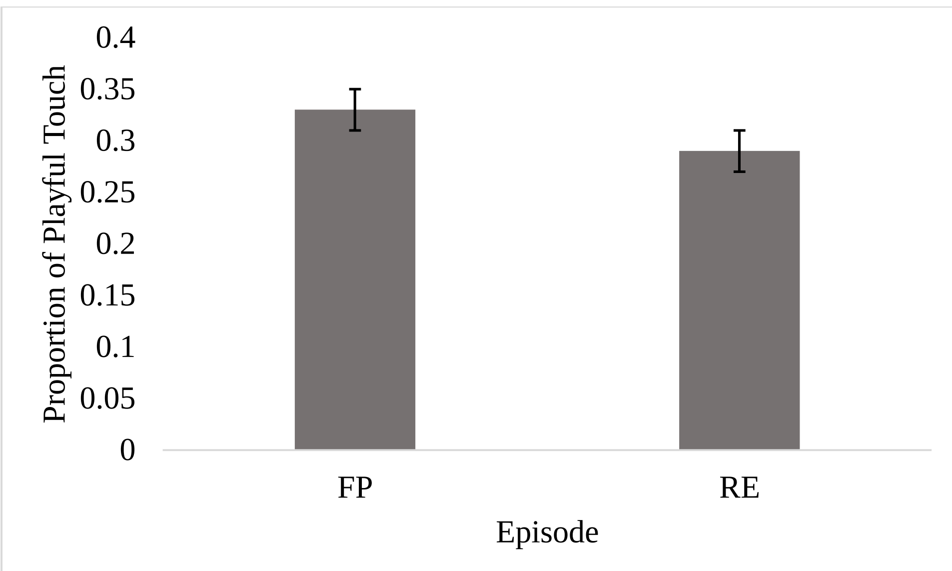


For playful touch there was a not a main effect of parent. There was a significant effect of episode, $F(1, 49) = 5.82$, $p = .02$, $\eta_p^2 = .11$, and an episode by parent interaction, $F(1, 49) =$

4.31, $p = .04$, $\eta_p^2 = .08$. There was a marginal mean difference between episodes (see Figure 4), $p = .08$, where infants received slightly more playful touch in the FP ($M = .33$, $SE = .02$) compared to the RE ($M = .29$, $SE = .02$). However, post hoc analyses did not result in any significant mean differences within the interaction, ps $\geq .15$. For active accompaniment, nurturing touch, attention-getting touch, and utilitarian touch there was no effect of parent, episode, or an interaction between the two.

Figure 4

Main Effect of Episode on Playful Touch



Specific Aim 1: Comparing the Still-Face Effect for Interactions with Mothers and Fathers

In order to examine the still face effect for mother-infant and father-infant interactions, (parent x episode) repeated measures analysis of variance (ANOVA) were conducted (see Table 4). Separate ANOVAs were conducted for the five infant arousal and regulation measures: negative affect, PEP, gaze aversion, self-comforting, and RSA. All post hoc tests were conducted with the Bonferroni adjustment.

Table 4

The Still-Face Effect

Variable	df	F	p	η_p^2	Observed Power	Bonferonnni
1. Negative Affect						
Parent	1,50	6.57	.01*	.12	.71	.64
Parent x Education (Father)		.91	.35	.02	.15	
Parent x Order		16.95	< .001***	.25	.98	
Episode	2, 100	4.74	.01*	.09	.78	<.001 – 1.00
Episode x Education (Father)		.51	.60	.01	.13	
Episode x Order		3.70	.03	.07	.67	
Parent x Episode	2, 100	3.02	.053	.06	.57	
Parent x Episode x Education (Father)		.14	.87	.00	.07	
Parent x Episode x Order		6.21	.003**	.11	.89	
2. PEP						
Parent	1, 51	2.63	.11	.05	.36	
Parent x Education (Mother)		1.58	.21	.03	.24	
Episode	2, 102	.52	.60	.01	.13	
Episode x Education (Mother)		.51	.60	.01	.13	
Parent x Episode	2, 102	.42	.66	.01	.12	
Parent x Episode x Education (Mother)		.31	.74	.01	.10	
3. Distraction						
Parent	1, 51	31.05	<.001***	.38	1.00	.003
Parent x Order		22.93	<.001***	.31	1.00	
Episode	2, 102	71.56	<.001***	.58	1.00	<.001 – 1.00
Episode x Order		.24	.79	.01	.09	
Parent x Episode	2, 102	.99	.38	.02	.22	
Parent x Episode x Order		.37	.69	.01	.11	
4. Self-Soothing						
Parent	1, 52	.13	.73	.00	.06	
Episode	2, 104	2.45	.09	.05	.48	
Parent x Episode	2, 104	1.57	.21	.03	.33	

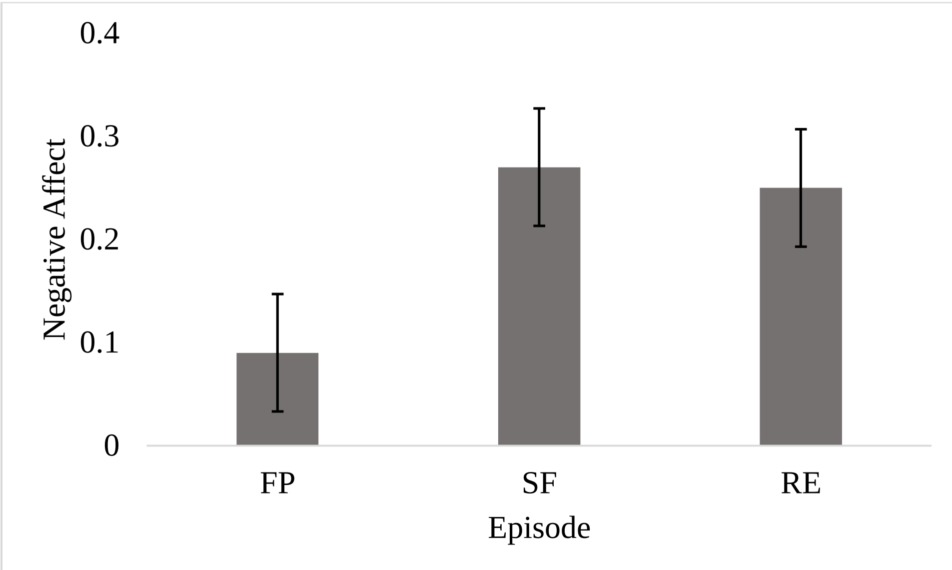
Variable	df	F	p	η_p^2	Observed Power	Bonferonnni
5. RSA						
Parent	1, 49	.04	.84	.00	.05	
Parent x Age		.25	.62	.01	.08	
Parent x Order		.41	.52	.01	.10	
Parent x Gender		.00	.96	.00	.05	
Episode	2, 98	2.76	.07	.05	.53	
Episode x Age		3.91	.02	.07	.69	
Episode x Order		2.24	.11	.04	.45	
Episode x Gender		3.54	.03*	.07	.65	
Parent x Episode	2, 98	3.57	.03*	.07	.65	.12 – 1.00
Parent x Episode x Age		2.68	.07	.05	.52	
Parent x Episode x Order		4.60	.01*	.09	.77	
Parent x Episode x Gender		1.46	.24	.03	.31	

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

For negative affect, there was a significant main effect of parent, $F(1, 50) = 6.57$, $p = .01$, $\eta_p^2 = .12$, and episode, $F(2, 100) = 4.75$, $p = .01$, $\eta_p^2 = .09$. There was not, however a significant interaction between episode and parent. For the main effect of episode, there was significantly more negative affect in the SF ($M = .27$, $SE = .04$) and RE ($M = .25$, $SE = .04$) compared to the FP, ($M = .09$, $SE = .02$), $p < .001$, but no difference between the SF and RE, $p = 1.00$ (see Figure 5). Post hoc analyses did not reveal a significant mean difference between parents, $p = .64$. For PEP, there was no significant main effect of episode, or parent, or a significant interaction, $F(2, 102) = .31$, $p = .74$, $\eta_p^2 = .01$.

Figure 5

Main Effect of Episode on Negative Affect



For distraction, there was a significant main effect of episode, $F(2, 102) = 71.56$, $p < .001$, $\eta_p^2 = .58$, and of parent, $F(1, 51) = 31.05$, $p < .001$, $\eta_p^2 = .38$. However, there was no episode x parent interaction. For the main effect of episode, there was more distraction in the SF ($M = .67$, $SE = .02$) episode compared to the FP ($M = .32$, $SE = .02$) and RE ($M = .32$, $SE = .02$), $p < .001$, which did not significantly differ, $p = 1.00$ (see Figure 6). For the main effect of parent (see Figure 7), infants engaged in more distraction behaviors with their fathers ($M = .47$, $SE = .02$) compared to their mothers ($M = .40$, $SE = .02$). For self-soothing, there was not a significant main effect of episode, or parent. Because of a violation of sphericity, the Greenhouse-Geisser correction was used for the interaction, which was also non-significant. For RSA, there was a marginal effect of episode, $F(2, 98) = 2.76$, $p = .07$, $\eta_p^2 = .05$, but no main effect of parent. There was a significant parent x episode interaction, $F(2, 49) = 3.57$, $p = .03$, $\eta_p^2 = .07$. However, post hoc analyses did not yield any significant mean differences, ps > .12.

Figure 6

Main Effect of Episode on Distraction

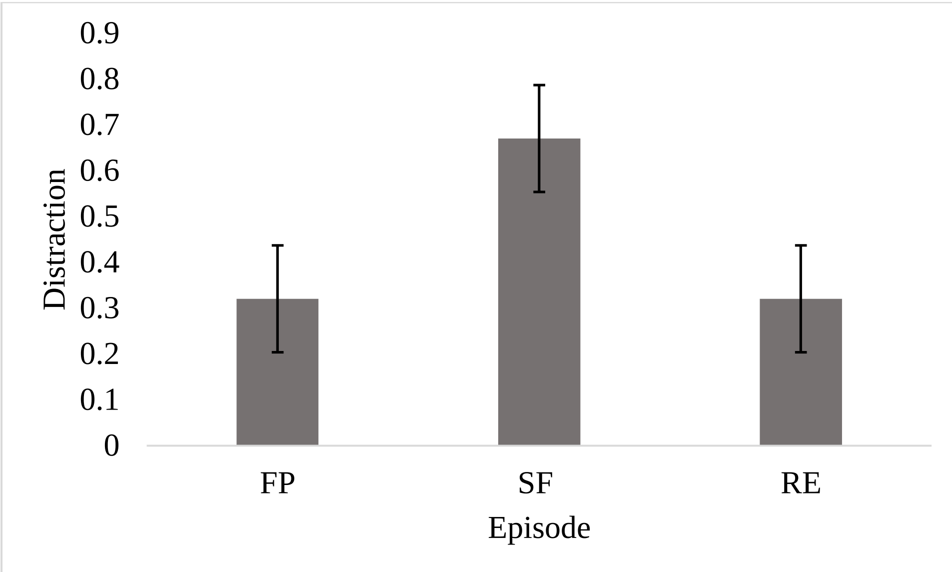
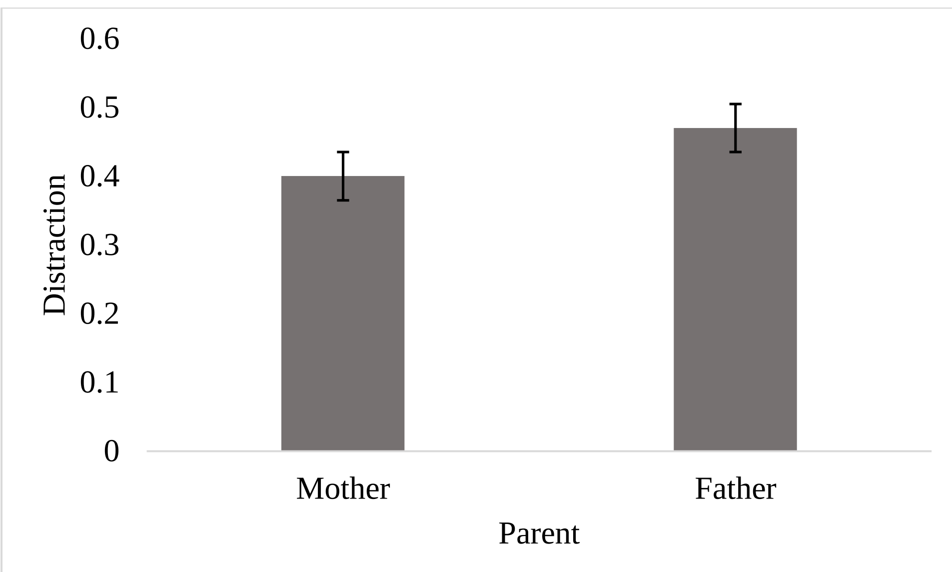


Figure 7

Main Effect of Parent on Distraction



Specific Aim 2a: The Associations between Infant Negative Temperament, Parental Depressive Symptoms, and Parental Touch

In order to examine the associations between infant negative temperament, parental depressive, and parental touch during the free play and reunion, separate correlation analyses were conducted with mothers and fathers between these two measures and the proportion scores of the six functions of touch, and overall levels of touch. Infant negative temperament was associated with attention-getting touch during the FP, $r = .29$, $p = .02$, as well as active accompaniment during the RE, $r = .26$, $p = .04$. Maternal depressive symptoms were associated with active accompaniment during the RE, $r = .32$, $p = .01$, and attention-getting touch during the RE, $r = .29$, $p = .02$. Infant temperament and depressive symptoms had no impact on fathers' use of touch.

Specific Aim 2b: The Association between Parental Touch and Infant Emotion Regulation

Five change scores were calculated for the change from the free play to the SF episode, and five more change scores were calculated for the change from the SF episode to the reunion with regards to all emotion regulation variables (negative affect, PEP, self-soothing, gaze aversion, and RSA). In order to examine the effect of parental touch during the free play and reunion episodes on infant emotion regulation during the SF and reunion episodes, separate correlation analyses were conducted for mothers and fathers. Further, in order to examine the indirect impact of parenting behaviors, correlation analyses between parent depressive symptoms, infant negative temperament, and emotion regulation variables were also calculated.

For mothers, nurturing touch during the FP was associated with the change in negative affect from FP to SF, $r = -.34$, $p = .01$. Passive accompaniment during the FP was associated with the change in negative affect from SF to RE, $r = .32$, $p = .01$. Attention-getting touch during the FP was associated with the change in self-soothing behaviors from the SF to the RE, $r = -.28$, $p = .02$. Attention-getting touch during the RE was also associated with the change in self-soothing from SF to RE, $r = -.28$, $p = .02$, as well as RSA change from SF to RE, $r = -.47$, $p < .001$. Maternal depressive symptoms were directly associated with RSA change from FP to SF, $r = -.29$, $p = .02$. Infant negative temperament was associated with the change in negative affect from SF to RE, $r = .28$, $p = .03$.

For fathers, active accompaniment during the FP was associated with change in distraction from FP to SF, $r = -.38$, $p = .003$, and from SF to RE, $r = .29$, $p = .02$. Passive accompaniment in the FP was associated with RSA change from SF to RE, $r = .28$, $p = .03$. Playful touch during the FP was associated with change in distraction from FP to SF, $r = .33$, $p = .01$, and RSA change from FP to SF, $r = -.28$, $p = .03$. Attention-getting touch during the FP was associated with distraction in the SF, $r = -.31$, $p = .02$, and RSA change from FP to SF, $r = .26$, $p = .04$. Active accompaniment in the RE was associated with change in distraction from SF to RE, $r = .35$, $p = .01$. Playful touch during the RE was associated with change in negative affect from SF to RE, $r = -.36$, $p = .01$, and change in distraction from SF to RE, $r = -.27$, $p = .04$. Attention-getting touch in the RE was associated with change in distraction, $r = .37$, $p = .004$, and RSA, $r = -.30$, $p = .02$, from SF to RE. Infant temperament and paternal depressive symptoms were not directly related to any of the infant emotion regulation outcome variables.

Aim 2c: The Direct and Indirect Factors that Are Associated with Infant Emotion Regulation

In order to examine the direct (infant negative temperament and parental depressive symptoms) and indirect (parental touch) factors that impact infant emotion regulation, structural equation modeling (SEM) utilizing Mplus software was conducted. SEM is appropriate because of the presence of multiple dependent variables in the models. The current analyses proposed were path analyses and contained only observed variables. Specifically, all indirect effects (a x b) were specified, because there were multiple indirect paths. Unstandardized values for the indirect pathways were reported. For the first models, touch from the FP was the mediator.

Figure 8a

First Hypothetical Mediation Model for Mothers

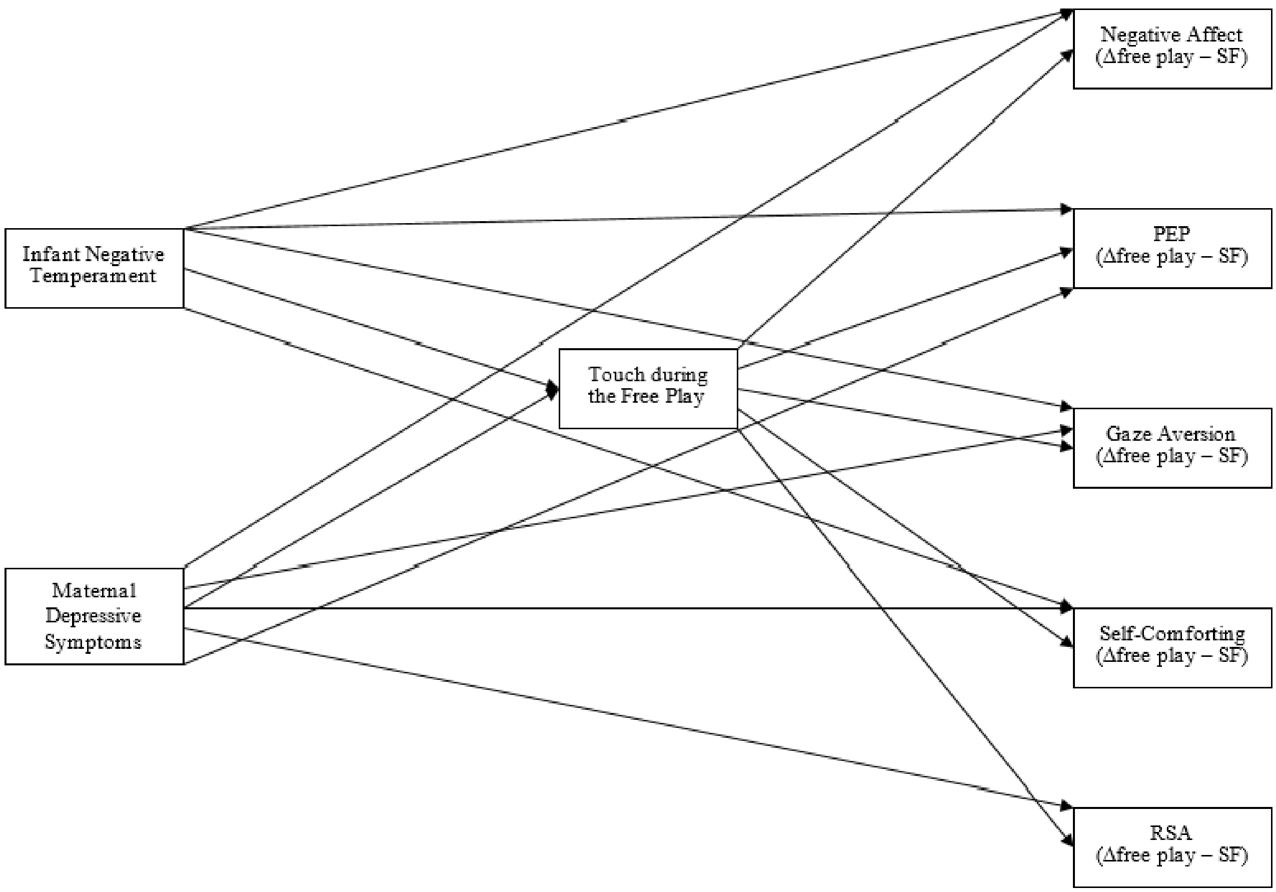
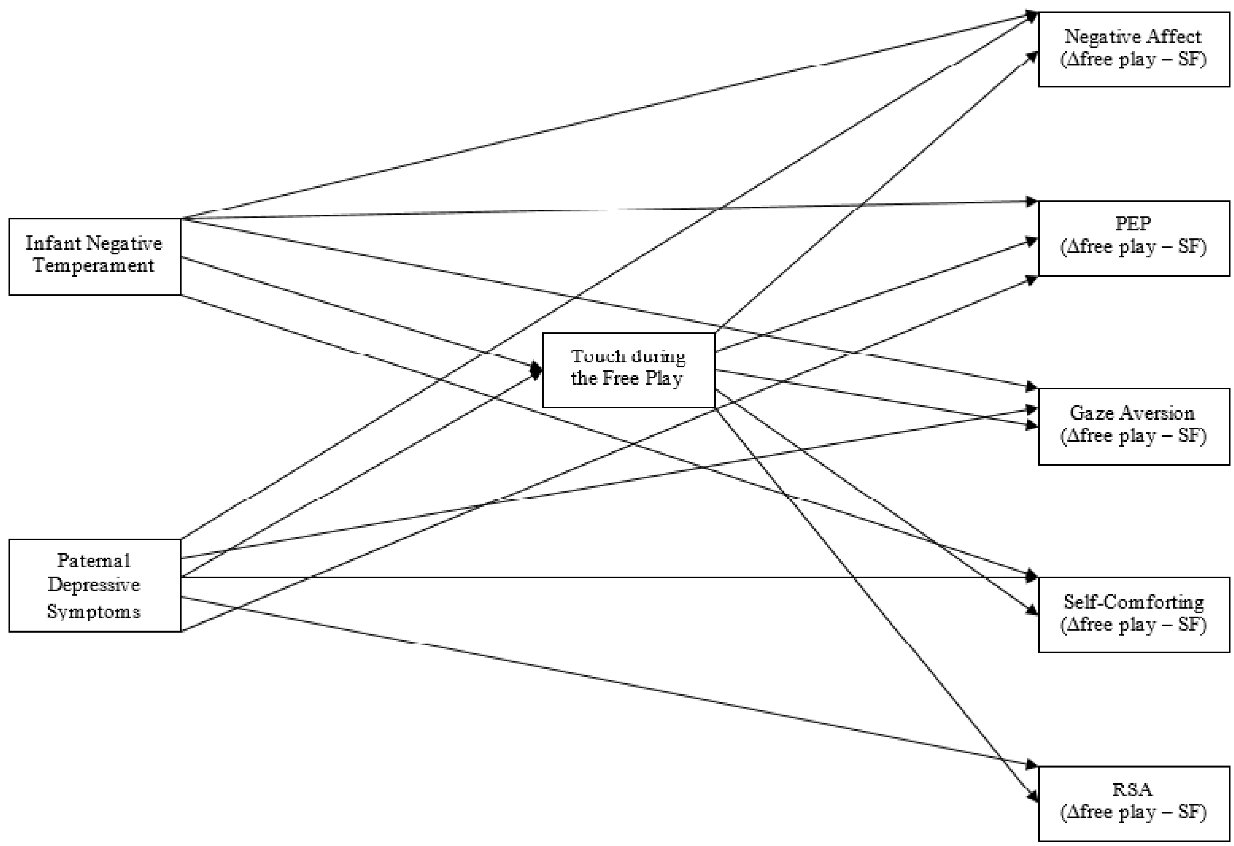


Figure 8b

First Hypothetical Mediation Model for Fathers

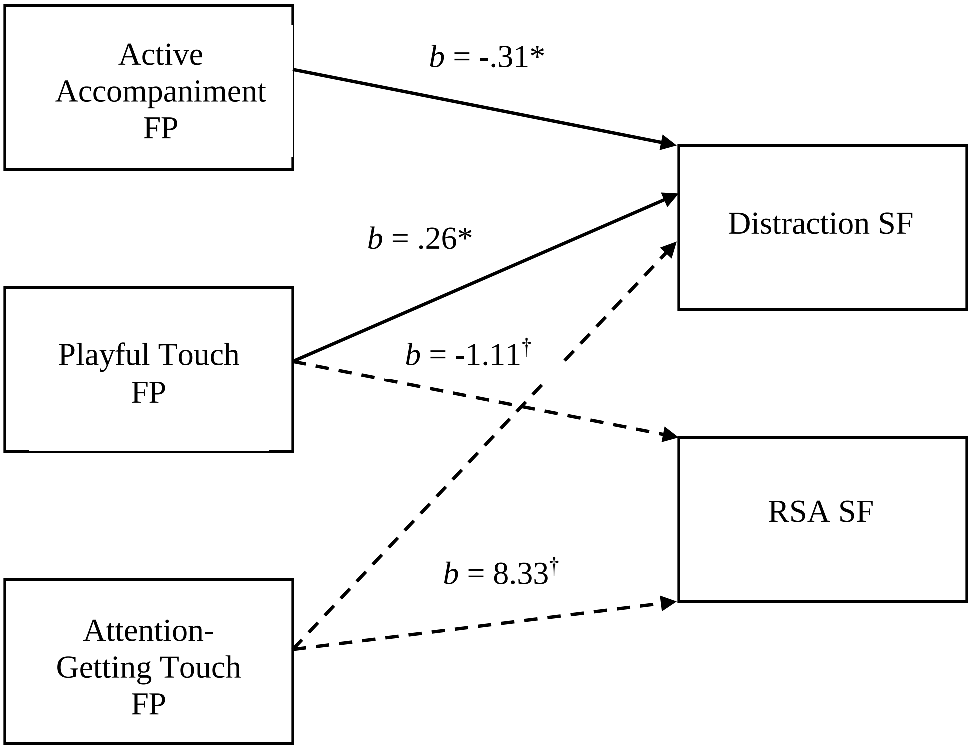


In the first model, infant negative temperament and maternal depressive symptoms were to be specified as the independent variables, significant touch during the free play episode from the exploratory analyses above as the mediating variables, and change scores from the free play to the SF episode for negative affect, PEP, gaze aversion, self-comforting, and RSA as the dependent variables (see Figure 1a). However for mothers, there was only a direct relationship between infant negative temperament and attention-getting touch during the FP, maternal depressive symptoms and change in RSA from FP to SF, and nurturing touch during the FP and change in NA from FP to SF. Because there were no paths where both the a and b path were significant, it was not appropriate to specify a mediation model in SEM.

For fathers, there were no significant a paths so the path model was specified in which only significant b paths from the preliminary analyses above were specified. This was also done in MPlus to allow for the simultaneous estimation of the model with the presence of both multiple independent variables and dependent variables. The model showed adequate fit to the data (Hu & Bentler, 1999). The Chi-Square value was 6.40 (df = 6, p =.38). The Comparative Fit Index (CFI) was .99, which is above the accepted .95. The Root Mean Square Error of Approximation (RMSEA) was .03 (CI: .00 - .17), which is below the accepted .05 and the upper bound of the CI was close to the accepted .10. Finally, the SRMR was .06, which is close to the accepted value of .05. There were not model fit indices, and due to the small sample size, he unstandardized values were examined and interpreted for this model (see Figure 10). Active accompaniment during the FP, b = -.31, SE = .13, p = .02, and playful touch during the FP, b = .26, SE = .11, p = .01, were associated with distraction during the SF. Attention-getting touch during the FP was not associated with distraction during the SF. Infants who received more active accompaniment during the FP showed less distraction behaviors during the SF, but infants who received more playful touch during the FP showed more distraction during the SF. Playful touch, b = -1.11, SE = .60, p = .06, and attention-getting touch during FP, b = 8.33, SE = 4.83, p = .09, were marginally associated with RSA change from FP to SF. Infants who received more playful touch had lower levels of RSA during the SF, but infants who received attention getting touch had higher levels of RSA.

Figure 9

First Model for Fathers



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

A second mediation model was conducted for both mothers and fathers where infant negative temperament and maternal depressive symptoms would be specified as the independent variables, significant touch during both the free play and reunion episodes from the exploratory analyses as the mediating variables, and change scores from the SF to the RE episode for negative affect, PEP, gaze aversion, self-comforting, and RSA as the dependent variables (see Figures 2a and 2b).

Figure 10a

Second Hypothetical Mediation Model for Mother

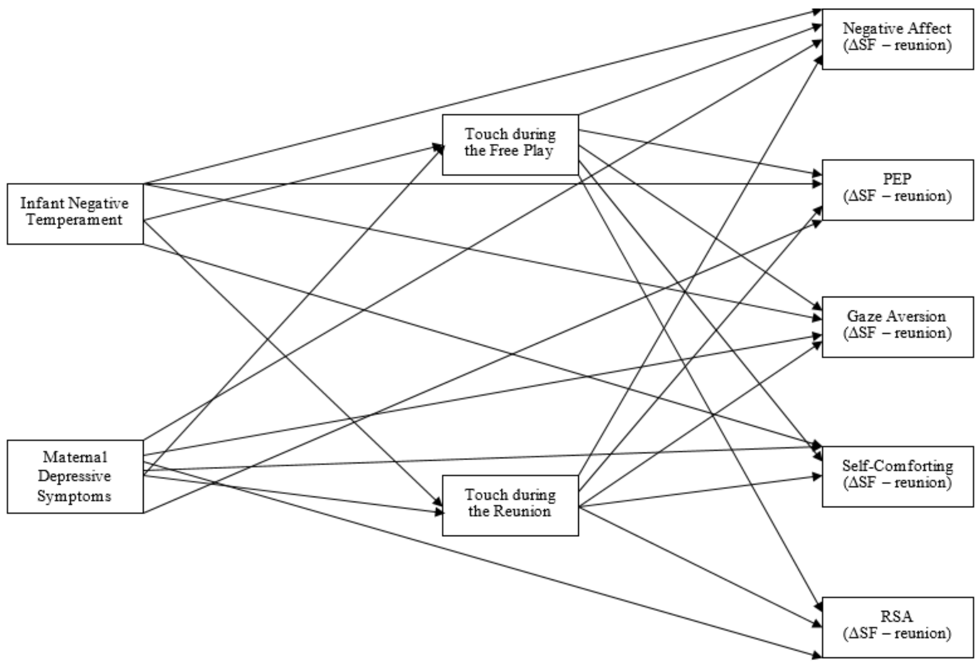
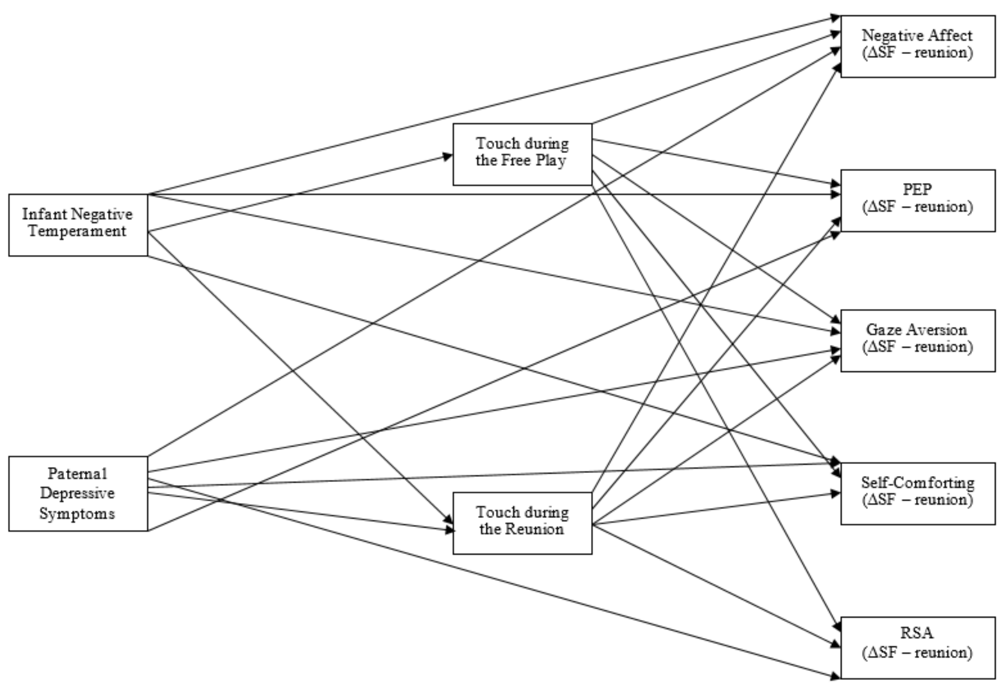


Figure 10b

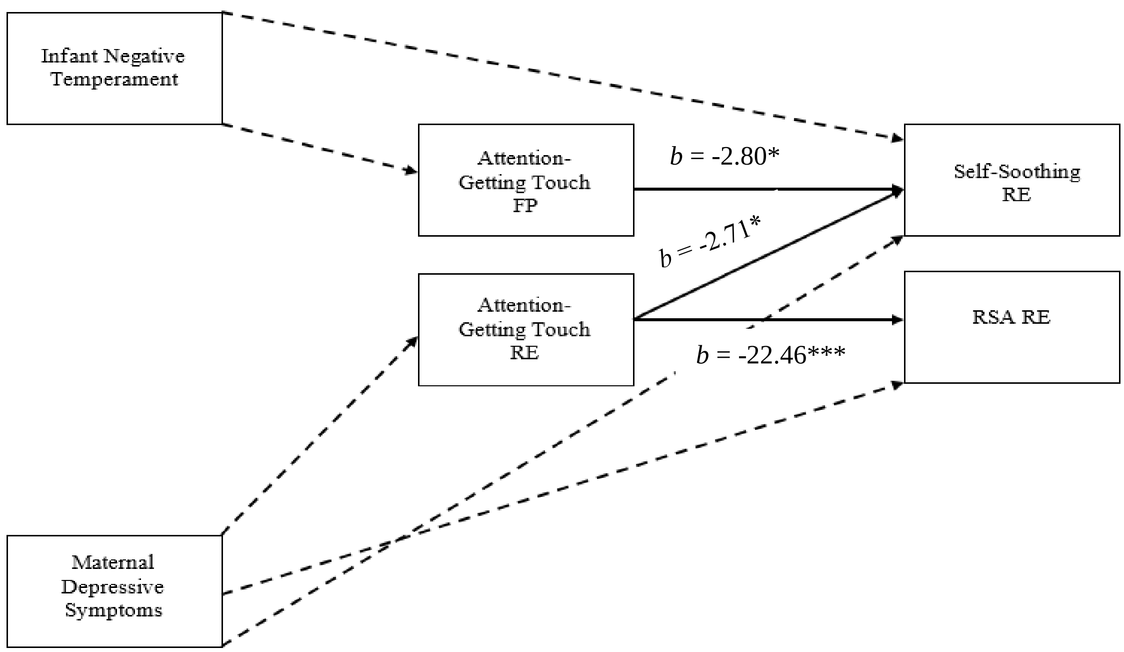
Mediation Model for Fathers



For mothers, only the significant a and b paths from the above exploratory analyses were conducted because the indirect effect is calculated by multiplying these paths. It was not appropriate to specify other paths, because it did not allow for the testing of a mediational model, the goal of this study. The model showed acceptable fit to the data (Hu & Bentler, 1999). The Chi-Square value was 19.74 (df = 14, p = .14). The Comparative Fit Index (CFI) was .88, which was close to the accepted .95. The Root Mean Square Error of Approximation (RMSEA) was .08 (CI: .00 - .15), which is not below the accepted .05 and the upper bound of the CI was close to the accepted .10. Finally, the SRMR was .08, which was not close to the accepted value of .05. Because there were no model fit indices given to improve the model and there was a small sample size given the number of parameters being estimated, the unstandardized values were examined and interpreted for this model as specified using 10,000 bootstrapping samples (see Figure 11). Attention getting touch during the FP, b = -2.80, SE = 1.35, p = .04, 90% CI [-5.21, .12] and RE, b = -2.71, SE =1.37, p =.047, 95% CI [-6.32, -.75] were both associated with self-soothing in the RE. There were no direct effects of infant negative temperament, or maternal depressive symptoms on self-soothing during the RE. Infants who received attention-getting touch in the FP and the RE showed less self-soothing behaviors in the RE compared to the SF. Attention-getting touch during the RE was also associated with change in RSA from SF to RE, b = -22.46, SE = 6.30, p < .001, 90% CI [-31.72, -6.84] but maternal depressive symptoms were not directly related to RSA. Infants who received attention-getting touch in the RE showed lower RSA levels in the RE compared to the SF. In addition, infant negative temperament was not associated with attention-getting touch during the FP, and maternal depressive symptoms, were not associated with attention-getting touch during the RE. Because of this lack of association, there were no significant indirect effects in this model *p*s = .18 - .25, and all 95% CI's contained zero.

Figure 11

Second Model for Mothers



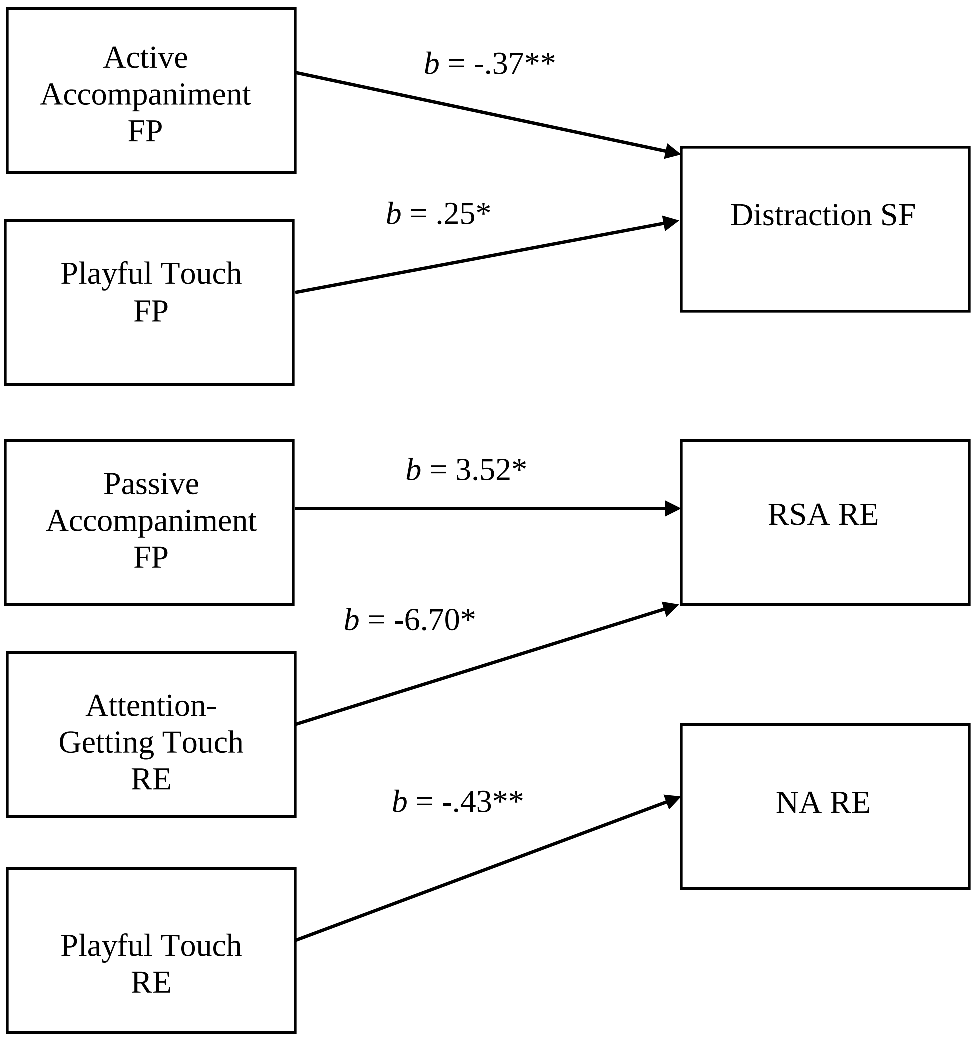
*Note. *** p <.001, ** p < .01, * p < .05*

For fathers, as before, there were no significant a paths, so the model was specified where only the significant paths from FP and RE touch to the emotion regulation outcomes in the SF and the RE were specified. The model showed poor fit to the data (Hu & Bentler, 1999). The Chi-Square value was 135.86 (*df* = 63, *p* < .001). The Comparative Fit Index (CFI) was .62, which was not close to the accepted .95. The Root Mean Square Error of Approximation (RMSEA) was .13 (CI: .11 - .17), which is not below the accepted .05 and the upper bound of the

CI was close to the accepted .10. Finally, the SRMR was .1, which was not close to the accepted value of .05. Because there were no model fit indices given to improve the model and there was a small sample size given the number of parameters being estimated, the non-significant paths were deleted out. A Chi-Square Difference Test revealed that this was a significant improvement from the previous model. The Chi-Square value was now 36.78 (df = 19, p = .01). The Comparative Fit Index (CFI) was .75, which was closer to the accepted .95. The Root Mean Square Error of Approximation (RMSEA) was .12 (CI: .06 - .18), which is not below the accepted .05 and the upper bound of the CI was close to the accepted .10. Finally, the SRMR was .09, which was closer to the accepted value of .05. Because there were no additional modification indices given to improve the model, the unstandardized coefficients were examined and interpreted for this model (see Figure 12). Active accompaniment, b = -.37 SE = .12, p =.003, and playful touch during the FP, b = .25, SE = .11, p = .02, were associated with distraction during the SF. Specifically, infants who received more active accompaniment showed less distraction during the SF, whereas infants who received playful touch during the FP showed more distraction. Passive accompaniment during the FP, b = 3.52, SE = 1.42, p =.01, and attention-getting touch during the RE, b = .25, SE = .11, p = .03, were associated with the change in RSA from SF to RE. Infants who received passive accompaniment during the FP had higher rates of RSA during the RE compared to the SF, whereas infants who received attention-getting touch during the RE showed lower levels of RSA. Finally, infants who received playful touch during the RE showed less negative affect in the RE compared to the SF, b = -.43, SE = .13, p = .001.

Figure 12

Second Model for Fathers



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

Discussion

The overall purpose of the current study was to examine the direct and indirect effects on infant emotion regulation by examining parental touch and infant emotion regulation as it occurs within the SFP as well as the influence of infant temperament and parental well-being on these processes. The current study was the first to examine both behavioral and physiological indices of emotion regulation, particularly PEP, as it relates to parental touch as well as one of only a few preexisting studies to examine parental touch as it occurs throughout the SFP and also the first to examine these processes in fathers. In order to achieve this overall goal, there were several specific research questions explored within the study: (1) parental differences in touch across the SFP; (2) infant differences in physiology and behavior during the SFP; (3) the associations between infant temperament, parental depressive symptoms, and parental touch; (4) the association between parental touch and infant emotion regulation; (5) simultaneously examining both the direct and indirect influences on infant emotion regulation.

Differences in Parental Touch

The current study aimed to examine touch as a component of parental sensitivity Consistent with hypotheses, more touch occurred during the RE compared to the FP. Based on the overall definition of sensitivity, parents should be able to soothe the child in times of discomfort (Braungart-Rieker et al., 2001). Because the SF episode is distressing for infants, one would expect to see more sensitivity following the SF episode due to the infant's displays of discomfort. It appears that parental touch is one of the behaviors that comprises sensitivity since patterns of touch during the SFP mirror patterns of sensitivity. This is important because parental sensitivity in times of distress is important for the infant outcomes, such as attachment (Leerkes, 2011). Touch is a co-regulatory mechanism through which an infant can use the parent for regulation (e.g., Feldman et al., 2003; Tronick, 1995). These findings suggest that parents are using this mechanism to help infants recover from a stressful experience. It is also possible that parents are using touch for themselves as well. The SFP is a situation that is unnatural for many parents where they are not allowed to touch their infant. Therefore, they may also be engaging in more touch during the RE episode to make up for the time they were not allowed to touch the infant. Because touch is a modality in which positive emotions can be evoked (Hertenstein, 2002), parents may be trying to confer positivity that they were unable to communicate during the separation of emotion. Parents may be using touch to not only communicate with the infant about distress but also to help the infant recover from distress.

Consistent with hypotheses, there was slightly less playful touch in the RE compared to the FP. Sensitivity involves interacting with a child in a way that matches the child's affective state (Braungart-Rieker et al., 2001). Because of the still-face effect and the carryover of negative affect into the RE (Mesman et al., 2009, Weinberg & Tronick, 1996), it is understandable why parents would engage in less play during this episode. To try and play upbeat games with a child that is distressed may not be appropriate. Although playful touch is not always insensitive, playful touch during a period when a child is distressed may be more intrusive rather than sensitive. In addition, the parent may be trying to reestablish rapport with the child after being emotionally unavailable, and different functions of touch may be more appropriate for that goal.

Contrary to hypotheses there were no parental differences in overall touch. This finding may not be as surprising as thought. For one, the research on parent differences in overall sensitivity is inconsistent. While some studies have found parental differences in sensitivity (e.g., Planalp et al., 2013) others have not (e.g., Braungart-Rieker et al., 2001). Some of these discrepancies may come from the fact that past studies have examined global sensitivity, which consists of vocalizations, gaze, and touch. There may be overall differences in sensitivity, but there are not differences in the particular behavior of touch. When interacting with their infants, it appears that fathers have the same capacity as mothers to use touch as a mechanism to communicate with their infants.

Although not frequently studied, there is evidence that fathers use touch to serve different functions (Shields, 1993), and. in this study fathers used all functions of touch. There may not be overall differences in touch, but there were specific differences in the proportion of time mothers and fathers used certain functions of touch. Infants received more passive accompaniment, which refers to touch that is not mobile in nature and accompanies another modality of communication, from their mothers compared to their fathers. Little to no research has been conducted with this specific function of touch, so this analysis was exploratory in nature. Examples of passive accompaniment include a parent resting his or her hand on the infant while speaking to the infant. Mothers often engage in infant-directed speech or talking with their infants, which evokes positive responses (Arias & Pena, 2016) and are more likely to do so than fathers (Kruper & Uzgiris, 1987). Mothers may only need speech to engage their infant's attention and obtain positive responses, whereas fathers may need more active modalities of communication. However, future studies should also examine the way in which mothers are speaking to their infants during this function of touch in order to fully support this conclusion.

Unexpectedly, there were no significant differences when comparing maternal playful touch to paternal playful touch. It was expected that fathers would engage in more playful touch, since father-child interactions typically are structured around play (Feldman, 2003). This may because of the way that touch was operationalized. There may have been subjective differences in the type of play that fathers and mothers engaged in. Fathers often played tickling games and other high intensity games whereas maternal play was more structured and often focused around song. However, for the purpose of this study that touch would have been categorized the same since it served the function of play. Future studies may need to examine the subjective aspects of the play, such as intensity level, type of play, or level of structure in the play, before the conclusion can be made that mothers and fathers do not differ in play during the SFP. This is not the only study to not find the expected differences in play. Planalp and colleagues (2013) found that mothers engaged in more play during the SFP. This may be because of the nature of the SFP. Because infants are buckled into a high chair, it may not be possible for fathers to engage in some of the high-intensity play that they would in another situation. For example, tickling may be the most intense type of play that can occur while an infant is constrained to a high chair.

The hypotheses about nurturing touch were also not supported. Mothers did not engage in more nurturing touch than fathersin either episode nor was there more nurturing touch overall in the RE compared to the FP. There were relatively low rates of nurturing touch in this sample throughout the SFP. This is surprising given the distressing nature of this task. However, it is possible that any form of touch was enough to convey a sense of comfort to an infant without specifically serving the function of being nurturing. In studies that have manipulated maternal touch and allowed mothers to touch their infants during the SF episode, the effects of the SFP were attenuated (Jean et al., 2014). Because parents were not allowed to touch the infant during the SF episode, any form of touch may have seemed better than no touch. Nurturing touch also varies according to infant affect and is used more in the context of distress (Jean & Stack, 2009). Therefore, the parents may not have perceived their infants to be distressed enough to need this particular type of touch. In addition, the lack of parental differences suggests that both mothers and fathers have the capacity to be nurturing in their touch. This additionally supports the idea that mothers and fathers may not differ in this particular component of sensitivity or perhaps overall sensitivity.

Overall, this study extended on the examination of parenting during the SFP by examining touch as it naturally occurs during the paradigm as well as being the first study to our knowledge to examine paternal touch in this context. The results from this study suggest that parents are attune to infant distress during the SFP and utilize touch as a means to comfort their infant by increasing touch following the stressful experience of the SF episode and decreasing the use of touch that does not match the infant's affective state (i.e., playful touch). Because mothers and fathers only differed in the use of playful touch, this suggests that mothers and fathers utilized different functions of touch in the same manner. This indicates that with this component of sensitivity, mothers and fathers have similar capabilities in interactions with their infant. In addition, the findings demonstrate that touch is a component of sensitivity that can be measured and examined during the SFP, which is important because of its potential association with infant regulation, a widely studied infant outcome during the SFP.

Comparing the Still-Face Effect for Interactions with Mothers and Fathers

Another main goal of the present study was to replicate the still face effect for the mother-infant and father-infant SFP. Consistent with previous research (e.g., Braungart-Rieker et al., 1998; Ekas et al., 2013a; Ekas et al., 2013b; Mesman et al., 2009) there was more negative affect in the SF episode compared to the FP episode as well as more visual distraction in the SF compared to the FP and RE. There was also not a difference in negative affect between the SF and RE episode which replicates findings that the effects of the SF episode often carry over into the RE episode. However, there was not more self-soothing in the in the SF episode nor was there PEP shortening or RSA suppression in the SF episode as expected. These findings were across both parents.

It was surprising that certain aspects of the still face effect were not replicated. Self-comforting is one of the first emotion regulation strategies to develop in infancy because it originates from an innate reflex (Kopp 1989; Stifter & Braungart, 1995). Because the SFP is arousing and novel for an infant, it would be expected that infants would self-soothe as it is a reflexive strategy. Additionally, the presence of more self-soothing during the SF has been observed by other researchers (e.g., Manian & Bornstein, 2009; Planalp & Braungart-Rieker, 2015). One explanation may come from the fact that self-soothing did not occur frequently in this sample. Some studies have found that self-comforting is used more among infants of depressed mothers as opposed to the use of distraction in infants of non-depressed mothers (Manian & Bornstein, 2009). The present sample was relatively high-functioning, so the lower amounts of depressive symptoms may explain why the still-face effect was not observed in terms of self-soothing. Other studies (e.g., Planalp & Braungart-Rieker, 2015) also used infants of younger ages (i.e., 3, 5, and 7 months) as opposed to the present sample (6 and 9 months). By 6 months infants become more intentional in their regulatory strategies and use more sophisticated strategies, such as gaze, because of physical developments (Calkins & Hill, 2007). Other researchers have also found that self-soothing declined from 3–7 months (Ekas et al., 2013). That further helps to elucidate why there was more distraction in the SF but not more self-comforting in the present sample.

Another main goal of the study was to pair behavioral measures of emotion regulation with physiology to measure the still face effect. Unfortunately, there were no differences betwee episodes in PEP or RSA, which represent physiological arousal and regulation respectively, in the present study as it was expected that PEP and RSA values would be lower in the SF episode. However, there fewer studies have investigated physiology during the SFP compared to behavior. The sample itself could have impacted these findings. Parent order was significantly associated with RSA values, where infants who did the SFP with fathers first showed lower RSA values during the FP and less change in RSA between episodes. Because of the concurrent nature of the current study, it is possible that infants were already regulating at the start of the second SFP. This could result in less of an effect between episodes for the second SFP because it was difficult for RSA values to go lower than they already were.

It is possible that this was the case for PEP as well, but parent order was not a significant covariate. Even less evidence exists for PEP shortening during the SF episode, as most studies have examined PEP in older children (e.g., Buss et al., 2005; Kahle et al., 2016; Stifter et al., 2011), with only one study examining PEP during the SFP (Suurland et al., 2016). Although researches assert that PEP is valid to measure as early as 6 months of life (Alkon et al., 2006), PEP shortening was not observed in this sample of 6 and 9 month-olds. Some researchers, although they still saw changes in reactivity, noted that preschool children's reactivity is smaller than adults' (Quigley & Stifter, 2006). The only study that measured PEP during the SFP did so in a population of high-risk infants (Suurland et al., 2016). The PEP shortening that they witnessed in their sample of 6-month-old infants may not generalize to all infants of the same age. Because the autonomic nervous system is sensitive to adverse environments, the maturity of the system may be altered and change an infant's response to a stressor (Suurland et al., 2016; Alkon et al., 2014). Suurland and colleagues (2016) were the first to examine this theory with measures of PEP, and they did find that with increased stressors, infants showed greater PEP shortening during the SF episode. As mentioned, they were the first to examine this and the upper middle class nature of the current study suggests support that PEP shortening may only be seen in infants during the SFP if they have experienced adversity. However, more research is needed as this study did not have a measure of risk other than household income so it is possible that because of age, these particular infants did not show enough shortening for the change to be significant.

Beyond replicating the still face effect with both mothers and fathers, the current study examined differences in infant physiology and behavior during the SFP with mothers and fathers, since few studies have included fathers. Consistent with hypotheses, there were only subtle differences in behaviors seen with mothers and fathers as infants only showed more distraction behaviors with their fathers. This is contrary to previous research that found that infants did less distraction behaviors with their fathers during the SF episode (Braungart-Rieker et al., 1998; Braungart-Rieker et al., 2001). It is important to note that the effect in this study was regardless of episode since there was no episode interaction, so that could account for the differing results. Infants may have been regulating more during the SF episode as well as being more distracted with their fathers during the FP and RE. It is also important to note that differences in certain behaviors during the SFP have only been found in a couple of studies because of the paucity of research with fathers. Overall, since the rest of the behaviors did not differ between parents, it appears that infants react similarly to the SFP with both their mothers and their fathers.

The Associations between Infant Negative Temperament, Parental Depressive Symptoms, Parental Touch, and Infant Emotion Regulation

A stepwise procedure was used to build a mediation model in which the relationship between infant negative temperament, parental depressive symptoms, and infant emotion regulation occurs via parental touch. Because of the nature of this process, some significant correlations found in Specific Aims 2a and 2b for mothers were not included in the final analyses. Mothers who endorsed a greater number of depressive symptoms had infants who showed greater RSA suppression (i.e., better regulation) during the SF. This is a surprising finding given that infants rely on their caregivers to learn how to regulate (e.g., Calkins, 1994). Mothers that endorse higher levels of depressive symptoms have difficulties regulating emotions.

This sample, however, was not low-risk and only four mothers met the suggested cut-off for clinical levels of depression. Mothers that were endorsing some symptoms may have still been in the sub-clinical range which still allowed them to help their infants regulate. Some research has also shown that some regulatory behaviors in infants of mothers with depression are still present (Manian & Bornstein, 2009). One such behavior is self-soothing, so it is possible that infants have had to learn on their own to regulate and RSA is an internal mechanism similar to self-soothing.

Mothers who reported more depressive symptoms also engaged in more active accompaniment during the RE. Studies have shown that maternal depression is associated with more intrusive touch (Beebe et al., 2008). The current study only examined the function of the touch, however. Active accompaniment was defined as touch that was mobile, active, and accompanied another modality of communication (e.g., talking). It is possible that this touch could have been intrusive in nature because it was active. However, the quality of the touch would need to be evaluated in order to fully support that claim.

Infants who received more nurturing touch during the free play, displayed less negative affect during the SF. This was consistent with hypotheses since touch was considered a component of sensitivity and nurturing touch most closely resembles the facets of sensitivity. These findings are consistent with previous research that found an association between maternal sensitivity and less negative affect during the SF (Braungart-Rieker et al., 1998; Braungart-Rieker et al., 2001). This study extends these findings to a more specific parenting behavior of touch and suggest that nurturing touch functions in the same regulatory manner as global sensitivity.

When mothers reported infants as having a more negative temperament, the infant received more attention-getting touch during the FP. Infants who were more negative may have been more resistant to the task itself. Because they were in a highchair, this could have evoked distress to limitations, which infants who are more negative display high levels of (Braungart-Rieker et al., 2014; Putnam et al., 2008). Therefore, the mothers may have had to make extra effort to get the infant to direct their focus on them and not on the discomfort of the task. Infants also received more active accompaniment during this recovery period, which once again suggests that with high levels of distress they need more active attention from their mothers. It may be possible that this active attention does not result in less discomfort. It is also possible that negative temperament and distress evokes this type of touch. Because negative temperaments often evoke insensitive responses from parents (Ghera et al., 2006), it may be possible that this touch is not sensitive and soothing in nature. Infants high in negative temperament did indeed show more negative affect in the RE and decreases in affect have also been associated with attention-getting touch (Lowe et al., 2016). This supports research that suggests that temperament contributes to the carry-over of negative affect from the SF to the RE (Yoo & Reeb-Sutherland, 2013). Once distressed from potentially the task overall and specifically the SF episode, it is difficult for these infants to recover and may evoke insensitive responses from mothers.

The Direct and Indirect Factors that Are Associated with Infant Emotion Regulation

The ultimate goal of the current study was to examine the direct and indirect influences on infant emotion regulation through a mediation model. With their mothers, infants who received more attention-getting touch in the FP and the RE showed continued physiological regulation in the RE episode but not behavioral regulation. This suggests that attention-getting touch may be associated with infants having to continue to regulate during an episode which should not be as stressful as the SF episode. Because of this, it is possible that attention-getting touch is insensitive in nature. This is mainly supported by previous research. Sensitivity is associated with recovery from arousal such as higher levels of RSA during the RE episode as well decreases in behavioral measures of regulation (Condradt & Ablow, 2010). However, this study only indicated that attention-getting touch was associated with behavioral recovery from the SF episode. In previous research that examined touch on a second-by-second basis, attention-getting touch was associated with increases in negative affect (a sign of arousal/discomfort; Lowe et al., 2016). Attention getting touch does not enhance infants' regulatory capacities but rather hinders arousal potentially because they are still aroused. Some studies have found that infants that are later classified as resistant or disorganized often coordinate gaze aversion with maternal touch potentially due to the dysregulated features of the touch interactions (Beebe et al., 2010). Infants that are averting gaze in response to maternal attempts at touch could result in attention-getting touch since the infant is no longer focused on the mother. Because sensitivity is associated with later attachment security (Finger, Hans, Bernstein, & Cox, 2009), this would further suggest that attention-getting touch may be a form of insensitive touch when conceptualizing touch as a component of sensitivity. However, the finding from the current study provides inconclusive evidence as infants were only showing continued physiological regulation but not behavioral. It is possible, that infants are outwardly trying to indicate they are recovering when they truly are not in order to regain synchrony with their mothers. However, if this type of touch is insensitive or may even be potentially insensitive it could allow for more specific changes in maternal touch in interventions targeted at enhancing attachment security rather than trying to have mothers change overall sensitivity as this may be a more concrete way for mothers to adapt their behavior. For mothers, it also appears that touch during the FP and RE was most important for behaviors during the RE rather than during the SF. The RE is a particularly important episode because mother and infant are reestablishing a connection after a disruption and often infants are still aroused during the RE (Yoo & Reeb-Sutherland, 2013) Therefore, touch may impact recovery rather than arousal during the SF.

Contrary to hypotheses, nurturing touch was not associated with infant regulation in the mediation model. This is surprising given that nurturing touch most closely maps on with sensitivity. Further, it was expected to be most important since nurturing touch is associated with later attachment security (Weiss, Wilson, Hertenstein, & Campos, 2000) in much the same way that sensitivity is. As mentioned earlier, nurturing touch did not occur very frequently in this sample which could explain the lack of association. The sample was also not a high-risk sample, so these infants might be used to receiving quality touch and caregiving. In a context that is stressful for both mothers and infants, infants may be more attune to insensitive touch. This is important to note, because during times of distress sensitivity is most important (Leerkes, 2011). If sensitivity is breaking down during stressful interactions, this could be a risk factor for not only infant outcomes but the mother-child relationship.

For the first model with fathers, playful touch during the FP was associated with more distraction during the SF where active accompaniment was associated with less distraction. Playful touch was marginally associated with lower RSA values during the SF where attention-getting touch was associated with higher RSA levels during the SF. This is evidence that, for fathers, the playful nature of touch helps infants regulate during stressful experiences. It also adds further evidence that attention-getting touch may be a form an insensitive form of touch but potentially only for physiological regulation. Because playful touch is associated with better infant regulation, that means that touch functions differently for mothers and fathers. This evidence supports previous research that fathers arouse their infants through play and have higher intensity in their interactions (Feldman, 2003), and that this type of interaction allows infants opportunities distinct from mother-child interactions to learn how to regulate (Parke, 1994). Further, Paquette's seminal theory concerning fathering asserts that paternal play contributes to the emotional bond that fathers form with infants in much the same way that sensitivity contributes to the mother-child bond (Paquette, 2004). Even though infants are in a high chair and this may be a different environment for interaction, it is the active and playful nature of fathers' touch is most important.

In the second mediation model for fathers, active accompaniment and playful touch remained significant predictors of distraction. Passive accompaniment during the FP was associated with higher rates of RSA during the RE compared to the SF, and attention-getting touch during the RE was associated with lower rates of RSA during the reunion. Playful touch during the RE was also associated with less negative affect in the RE. This shows support that playful touch during both the FP and the RE are important for infant emotion regulation. Playful touch has such an impact on regulation that it does not matter whether it occurs under the context of arousal or recovery. Attention-getting touch during the RE further appears to be insensitive and does not help to ameliorate the physiological stress from the SF and subsequent RE much like with mothers. This type of touch appears to function similarly across mothers and fathers. Finally, it appears, that paternal touch does not always have to be active and playful in order to have a positive effect, seen in the better recovery in infants during the RE from just passive accompaniment. This may be because of the nature of fathers' passive accompaniment. Fathers may be incorporating play during these instances, like making funny faces or leading up to a playful interaction. Overall, it appears that playful touch is particularly important in infant-father interactions. If fathers are having difficulties in interactions with their infants or infants have emotion-regulation issues, encouraging fathers to play with their children may have a greater impact. According to Paquette's theory about the father-child activation relationship, play is also essential in order for fathers and infants to form a proper emotional bond which is important for later development of obedience and confidence (Paquette, 2004).

For mothers and fathers there was not an impact of depressive symptoms or infant negative temperament on touch or infant regulation in the mediation models. It was only expected that maternal depressive symptoms would have an impact as well as infant negative temperament, but for fathers the only hypotheses focused on infant negative temperament because fathers often interact with infants more negatively when they have a more negative temperament (Braungart-Rieker et al., 2014). This suggests that touch itself is most important for child emotion regulation between 6 and 9 months. Therefore, interventions should focus specific parenting behaviors like touch in order to enhance child emotion regulation. However, because of previous research that has found a strong link between these infant and parent characteristics and parenting and infant outcomes (e.g., Fox & Calkins, 2003), future studies should examine other factors such as parenting stress and parent anxiety.

Limitations and Conclusions

Despite the fact that this study expanded on gaps in the literature by examining naturally occurring touch among both mothers and fathers during the SFP as well as incorporating multiple emotion regulation measures of both behavior and physiology, there are some important limitations to consider. For one, this sample was affluent and relatively high-functioning. Future research should target either more diverse populations or more at-risk samples, especially since some of the discrepant findings from previous research were with studies that used high-risk populations (e.g., Suurland et al., 2016). Future studies should also examine the relationships between infant characteristics, parent characteristics, touch, and emotion regulation in order to determine the causal nature of these associations. Because parent order was a significant covariate, it may also be important for future studies to examine different methodology for the SFP, such as mother and father SFP on different days or a bigger gap between the two. There was a large amount of participants excluded because of noisy physiological data because of the placement of the sensors. Future studies should look at alternative ways to place the sensors in order to avoid losing data. Finally, there was no information collected about parents' previous experience with touch. However, the current study did screen for premature infants who may have received kangaroo care, a touch-specific intervention (e.g., Head, 2014). It is possible that other parents have more understanding of the benefits of touch compared to others.

In summary, this study found that mothers and fathers did not differ in the amounts of overall touch used and utilized most of the functions of touch in similar manners with the only found difference being that mothers engaged in more passive accompaniment than fathers. Mothers and fathers also adjusted their use of touch depending on context by increasing overall levels of touch following distress as well as reducing playful touch during this time. This study replicated the still face effect by demonstrating higher levels of negative affect and self-soothing during the SF episode, which was similar across mothers and fathers except for the finding that infants engaged in more distraction overall with their fathers. Attention-getting touch during the FP and RE was associated with continued physiological regulation during the RE but also with behavioral recovery. It is inconclusive if this is a type of insensitive touch, but suggests it is possible. Because paternal attention-getting touch was associated with poor physiological regulation and recovery, this suggests that attention-getting touch may indeed be an insensitive form of touch but this may only manifest in physiology and not behavior. Playful touch however, and not just active accompaniment, was associated with great regulation and better recovery with interactions with fathers suggesting that the playful touch fathers provide aids in infant emotion regulation.

This study was the first study to examine naturally occurring touch during the SFP with both mothers and fathers. In addition, it was the first study to combine several behavioral and physiological measures of emotion regulation with both mothers and fathers. Overall, this study indicates the importance of studying both mothers and fathers, because certain functions of touch, such as attention-getting and playful touch, were associated with different infant outcomes. Also, by examining a more specific component of sensitivity this study helps to elucidate why mother-child and father-child interactions may differ. The findings with playful touch support this difference. By discovering the specific parenting behaviors that contribute to infant emotion regulation, parenting classes and books can be amended to give parents more tangible and specific behaviors to implement when they have a child. In addition, interventions can be informed of these findings to help with difficulties in parent-child interactions as well as infant emotion regulation itself. Findings from this study suggest that mothers should be informed of the detrimental impacts of attention-getting touch. Fathers should also be informed about the importance of play with infants. Although most hospitals and doctors focus on kangaroo care and touch with preterm infants, it is important for all parents to be informed of the benefits of touch. Touch is one of the most important ways to communicate with babies in a way that evokes positive responses. If parents know this, then they will have a tangible strategy for interacting with their babies that is not only relatively easy but also beneficial for the infant.

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ABSTRACT

THE PHYSIOLOGICAL MECHANISMS OF EMOTION REGULATION DURING INFANCY: THE ROLE OF MATERNAL AND PATERNAL BEHAVIORS

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The purpose of the current study was to examine the impact of infant characteristics and parent characteristics on infant emotion regulation. However, it was hypothesized that this relationship would be mediated by parenting behaviors (i.e., touch). Further, this study examined these processes in mother-infant and father-infant dyads. Eighty-three mothers and fathers completed the study with their infant. Infants were placed in a high chair and the parent was seated in a chair face-to-face with their infant. Next, the still face paradigm (SFP) was completed with the mother and the father. This study found that mothers and fathers did not differ in the amounts of overall touch used and mothers only engaged in more passive accompaniment than fathers. Mothers and fathers increased overall levels of touch following distress as well as reduced playful touch during this time. This study replicated the still face effect by demonstrating higher levels of negative affect and self-soothing during the SF episode. Attention-getting touch during the FP and RE was associated with continued physiological regulation during the RE but also with behavioral recovery. Paternal attention-getting touch was associated with poor physiological regulation and recovery. Playful touch however, and not just active accompaniment, was associated with great regulation and better recovery with interactions with fathers suggesting that the playful touch fathers provide aids in infant emotion regulation.