Maternal Tactile-Gestural Stimulation and Infants' Nonverbal Behaviors During Early Mother-Infant Face-to-Face Interactions: Contextual, Age, and Birth Status Effects

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ABSTRACT

Maternal Tactile-Gestural Stimulation and Infants' Nonverbal Behaviors During Early Mother-Infant Face-to-Face Interactions: Contextual, Age, and Birth Status Effects

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The preverbal period of infancy is characterized by the absence of receptive and expressive verbal communication and substantial reliance on nonverbal forms of communication. Although nonverbal behavior is believed to be particularly salient to infants during early infancy, little is known about the nonverbal strategies that mothers employ when attempting to influence their infants' behavior or state of arousal, or about infants' nonverbal behavioral reactions to such stimulation. The two studies comprising this dissertation aimed to examine contextual, developmental, and birth status effects on the expressions of maternal and infant nonverbal behavior. In Study 1, maternal tactile-gestural stimulation and infants' gaze and affect were assessed during four brief interaction periods. Contextual variations to the interaction were introduced by: (a) providing different instructions to mothers on the behavior/state to elicit from their infants, and (b) varying the method by which mothers attempted to accomplish these goals (uni-modal touch only vs. multi-modal). Two within modality comparisons were conducted to evaluate whether the instructions to mothers to modify their infants' behavior/state of arousal actually influenced mothers' tactile-gestural behavior and infants' gaze and affect. A subsequent comparison between the uni-modal and multi-modal groups was then conducted to specifically examine whether, and in what way, mothers' and infants' nonverbal behaviors differed when these identical instructions were attempted in different ways. Within each of these comparisons, developmental differences were assessed by examining infants at 3½ and 5½ months. In addition, patterns of co-occurrence were evaluated to assess for differences in the organization of nonverbal behaviors. The results of Study 1 revealed differences in the amount of maternal touch and gestures, the qualities of maternal touch, infants' gaze and affect, and the organization of these behaviors as a function of the context of the interaction. Developmental differences in the expression of these behaviors were also noted with age. Older infants gazed away more from their mothers. Furthermore, supporting the transition from proximal to distal forms of communication with age, mothers touched their 3½-month-olds more and gestured toward them less than mothers of 5½-month-olds. Mothers were also found to use different types of touch with their infants and to touch them on different areas of their bodies with age. In Study 2, mothers' uses of touch and gesture and infants' gaze and affect were examined in very low birth weight pre-term (VLBW-PT) and normal birth weight full-term (NBW-FT) infants during a brief period of maternal affective disengagement achieved through use of the SF procedure. Contrary to previous suggestions, the results of Study 2 indicated that the infant's birth status did not appear to contribute to differences in maternal touching or gesturing, but was associated with differences in infants' affective expressions and some small differences in the organization of nonverbal behaviors. Taken together, the results of these studies underscore the importance of nonverbal behavior in eliciting, directing, and maintaining social interactions from 3½ to 5½ months of age and highlight the considerable breadth and diversity of touch and gesture as a communicative channel in early mother-infant social interactions.

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CHAPTER 1: Introduction

The term nonverbal communication refers to all human communicative acts that do not involve words (Dittman, 1987; Knapp, 1978; Matlin, 1995). Although this definition allows for a broad range of phenomena, psychologists have primarily focused their attention on those aspects of nonverbal behavior that are crucial to the occurrence, structure, and regulation of interpersonal interaction (Harper, Weins, & Matarazzo, 1978; Webbink, 1986). As a result, research on nonverbal communication has generally been directed at behaviors such as: (a) paralanguage (i.e., the use of vocal cues other than words themselves, such as tone of voice, pitch, pauses, and inflection of the voice), (b) touch, (c) gestures (i.e., visual interactive hand movements), (d) body orientation or posture, (e) body movement (i.e., kinesic behavior), (f) eye behavior such as direction of gaze, and (g) facial expression (Argyle, 1988; Burgoon, 1985; Dittman, 1987; Knapp, 1978; Matlin, 1995; Webbink, 1986).

Studies of adult-adult social interchange have emphasized the important contribution of nonverbal cues in the transmission of meaning during social encounters. For instance, Birdwhistell (1963) estimated that between 60 and 65% of meaning in a social situation is communicated nonverbally, an estimate supported by other researchers (e.g., Kundu, 1976; Philpott, 1983; as cited in Burgoon, 1985). Taken together, these studies indicate that nonverbal signals are more than merely a backdrop against which verbal exchanges take place. Rather, they suggest that nonverbal behavior is an important component of effective communication that imparts meaningful information in its own right (Burgoon, 1985; Turner, 1997).

Given the aforementioned estimates regarding the importance of nonverbal communicative behavior, it is surprising that the nonverbal component of interpersonal interaction has received only limited attention, even by researchers whose primary interest is communication (Burgoon, 1985). Nevertheless, research has highlighted the extensive repertoire of nonverbal behaviors that humans have at their disposal with which to communicate their thoughts, feelings, and intentions, as well as to influence others' behavior (e.g., Birdwhistell, 1970; Hewes, 1957; Pei, 1965).

Nonverbal behaviors are argued to function both individually and collectively in achieving multiple social functions (Burgoon, 1985). In addition to repeating, contradicting, complementing, and/or accenting verbally-presented information (Argyle, 1988; Knapp, 1978), it has been suggested that nonverbal signals are the primary method through which emotional messages are transmitted during interpersonal encounters (Burgoon, 1985; Darwin, 1934; as cited in Turner, 1997). Furthermore, they provide invaluable pragmatic information during adult discourse, functioning to influence and direct the progression and patterning of social interaction, as well as listeners' attitudes and overt behavior (Burgoon, 1985; Kendon, 1987; Knapp, 1978). However, nonverbal behavior may take on its greatest importance in contexts where verbal communication is made difficult or impossible (Kendon, 1987; Knapp, 1978). Dittman (1987) contends that simply because an individual is unable to use speech as a mode of expression is not to say that the individual is without means of communicating, or that the means employed is not a 'language'.

One of the most impressive examples of human beings' innate capacity for linguistic communication is their use of primary sign languages (Dittman, 1987; Kendon, 1987). Even young deaf infants have been observed to communicate through the use of sign language (Petitto & Marentette, 1991). In a comparison of deaf children learning American sign language and hearing children learning a spoken language, Folven, Bonvillian, and Orlansky (1984/1985) found that the same nonlinguistic communicative gestures, giving and communicative pointing, were the strongest gestural correlates of lexicon size in both groups. That is, the frequency with which both deaf and hearing children between 9 and 12½ months gave objects to their mothers and pointed to objects while monitoring their mothers for a response correlated positively with the number of different signs or words in the child's lexicon, both at that time and through the age of 26 months. On the basis of these findings, the authors concluded that the early stages of visuomotor and spoken language appear to emerge from the same communicative bases. Moreover, sign language has been argued to resemble spoken language in a variety of ways, including time course and structure, again suggesting that a common linguistic capacity may underlie the two forms of communication (Petitto, 2001).

Another example of the robustness of early infant communication is highlighted in the work by Iverson, Tencer, Lany, and Goldin-Meadow (2000). These authors reported that, like sighted infants, blind infants use gesture at the earliest stages of word learning. Furthermore, the distribution of gesture types was quite similar for the two groups, with the majority of gestures consisting of deictic gestures that functioned to draw attention to a referent. The authors concluded that gesture is a salient component of infant communication that emerges even in the absence of a visual model.

The contribution of nonverbal communication to hearing and sighted mother-infant dyads is no less important. Von Cranach and Vine (1973) have suggested that the largely unconscious nonverbal signals produced by adults originate from social interactions early in life. Thus, a great deal may be learned from studying infants' uses of, and their reactions to, nonverbal signals within the context of early caregiver-infant social interactions. Moreover, by observing such interactions, important information about the ways in which these signals develop over time and are expressed in different contexts may be revealed.

The two studies comprising this dissertation directly examine the occurrence and organization of nonverbal signals during mother-infant social interactions by examining two salient aspects of maternal nonverbal behavior, namely tactile and gestural communication, and infants' nonverbal behaviors, specifically gaze and affect, during social interactions involving these forms of stimulation. While maternal facial and vocal expression are undoubtedly important to effective communication, much less attention has been devoted to tactile-gestural expression and the ability of touch and gesture to guide and influence infant behavior (Stack, 2001; Stack & Arnold, 1998; Stack & LePage, 1996).

In addition, although touch and gesture are typically integrated with facial and vocal behavior during social interactions, little is known about the independent communicative ability of the tactile-gestural modality, or how its use is modified when integrated with the other communicative channels (Arnold, Brouillette, & Stack, 1996; Stack, 2001). To directly address this issue, mothers' uses of touch and gesture were observed in different contexts (e.g., touch-alone vs. touch in combination with face and voice) to assess their specific contribution during uni-modal and multi-modal interactions in which mothers attempted to influence their infants' arousal. The period of early infancy is one in which mothers are argued to play a key role in regulating their infants' arousal. However, the roles of maternal touching and gesturing in mothers' attempts to influence their infants' behavior/states of arousal remain largely unexplored, particularly in the context of social interactions occurring beyond the neonatal period.

In addition, little is known about how mothers' uses of touch and gesture and infants' responses to these forms of stimulation change over time. As it is likely that mothers adapt their uses of touch and gesture as infants mature in their interactive capabilities, mother and infant nonverbal behaviors were observed when infants were 3½ and 5½ months, thereby permitting an examination of developmental changes in mothers' uses of touch and gesture, and infants' gazing and affective behaviors to these forms of stimulation, with age.

In a second study, the observation of very low birth weight pre-term (VLBW-PT) mother-infant dyads permitted a unique opportunity for the study of mother-infant nonverbal behavior. In VLBW-PT infants, several factors (e.g., restricted opportunities for physical contact following birth, modified experiences with touch early in life) may alter their abilities to process tactile-gestural stimulation in the same way as normal birth weight full-term (NBW-FT) infants. Thus, mothers' uses of touch and gesture toward their VLBW-PT and NBW-FT infants, and infants' gaze and affect, were observed in the context of social interactions involving a brief period of maternal unavailability.

In order to provide a framework within which the present work is integrated, several pertinent areas of literature will be reviewed, beginning with a discussion of some of the major theoretical approaches to infant development. The discussion of theory will be followed by a review of research addressing infants' nonverbal communicative abilities within the context of dyadic social interactions, with particular emphasis on gaze and affective behaviors reflective of arousal and arousal regulation. Research will then be presented that highlights the mutual responsiveness exhibited by mothers and infants to changes in one another's socio-communicative behavioral signals. A review of the research emphasizing the importance of maternal nonverbal behavior, namely tactile-gestural stimulation, to infant development will then be presented, as will the results of studies highlighting the ways in which perturbations of the interactive context influence mothers' uses of touch and gesture and infants' behaviors to these. A case of naturally perturbed interactions, that of VLBW-PT infant-mother dyads, will then be reviewed, leading into a description of the present studies.

Although fathers' contributions to the development of their infants' social and regulatory capacities are important and have increasingly become the focus of investigation (e.g., Arco, 1983; Dickson, Walker, & Fogel, 1997; Lamb, 1997; Power, 1985), the majority of past studies of dyadic social interactions have included mothers. The over-representation of mothers is undoubtedly related, at least in part, to their greater accessibility and availability during the early months of their infants' development, as they continue to function most often as primary caregivers. Consequently, most of the research reviewed herein reflects the findings from studies of mother-infant social interactions.

Infant Development and Communication in a Social Context: Theoretical Approaches

Prior to the 1970s, infant social behavior was largely conceptualized as *individual* behavior. Although social behaviors (e.g., infant smiling) were observed in the presence of other people, the role of the interactive partner in the development and elicitation of infant behavior was not taken into account (Schaffer, 1989). Sander (1962) was instrumental in inciting changes in the conceptualization of the mother-infant relationship from that of a one-way process of individual contributions, to that of a dyadic relationship driven by mutual and reciprocal influences.

The 1970s heralded a conceptual shift from the study of the individual to that of the dyad, and research questions became ones of how interactions were established, maintained, and developed over time, and the contributions of the infant and adult to these processes (Schaffer, 1989). Such investigations have yielded a great deal of information about the abilities that even young infants bring to social interactions, the way(s) in which they develop and refine their social and communicative skills over time, the strategies adults employ to foster and support these skills, and the mutual and reciprocal influences of both partners in the regulation of social encounters (Schaffer, 1989).

The view of development as a complex process involving multiple sources of influence is captured in transactional models and systems theories, which have been argued to provide a more accurate and complete depiction of the developmental process (e.g., Belsky, 1981; Fogel & Thelen, 1987; Sameroff & Chandler, 1975). Systems theories posit that development is non-linear, involving the interrelation between multiple systems (e.g., physiology, cognition, behavior, social environment, culture). As a result, these theories are believed to represent an advance over previous theories of development that primarily emphasized the individual roles of the infant and caregiver, without acknowledging the mutual influence that arises in the context of the relationship between the two.

The concept of reciprocal influence between caregiver and child was also central to Vygotsky's (1978) theory of development. According to Vygotsky, development occurs within a social context, with higher cognitive skills such as language first being learned in the context of joint interpersonal interactions and only later being internalized into intrapersonal capabilities (e.g., talking to oneself; Schaffer, 1989; van der Veer & van Ijzendoorn, 1988). He coined the term *zone of proximal development* to describe the process by which adults provide a supportive framework in which their children can achieve higher functions. Through the structuring and guidance afforded by their caregivers, children are prompted to engage in tasks that are slightly above their level of independent performance (van der Veer & van Ijzendoorn, 1988). Unfortunately, as much of Vygotsky's work was aimed at the preschool period onward he did not extensively discuss how the concept of the zone of proximal development applied to infancy (Moss, 1992; van der Veer & van Ijzendoorn, 1985, 1988).

Wood, Bruner, and Ross (1976) were the first to introduce the term *scaffolding* to describe the process by which children's efforts at problem solving are assisted and fostered by others who are more skillful than the child. Bruner (1983, 1984) later extended the concept of scaffolding to earlier childhood and, in so doing, demonstrated the importance of preverbal adult-infant interactions to later development (van der Veer & van Ijzendoorn, 1988). In particular, Bruner emphasized the supportive and structuring role that caregivers play in compensating for their infants' interactive limitations (i.e., those abilities not yet acquired or undergoing development; Schaffer, 1989). Similar to Vygotsky (1978) and Wood et al. (1976), Bruner (1983, 1984) asserted that parents provide a supportive framework for the development of their infants' skills. For instance, in the context of parent-infant activities, the structure or 'scaffold' afforded by highly ritualized parent-infant games (e.g., pat-a-cake, peek-a-boo) has been argued to enable the infant to participate without having internalized all of the components that comprise the activity. Parents initially take the initiative and responsibility for the occurrence and structure of the game and, in so doing, carefully regulate and guide their infants' participation and learning (Bruner, 1983; Fogel, Nwokah, & Karns, 1993). As infants age, parents gradually encourage them to take greater responsibility and to increase their participation by playing a more active role (Gustafson, Green, & West, 1979; Rome-Flanders, Cronk, & Gourde, 1995). However, the pace at which parents do so remains closely tied to the developmental competencies of the infant (Vygotsky, 1978; Bruner, 1983).

The contribution of adult facilitation to infant learning has similarly been highlighted by Fogel (1977; as cited in Kaye, 1982) who described the mother as providing a *frame* for the occurrence of infant gazing, and by Kaye (1982) who forwarded the concept of the infant as *apprentice*, one whose skill acquisition is conducted under the tutelage of a sensitive adult. For example, although the infant's capacity for self-regulation is initially quite limited, over the course of the first year of life there is a gradual transition from parental regulation to co-regulation (Maccoby & Martin, 1983). As a means of increasing their infants' self-regulation capacities, parents expose them to interactive situations that challenge their abilities so as to foster development of those necessary skills. Bronfenbrenner (1999) posited that in order to be developmentally effective, the activities to which the infant is exposed must become increasingly complex so as to capture the infant's attention, exploration, manipulation, elaboration, and imagination, thereby urging development forward. Notably, however, developmental growth impacts not only the infant, but also the infant's relationship with his/her significant others, and the evolving roles that these others must adopt. As infants mature in their capabilities, adults must adjust and tailor their strategies to the infant's developmental level. Consequently, developmental research is beginning to examine the role of infant development on parental behavior and the evolution of the strategies they employ (e.g., Colburne, 2000; Leiba, 2000).

In summary, the field has experienced a marked shift in the conceptualization of infant development over the past thirty years from one of individual contributions to one of mutual and reciprocal influences between mother and infant. However, a common theme in the theories discussed is the belief that developmental changes arise in the context of social relationships with others. Developmental growth alters infant behavior, as well as the infant's relationship with his/her significant others, and the evolving roles and strategies that these others must adopt in order to further the infant's development. Thus, it can be argued that infant' social and communicative development is best studied in the context of interactions with others, particularly their caregivers.

Importance of Infant Nonverbal Behavior During Social Interactions

The preverbal period of infancy is a particularly salient developmental stage in which nonverbal communicative behavior assumes primary importance. In fact, the term "infant" in Latin translates literally to "before speech" or "nonspeaker" (Bornstein, 2000; Bullowa, 1979; Diskin & Heinicke, 1986). One of the primary obstacles to the study of infant communication has been researchers' inclinations to think of communication as consisting primarily of spoken language (Bullowa, 1979). Indeed, Papoušek, Papoušek, and Kesterman (2000) contend that, as recently as three decades ago, the field was marked by an absence of systematic interest in the preverbal period of infancy. Consequently, it is a comparatively recent notion that infants are communicative creatures despite their inability to speak (Bullowa, 1979). Nevertheless, Goldschmidt (1997) contends that, "communication via gesture, facial expression, and physical contact is as ontogenetically prior to verbal communication as it is phylogenetically" (p. 229).

According to Papoušek et al. (2000), preverbal communication is a fundamentally prosocial human behavior that serves three main communicative functions, including: (a) the delivery of information regarding biological state, (b) assessment of the infant's momentary motivation and needs, and (c) communication of required assistance in self-regulation. Even newborns have been observed to exhibit behaviors such as limb movements and preverbal vocalizations that communicate valuable information to adults regarding their physiological states of arousal (Fogel, 1992; Hsu & Fogel, 2001; Hsu, Fogel, & Cooper, 2000; Papoušek, 1992; Wolff, 1967). Additional nonverbal signals of arousal and arousal regulation, including posture shifts, affective expressions, gestures, gaze, and gaze aversion have been found to form part of the infant's interactive repertoire from the first months of life (Field, 1979; Rogoff, Mistry, Radziszewska, & Germond, 1992; Symons & Moran, 1994; Tronick & Cohn, 1989). Such behaviors are believed to provide a window through which important aspects of the infant's social, affective, and cognitive development may be revealed (e.g., Bruner, 1971; Stern, 1985).

One of the earliest means with which infants impart information regarding their arousal states during social interactions is through the direction of their gaze (Field, 1977; Kaye & Fogel, 1980; Symons & Moran, 1987). The way in which the infant's head and eyes are positioned serve as powerful nonverbal communicative signals to their interactive partners (e.g., Stern, 1977; Webbink, 1986). It has been argued that gaze serves as a foundation for the development of interpersonal relatedness, communication, and emotional exchanges (Stern, 1977), as even the youngest infants experience opportunities to participate in eye-to-eye contact with their mothers (Heaton, 1968; Robson, 1967).

The visual-motor system is remarkably advanced when contrasted with the immaturity of other systems of communication, including speech, gesture, and locomotion (Stern, 1974, 1977; White, Castle, & Held, 1964). Development of this system provides visual perception with the unique characteristic of being able to turn sight on or off at will (Stern, 1977), an ability that is exceptional when compared to the functioning of other sensory modalities which have no means for terminating incoming stimulation (Cappella, 1981; Stern, 1974). Additional maturational changes in the neurophysiological organization of visual control between 3 and 6 months of age enable voluntary shifting of attention between stimuli (Rothbart, Posner, & Boylan, 1990), a hallmark that is contrasted with the 'obligatory attention' observed in younger infants (Thompson, 1994). Through this ability to alternate gaze direction, infants acquire some measure of voluntary control over perceptual input.

The ability to regulate perceptual input has also been argued to play a crucial role in regulating internal physiological state during early mother-infant face-to-face interactions (Brazelton, Koslowski, & Main, 1974; Field, 1981; Stern, 1974; Tronick & Weinberg, 1990). By visually disengaging from emotionally arousing events, infants actively participate in modulating their arousal (Kagan, 1971; Kopp, 1989; Tronick & Weinberg, 1990). Although the majority of existing research pertains to the role of gaze aversion as a means of reducing arousal in response to aversive conditions (e.g., fear, wariness, distress), research by Stifter and Moyer (1991) demonstrated that infants also avert their gaze in response to excitement, such as that engendered by positively-charged emotional interactions (i.e., following highly intense infant smiles). Alternatively, infants may avert their gaze from familiar or redundant stimulation for the purpose of seeking out more active or novel stimulation, thereby reducing their boredom and increasing their arousal to an optimal level (Kagan, 1971). Such momentary shifts in gaze direction either toward or away from the caregiver's stimulation in accordance with the arousal engendered are argued to permit infants some measure of control in maintaining their arousal within acceptable levels (Gable & Isabella, 1992). When attuned to their infants' nonverbal signals, such shifts also act as influential signals to their caregivers regarding their states of engagement and disengagement.

As they mature in their visual capabilities, infants become capable of assisting adults in regulating the degree of interaction and flow of behavior during interpersonal exchanges (Stern, 1977). Notwithstanding their considerable proficiency, however, infants' understanding of the impact of their direction of gaze as a means of social influence becomes increasingly refined with age and interactive experience. Researchers (e.g., Brazelton, 1984; Kaye & Fogel, 1980; Stern, 1977) have argued that it is within the context of early social interactions with their caregivers that infants acquire and refine their knowledge about the process of human communication and interpersonal relatedness. In addition, it is through such experiences that infants learn how their social partner's stimulation influences their behavior and the ways in which their own behavior influences their partner in return. Given that visual-motor maturity coincides with the peak period of mother-infant face-to-face interactions (i.e., 3 to 6 months; Kaye & Fogel, 1980), researchers may discover a substantial amount about infants' uses of gaze direction as regulatory signals during such interpersonal encounters.

One important socio-communicative milestone is the development of joint attention, defined simply as "looking where someone else is looking" (Butterworth, 1991,

p. 223). Traditionally, it was assumed that infants' egocentric perspectives prevented them from taking another's perspective (Butterworth, 1991). However, recent research has called this assumption into question, and has suggested that even young infants may have the ability to follow an adult's direction of gaze.

Although the precise nature of infants' understanding regarding their social partner as an intentional agent remains unclear (Carpenter, Nagell, & Tomasello, 1998), infants show some ability to follow an adult's gaze to targets that are within their visual field from the first 6 months of life (Butterworth, & Cochran, 1980; Butterworth & Jarrett, 1991; D'Entremont, Hains, & Muir, 1997). Scaife and Bruner (1975) reported that 30% of 2-4-month-old infants turned their heads to follow an adult's direction of gaze, with percentages steadily increasing so that, by 11-14 months of age, 100% of infants were demonstrating this ability. Corkum and Moore (1995), using a similar but more controlled procedure than that of Scaife and Bruner (1975), reported that it is not until approximately 10 months of age that infants can reliably follow an adult's gaze direction based on head orientation. By approximately 12 months of age, infants begin to use head orientation to follow an adult's gaze to targets outside their visual field (Corkum & Moore, 1995, 1998). However, it is not until approximately 18 months that they can follow gaze using eye direction alone (Butterworth & Jarret, 1991; Moore & Corkum, 1998). Taken together, studies of infant gaze suggest that gaze is one of infants' earliest communicative signals, that is serves several functions including the regulation of perceptual input and physiological state, and that its salience as a communicative signal emerges and becomes refined within the context of adult-infant interactions.

Other particularly salient nonverbal communicative behaviors of arousal that infants have at their disposal are their facial expressions of positive and negative affect. Similar to the proposed functions of infant gaze and gaze aversion, Segal et al. (1995) suggested that facial expressions are biologically preadapted signals that function to provide information to caregivers regarding infants' states of alertness, goals, need states, and affective responses to social and environmental stimuli.

Despite their biological origin, infants' abilities to modulate these affective displays and to employ these signals as effective means of communication unfold within the context of repeated interactions with caregivers over the first months of life. Studies of infants' affective communicative displays are beneficial, as they permit not only an examination of infants' uses of emotional expressions as a primary means of communication, but also the degree to which caregivers exert influence over their infants' overt affective displays and their regulation of such emotions (Osofsky, 1992). In addition to the degree of influence, however, one might argue that the strategies themselves that mothers use to influence their infants' affective displays are also of importance and, at the very least, merit investigation.

Infants' facial expressions of positive affect have been found to be particularly salient to mothers during the course of face-to-face interactions. That mothers are attuned to their infants' smiles is not surprising, given that infants have been found to reserve their smiles for people as compared to objects (Adamson & Bakeman 1985; Ellsworth, Muir, & Hains, 1993; Legerstee, Pomerleau, Malcuit, & Fieder, 1987), and particularly their mothers (Wahler, 1967). Furthermore, the expression and organization of their smiling appears to be influenced by their mothers' behavior (Messinger, 1994). Infants' affective expressions have also been found to serve as salient indices of arousal, and of engagement and disengagement in response to external stimulation. Past research has documented associations between affective expressions and physiological responses that function as direct indices of infant arousal. For instance, during a period of mother-infant interaction, infant smiling was associated with diminished heart-rate acceleration, concomitant heart-rate deceleration and, ultimately, regulation of arousal (Brazelton et al., 1974; Field, 1981).

In summary, research suggests that both gaze behavior and affective expressions are manifestations of cognitive and physiological functioning (Gable & Isabella, 1992; Stern, 1974), and serve as salient communicative indices of social engagement and disengagement and arousal regulation. This is not to say, however, that young infants have intentions to communicate specific messages to their caregivers through their nonverbal behavior. Intent would require that the infant recognize the caregiver as a separate entity with his or her own motives and goals, a phenomenon which reportedly does not begin to occur until approximately 7 or 8 months of age (Bornstein & Lamb, 1992). Nevertheless, as even newborn infants display innate or prenatally-acquired patterns of behavior in response to environmental changes, caregivers tend to interpret these nonvocal forms of behavior as intentional communicative feedback, and respond as if their infants are behaving intentionally, or are 'communicating' (Brazelton et al., 1974; Kaye, 1982; Papoušek et al., 2000). Such convictions imbue infants' nonverbal actions with particular significance for caregivers and, in so doing, influence the way they interact with their infants.

A considerable body of evidence has accumulated suggesting that mothers are sensitive and responsive to their infants' nonverbal behavior during social interactions. For instance, Gewirtz and Boyd (1976, 1977) demonstrated that infants' preverbal vocalizations and head-turns increased the likelihood of their mothers' vocalizations and smiles, and full and partial smiles, respectively. Moreover, Blehar, Lieberman, and Ainsworth (1977) found a significant negative correlation between infants' directions of gaze and changes in mothers' interaction rates. That is, mothers appeared to tailor their stimulation in accordance with their infants' periods of attention and inattention by decreasing the intensity and/or pace of their stimulation when their infants looked away from them. Similar findings have been reported by DeBoer and Boxes (1979). Kaye (1977, as cited in Kaye, 1982) reported that during a teaching task, mothers tailored their task demonstrations to their infants' visual signals by timing these demonstrations to their infants' periods of visual engagement. Papoušek and Papoušek (1978) reported that caregivers, and mothers in particular, were so adept at reading their infants' bodily behavior that they were able to identify and predict discomfort in their infants and to respond to the first signs even before the infants started crying. Taken together, these results highlight the considerable influence of infants' nonverbal actions in directing, sustaining, and terminating maternal stimulation. Moreover, findings suggest that mothers are highly attuned and responsive to their infants' nonverbal behaviors, and that they adapt their stimulation in accordance with their infants' signals of engagement and disengagement, thereby assisting them in regulating their levels of arousal.

Infant Sensitivity to Maternal Behavior in Naturalistic and Experimentally Manipulated Contexts

Paralleling research documenting mothers' responsivity to infants' nonverbal signals has been a proliferation of research investigating the degree to which infants are attuned and responsive to their mothers' behaviors. Fernald (1993) reported that 5-month-old infants responded with more positive affect in response to maternal vocalizations of approval and more negative affect in response to prohibitions, even in the absence of facial affective information. Furthermore, infants familiar with only the English language were able to discriminate vocal affective expressions presented in infant-directed (i.e., motherese) speech in several unfamiliar languages, including German, Italian, and nonsense English, but were unable to do so in Japanese, perhaps reflecting the attenuation of affect and concomitant acoustic differences in the Japanese language compared to the other languages studied. Notably, infants did not respond with differential affect in response to approvals and prohibitions presented in adult-directed speech, suggesting that infant-directed speech is more effective in eliciting infant affect.

Kaye and Fogel (1980) reported that, during the course of naturalistic face-to-face interactions occurring between 6 and 26 weeks of age, maternal behavior affected the likelihood of occurrence of infant facial expression. More specifically, mothers' facial greetings (e.g., nodding, smiling) served to elicit facial greetings from their infants, and the likelihood of this occurrence increased with infant age. Cohn and Tronick (1987) also observed mother-infant pairs during naturalistic face-to-face interactions occurring at 3, 6, and 9 months and found that, at both 6 and 9 months of age, periods of dyadic engagement originated with mothers' uses of positive affective expressions. That is, mothers' facial expressions of positivity were successful in eliciting their infants' attention when disengaged. Mothers' positive expressions were also found to precede the onset of the infants' positive expressions. In contrast, in her study of naturalistic face-to-face interactions involving depressed mothers and their 3-month-old infants, Beebe (2000) reported that these infants displayed more sadness and anger expressions, and fewer expressions of interest than infants of nondepressed mothers, suggesting that their mothers' depressed affect may have contributed to difficulties regulating arousal and more negativity.

Studies in which maternal behavior is experimentally manipulated have also been useful in demonstrating how variations in maternal behavior are associated with infant behaviors indicative of arousal and arousal regulation (e.g., Cohn & Tronick, 1983; Field, 1977; Fogel et al., 1982; Gable & Isabella, 1992; Gusella, Muir, & Tronick, 1988; Symons & Moran, 1994). Infants' sensitivities to changes in their mothers' social signals have been highlighted in several studies in which the normal pattern of mother-infant interaction has been altered by providing mothers with instructions on how to interact with their infants.

Studies employing such experimental manipulations have served to highlight changes in infants' behaviors across brief play periods, thereby suggesting infants' sensitivities to maternal social signals. Field (1977) reported that when mothers were instructed to elicit and maintain their infants' attention on their faces, infants displayed less smiling, more negative affect, and less gazing at their mothers than during a naturalistic interaction. In contrast, when they were instructed to imitate their infants' behavior, infant gaze behavior and responsiveness to the mother were found to increase. Field attributed the different patterns of infant gazing obtained during the two experimental periods to differences in infant arousal. Specifically, the decreased information processing demands inherent in the imitation condition, as well as mothers' greater attentiveness and contingent responding to their infants' signals during this period, appeared to elicit infants' behaviors indicative of arousal regulation. In contrast, infants' gaze aversion and negative affect in the attention-getting period were hypothesized to result from the increase in maternal activity, apparently contributing to excessive arousal and the need to disengage.

In a subsequent study, Symons and Moran (1987) found that 13- to 16-week old infants and their mothers were actively involved and highly responsive to changes in their partners' behavior during face-to-face interactions. Contrary to Field (1977) however, mothers successfully elicited and maintained their infants' attention when instructed to do so. In fact, there was a trend for infants to gaze more at their mothers during this episode than during either the normal or imitation interactions. When mothers were instructed to imitate their infants, infants maintained similar amounts of gaze as in the other play periods, but displayed significantly less positive affect. Similarly, mothers evidenced less activity and positive affect and rated the interaction as less communicative than either the normal or attention-getting episodes. Researchers (e.g., Gable & Isabella, 1992; Symons

& Moran, 1987) have attributed the divergent findings in studies of attention-getting (i.e., Field, 1977; Gable & Isabella, 1992; Symons & Moran, 1987) to differences in the wording of instructions to mothers. Specifically, they hypothesized that variations in the wording of experimental instructions may act to modify and/or constrain parents' behavior in a variety of ways that impact their contingent responding to their infants and contribute to different infant reactions. Consequently, Symons and Moran (1987) recommended the use of a variety of behavioral indices of infant involvement and responsiveness, rather than a single measure that may be inadequate to detect these subtle variations.

In a more recent investigation, Gable and Isabella (1992) longitudinally examined the relationship between maternal behavior and behavioral manifestations of infant arousal (e.g., infant gaze behavior, head orientation, facial expressions) at 1 and 4 months of age. Following a naturalistic interaction, mothers were asked to try to keep their infants' attention, to get them excited, and to smile. Their results revealed that maternal state and physical activity when infants were 1 month of age were significant predictors of 4-month-olds' arousal regulation abilities. That is, infants whose mothers were alert, attentive, and who provided appropriate levels of physical stimulation at 1 month were better able to regulate their arousal (i.e., exhibited more positive affect and spent more time gazing at their mothers) at 4 months of age. In contrast, mothers' whose tendencies were to provide either too much or too little stimulation had infants with less adequate abilities to regulate arousal, as indexed by their greater gaze aversion and less positive affect. Taken together, the results of these investigations (Field, 1977; Gable & Isabella, 1992; Symons & Moran, 1987) suggest that subtle manipulations of mothers' behavior achieved through the use of instructions affected their stimulation and interactive strategies and resulted in concomitant differences in infant behavior. When instructed to engage their infants in various ways, mothers appeared to use specific strategies to accomplish their goals, reflected in corresponding changes in their infants' behavior.

Importantly, mothers in the aforementioned studies were never directly asked to modify their behavior. Rather, they were simply instructed to elicit a behavior from their infants or mimic their infants' behavior. In contrast, other studies have more actively manipulated maternal behavior by directly instructing mothers to modify their stimulation in order to observe the effects on infant gaze and affect. Researchers using this approach have often employed the still-face (SF) procedure (Tronick, Als, Adamson, Wise, & Brazelton, 1978), and studies of this type have aided in clarifying infants' behavioral coping strategies in response to maternal disengagement.

The SF period effectively eliminates maternal facial, vocal, and tactile stimulation for a brief period of time, while eye-to-eye contact is maintained. In the first and third interaction periods of the SF procedure, mothers are instructed to play with their infants as they normally would at home. In contrast, during the second period, mothers are instructed to remain still-faced (i.e., facially neutral and unresponsive), silent, and to refrain from touching their infants. The SF procedure has been used extensively to evaluate young infants' communicative abilities, responsivity to manipulations of maternal behavior, and capacity to regulate their affective states (Tronick, 1989; Weinberg & Tronick, 1994).

A central assumption of the SF procedure is that infants are attuned to changes in their mothers' behavior, and that it is stressful to infants when their mothers act in ways that reflect affective disengagement (Kogan & Carter, 1996). Results of a host of investigations employing the SF procedure have supported this hypothesis, with infants as young as 1 month of age responding to the SF perturbation with decreased smiling and gazing at the mother's face and, in some instances, increased fretting (e.g., Lamb, Morrison, & Malkin, 1987; Mayes & Carter, 1990; Stack & Muir, 1990; Toda & Fogel, 1993; Tronick et al., 1978). In fact, the maternal affective disengagement engendered by the SF has been argued to be more stressful to 4-month-old infants than physical separation (Field, Vega-Lahr, Scafidi, & Goldstein, 1986).

In an effort to ascertain more specifically which component of maternal behavior was responsible for the SF effect, Gusella et al. (1988) examined the SF procedure in 3- and 6-month-old infants. Resulting age differences suggested that whereas 6-month-olds' responses were influenced by changes in maternal facial and vocal expression, evidenced by their increased gazing away from their mothers' faces and decreased positive affect during the SF period, 3-month-olds' responses appeared to be dependent on maternal touch. That is, 3-month-olds exhibited the SF effect only when maternal touch was included in the Normal period preceding the SF and their attention declined over time in the absence of tactile stimulation. These findings led the authors to conclude that touch appears to serve an important role in influencing the interaction and maintaining infant attention, particularly for infants of younger ages. A series of studies conducted with 6-month-old infants further determined that the SF effect did not result simply from a generalized drop in stimulation. Instead, the effect was found to be driven primarily by the change in maternal facial, rather than vocal, expression (Muir & Hains, 1993).

The Importance of Tactile-Gestural Stimulation

Research involving both animals and humans has documented the importance of the tactile modality to early physical, social, and emotional development (e.g., Field et al., 1986; Montagu, 1986; Scafidi et al., 1990; Schanberg & Field, 1987). Studies by Stack and colleagues (e.g., Stack & Arnold, 1998; Stack & LePage, 1996; Stack & Muir, 1990, 1992) have highlighted the important contribution of touch during mother-infant face-to-face interactions. For instance, Stack and Muir (1990) compared a standard SF procedure (N-SF-N) with a modified SF procedure in which mothers were permitted to touch their infants naturally and spontaneously, while maintaining their neutral facial expression and silence (SF with touch; SF+T). In this way, they were able to isolate the contribution of touch from the visual and vocal components of maternal behavior. The results of this study indicated that touch was frequently employed (i.e., over 65% of the time) during a normal period of face-to-face interaction, a result that has been corroborated in other studies of mother-infant social interaction (e.g., Symons & Moran, 1987; Weinberg, 1994, as cited in Tronick, 1995). Furthermore, 3-, 6-, and 9-month-old infants smiled more and grimaced less during the SF period in which touch was permitted, suggesting that touch can modulate infants' negative reactions to the SF. A subsequent study (Stack & Muir, 1992) determined that it was the tactile stimulation, and not the visual stimulation provided by the hands, that modified infants' responses during the SF with touch interaction. Taken together, these findings suggest that tactile stimulation alone is capable of influencing infant gaze and affect and of modulating the typical SF effect.

Similar findings have been reported by Brown and Tronick (in preparation; as cited in Tronick, 1995). Using a different methodology, the authors examined the independent contributions of touch, vision, and voice during mother-infant interactions by comparing the behavioral and affective responses of infants engaged in five experimental conditions: a normal play interaction, three experimentally manipulated interactions in which the infant only saw the mother, only heard her, or only felt her touch, and a last condition in which the infant was alone. Their results indicated that infants in the touch-only interaction scanned their environments less (i.e., a response the authors interpreted as indicative of stress), evidenced increased attention to objects, and smiled less than in the normal and face-only conditions. Notably, however, lower levels of fussing or crying were exhibited in the touch-only condition compared to the normal or face-only conditions, again suggesting that touch has the effect of calming the infant and reducing the infant's level of stress, even when presented in isolation. As Tronick did not discuss these findings in further detail, it remains unclear why higher levels of fussing would be exhibited during the normal than the touch-only interaction, or why no differences in fussing were exhibited between the touch-only and voice-only conditions, or between the touch-only and alone conditions.

More recent studies also employing the modified SF procedure (e.g., Stack & Arnold, 1998; Stack & LePage, 1996) have documented infants' sensitivity and responsivity to changes in maternal tactile stimulation presented in isolation. For instance, Stack and Arnold (1998) manipulated maternal behavior by instructing mothers to elicit specific behaviors from their 5½-month-old infants using only touch. Comparisons were then made between this experimental group and a corresponding control group in which mothers also used only touch but did not receive further instructions regarding the types of behaviors to elicit from their infants. Mothers were specifically instructed to engage their infants in a playful interaction and, similar to previous studies of this nature (i.e., Field, 1977; Symons & Moran, 1987), to imitate their infants, and to elicit and maintain their infants' attention on their faces. The results of this investigation revealed that durations of maternal tactile stimulation differed during the various periods as a function of the behaviors that mothers were asked to elicit from their infants, suggesting that mothers adjusted the amount of their touching to achieve their desired goals.

In turn, infants demonstrated their sensitivity to changes in their mothers' touching with corresponding shifts in their gaze and affect. Results revealed that infants in the experimental group gazed more at their mothers' faces when mothers were asked to elicit this behavior than did those in the control group. They also smiled more than their control counterparts during the playful interaction period, thereby revealing the considerable influence of the tactile modality in influencing infant gaze and affect, even when it is the only means of communication employed. Importantly, the finding that the behavior of infants in the experimental group differed from that of the control group during periods in which the durations of mothers' touching remained constant was taken as indirect evidence that the quality of mothers' touching must have differed. However, since the study was limited to overall duration of touch, firm conclusions regarding the contributions of qualitative aspects (i.e., type) of maternal touch in influencing infant gaze and affect were precluded.

Interestingly, many mothers interpreted the instruction to use only touch as including gestural hand movements (e.g., waving, wiggling their fingers), suggesting that mothers may interpret touch to mean any stimulation involving the hands. Specifically, mothers in the experimental group were found to gesture more toward their infants relative to those in the control group overall, and particularly during the period in which mothers were asked to imitate their infants.

The finding that mothers use gestures during social interactions with their 5½-month-olds is particularly salient, as the preponderance of studies investigating the role of maternal gesturing have been conducted with hearing-impaired infants or older hearing infants in the context of language acquisition. Research on these populations has confirmed the importance of maternal gestural signals in promoting and sustaining dyadic interactions. For instance, Schnur and Shatz (1984) examined the influence of maternal gesturing during caregiver-infant interactions by comparing the interactions of four 1-year-old hearing infants and their mothers during a free-play versus an 'ungestured' interaction in which mothers were instructed not to use their hands. Results indicated that when unable to use their hands, mothers' use of manual gestures was replaced by non-manual gestures (e.g., head nodding), highlighting the important contribution of gestural signals to mothers' communication. Furthermore, infants appeared more likely to attend to maternal statements that were preceded by a gesture than not during the free-play condition and attentiveness was found to decrease in the 'ungestured' condition.

Research has also documented developmental differences in mothers' use of gestural communication with age. In their study of hearing children ranging in age from 1 year, 7 months to 2 years, 10 months, Shatz and Graves (1976; as cited in Schnur & Shatz, 1984) found that the proportion of total gestures produced by mothers correlated with children's age, with mothers of younger children producing more hand gestures than mothers of older children. Moreover, maternal gesturing appeared to have a greater influence on the behavior of younger children (i.e., 1 year, 7 months and 1 year, 9 months) than older ones, as younger children responded more appropriately to maternal statements that were accompanied by gestures than those that were not. Declines in the use and effectiveness of maternal gesturing with infant age were hypothesized to relate to the onset of language and increased use and effectiveness of verbal communication as a means of exchange with older as opposed to younger children.

Although mothers have been reported to use gestures with young infants (Stack & Arnold, 1998), infants' understanding of the significance of adult gestures is less clear. Studies investigating infants' appreciation of these signals have generally been limited to adult pointing. To date, there is no evidence to suggest that infants below 9 months of age grasp the significance of this attention-directing cue (Carpenter et al., 1998). Butterworth and Grover (1988, 1990) reported that 6- and 9-month-old infants were as likely to fixate their mothers' pointing hands as they were to fixate the target at which their mothers were pointing. Whereas some researchers have reported that it is not until

12 months of age that infants reliably fixate targets instead of their mothers' pointing hands (Butterworth & Grover, 1988, 1990; Schaffer, 1984), others have claimed that this ability appears even later, at approximately 15 months (Desrochers, Morissette, & Ricard, 1995; Morissette, Ricard, & Gouin-Decarie, 1995).

Although it may be tempting to conclude on the basis of these findings that infants do not attend to the object of the gesture prior to 1 year of age, it is necessary to highlight several important differences between the studies reported herein. Firstly, the studies differed markedly in the types of gestures studied, with some including all visual interactive hand movements and others being limited specifically to pointing. Secondly, the studies differed with respect to the referent of the gesture, with the majority of studies investigating the ability of gestures to direct attention to the mother herself or an object that she held. In contrast, the studies of maternal pointing sought to examine infants' abilities to detect a more distant referent within the infants' field of vision. In other words, most studies examined the ability of the gesture to direct attention to the gesture itself whereas the studies on pointing examined the mother's ability through gesture to direct the infant's attention to something else. As gesturing is argued to be an attention-worthy event (Butterworth, 1991), it may be that infants attend to the source of the gesture until such time as they gain a cognitive awareness and appreciation of its signal function, at which point they develop the ability to attend to the referent of the gesture.

Taken together, the findings from these studies provide evidence for the hypothesized attention-eliciting role of maternal gesturing, a conclusion that is supported by the work of other researchers (e.g., Koester, 1995; Macnamara, 1977; Murphy &

Messer, 1977; Shatz 1982). Furthermore, they suggest that mothers' use of gestural communication is intimately tied to the developmental age of the infant toward whom the stimulation is being directed, with mothers of younger infants employing gestures as a means of influence more than mothers of older infants. Nevertheless, the majority of research is dedicated to the examination of maternal gesturing toward hearing-impaired infants and older hearing infants and toddlers above 1 year of age in the context of language acquisition. As a result, little is known about the role of maternal gestures in eliciting and directing younger infants' gaze (i.e., those prior to 1 year of age), or possible developmental progressions in mothers' uses of gestural stimulation during this early infancy period.

Although the duration of maternal tactile-gestural behavior has been demonstrated to be an important factor in influencing infant behavior, other aspects of tactile stimulation, including the type of touch, as well as the intensity, tempo, rhythmicity, and location of the physical contact are also likely to contribute to differential responding in infants. For instance, Brazelton et al. (1974) argued that the effect of a series of light pats on an infant's cheek is likely to differ radically from the effect of a series of forceful pats. Whereas the first may function to elicit and maintain the infant's attention, the latter would likely result in withdrawal.

In an effort to examine the qualitative aspects of maternal touching, Weinberg (1994; as cited in Tronick, 1995) examined the proportion of several different types of touch used by mothers with their 6-month-olds during face-to-face interactions. Her results revealed that the various forms of touch were distributed differently according to the affective quality of the touch employed. Specifically, the greatest proportions of time were devoted to affectively positive forms of touch such as stroking, rhythmic touching, and holding, with correspondingly smaller proportions of time being spent in discrete positive forms such as tickling and kissing. Little time was spent in affectively negative forms of touch such as poking or pinching.

In contrast, studies of depressed mothers' interactions with their infants revealed that mothers engaged in more intense and affectively negative forms of touch with their infants (e.g., poking and jabbing) than did control mothers, and these behaviors were directly associated with infants' negative affect and gaze aversion (Cohn & Tronick, 1989). Intrusive mothers have also been found to poke their infants (e.g., Field, Healy, Goldstein, & Guthertz, 1990; Malphurs, Field, Raag, Pickens, & Peläez-Nogueras, 1996). Taken together, these results suggest that maternal affective state may influence the types of touch used by mothers with their infants, as well as infants' behavioral signals of engagement and disengagement during interactions involving such stimulation. Moreover, manipulations of depressed mothers' behavior achieved through the provision of instructions regarding the optimal forms of touch to use with infants were found to modify depressed mothers' stimulation and, in so doing, alter infant responding, at least during a brief interaction period (Peläez-Nogueras, Field, Hossain, & Pickens, 1996).

Based on these results, several researchers (e.g., Stack, 2001; Tronick; 1995) have hypothesized that different forms of touch may actually convey different messages to infants, messages that may be just as salient and specific as those conveyed via other modalities (e.g., facial expressions). In addition, they have suggested that the quality of maternal stimulation may be key to the response it engenders. Thus, the type of touch employed may act to influence infants' state-regulation abilities, a function that Tronick (1995) has argued would be critical during early development and might continue to facilitate infant coping during stressful events and high levels of arousal even later in development.

Convictions similar to those expressed above (i.e., Brazelton et al., 1974; Stack, 2001; Tronick, 1995) have prompted the creation of research instruments that permit the evaluation of qualitative aspects of maternal touch. For instance, Weiss (1992) developed the Tactile Interaction Index (TII) to describe the sensory qualities (i.e., location, intensity, type, and duration) of touch used during social interactions. Similarly, Stack and colleagues (Stack, LePage, Hains, & Muir, 1998) developed the Caregiver-Infant Touch Scale (CITS), an instrument that permits an evaluation of the type, intensity, speed, extent, and area of tactile stimulation that mothers use during interactions with their infants.

To assess the qualitative and quantitative aspects of maternal touching employed during social interactions between mothers and their young infants, Stack et al. (1998) applied the CITS to a large data set from a study in which maternal behavior was manipulated during several still-face periods. Following a Normal interaction period, mother-infant dyads participated in three experimental periods in which mothers were asked to: (a) remain silent, still, and neutral, and use only touch (i.e., SF+T), (b) obtain the most smiling from their infants, and (c) touch their infants on only one area of the body of their choosing.

Results revealed that mothers used different types of touch with their 5½-month-olds as a function of the type of behavior they were instructed to elicit from their infants. For instance, mothers used more static touch (i.e., resting, holding) during the Normal period compared to the touch-only periods. In contrast, they used more active types of touch (i.e., lifting, tickling), as well as more intense and faster stimulation when asked to maximize their infants' smiling. When asked to touch their infants on one area of the body, mothers increased their use of stroking, and decreased the intensity of their touching.

These results strongly suggest a functional role for the tactile modality and reinforce the assertion that duration of touch in not a sufficient index to describe the complexity of maternal touch (Brazelton et al., 1974; Stack, 2001; Tronick, 1995). Rather, qualitative and quantitative dimensions of tactile behavior also require investigation if one is to gain a complete understanding of the capacity of adult touch to influence and sustain infant attention and affect. Information regarding the qualitative aspects of maternal touch are warranted, as previous research (e.g., Arco, 1983; Arco & McCluskly, 1981; Brazelton et al., 1974; Kaye & Fogel, 1980; Stern 1977) has demonstrated that the structure and timing of maternal stimulation has a pronounced effect on infants' behavior. Indeed, mothers' abilities to provide appropriate and contingent stimulation during face-to-face interactions has been associated with infant behaviors that are indicative of successful arousal modulation, including less gaze aversion and negative affect, and more smiling (Fogel, Diamond, Hoover Langhorst, & Demos, 1982; Gusella et al., 1988; Symons & Moran, 1987).

Co-Occurrence of Nonverbal Expressive Behaviors

Further studies examining the qualitative aspects of maternal tactile-gestural stimulation, and infants' responses to such behavior, would undoubtedly advance our understanding of the influence of nonverbal signals during mother-infant social interactions. However, to more precisely describe the organization of nonverbal behavior, researchers must also seek to describe the way in which different nonverbal behaviors are situated in a social context. Several researchers (e.g., Sroufe, 1979a; Sroufe & Waters, 1976; Symons & Moran, 1987) have asserted that behaviors do not occur in isolation; rather they are integrated with other behaviors that are, in turn, embedded in a stream of interaction. Accordingly, it is important to investigate how the expression of a given nonverbal behavior depends, in part, on other behaviors that occur in conjunction with, precede, and/or follow it.

The results of researchers who have studied co-occurrences between infant behaviors (e.g., Fogel & Thelen, 1987; van Wulfften Palthe & Hopkins, 1984; Weinberg & Tronick, 1994), have suggested that associations between infants' affective expressions and gazing at mothers' faces enhance the communicative significance of these socially-directed signals. For instance, Weinberg and Tronick (1994) found evidence of affective configurations of facial, vocal, gestural, postural, and regulatory behaviors in 6-month-old infants during a face-to-face SF interaction. Furthermore, these configurations were specific to the type of interactive context, suggesting that infants modify the organization of their behavioral and affective signals as a function of the type of interaction. For instance, facial expressions of joy, gaze directed toward the mother, neutral/positive vocalizations, and mouthing body parts characterized periods of social engagement, whereas facial expressions of interest and mouthing characterized engagement with objects.

In 1994, van Beek, Hopkins, and Hoeksma conducted a study to assess for co-occurrences between infants' expressive behaviors and looking at the mother. More specifically, they examined the development of looking, facial expressions, and vocalizing and found that positive facial expressions, but not vocalizations, were associated with looking at the mother's face in full-term infants. However, their findings were based on free-play, multi-modal interactions and did not address the relationship between expressive behaviors and gazing at mothers' hands. Reflecting their interest in the tactile-gestural modality, Stack and Arnold (1998) examined the association between infant expressive behaviors and gazing at their mothers' faces and hands during several touch-only interactions. Results revealed identifiable patterns of infant smiling and vocalizing with gazing at mothers' faces and hands. Furthermore, frequencies of co-occurrence varied as a function of instruction period, with more frequent co-occurrences of infant smiling and gazing at mothers' hands being exhibited during the normal interaction and the period of playful interaction relative to a period in which mothers were instructed to attract and maintain their infants' attention on their faces. In contrast, infant vocalizing was found to co-occur more frequently with gazing at mothers' faces during the attention-to-face period, suggesting that their vocal expressiveness was specifically associated with periods of visual engagement with their mothers. These findings suggest that infants' expressive and attentive behaviors varied as a function of the context of the interaction, thereby providing further evidence for infants' sensitivity to maternal tactile and gestural signals presented in isolation.

Taken together, co-occurrence studies highlight the complex organization of infants' behaviors. Nevertheless, our knowledge regarding the configuration of different nonverbal expressive behaviors, both within the infant and particularly between the infant and mother, remains limited (e.g., Bakeman & Brown, 1977; Cappella, 1981; Hopkins, 1983). For example, it remains unclear whether there exist developmental differences in patterns of co-occurrence between various infant behaviors, whether there is an association between maternal tactile-gestural stimulation and behavioral manifestations of infants' engagement and disengagement reflective of infants' arousal-regulating abilities, and whether these associations differ as a function of contextual variations in the social interaction and/or infant age.

Weinberg and Tronick (1994) have suggested that co-occurrences of expressive modalities may have clinical significance in evaluating and describing atypical emotional and social behavior in young infants. As such, comparisons of behavioral co-occurrences between healthy full-term and high-risk (e.g., pre-term) infants are warranted. Such an investigation might be helpful in ascertaining whether pre-term infants have difficulty organizing their behavior during social interactions, a hypothesis that was proposed by Field (1981). Different patterns of co-occurrence in full-term and pre-term infants might potentially help explain some of the interaction difficulties experienced by these infants and their mothers. Taken together, the information arising from such an investigation would advance our understanding of the communicative significance of nonverbal behavior, as well as the structural organization of dyadic nonverbal interaction.

Very Low Birth Weight Premature Infants

Although most studies have assessed the contribution of the tactile-gestural modality via experimentally contrived perturbations designed to manipulate maternal behavior, it is equally important to study nonverbal behavior in the context of mother-infant interactions that are "naturally perturbed" due to interactive deficits on the part of the infant and/or mother. Investigations of nonverbal behavior in naturally perturbed interactions are important as they provide a means of assessing ecological validity. One such situation in which mother-infant interactions may be naturally perturbed is the case of very low birth weight premature (VLBW-PT) infants and their families. According to definitions proposed by the World Health Organization (1990), VLBW infants are those born with birth weights below 1500 grams.

The past three decades have evidenced a marked increase in the survival of VLBW-PT infants, both in North America and abroad (Bauchner, Brown, & Peskin, 1988; Behrman, 1985; Hack, Faranoff, & Merkatz, 1979; Knobloch, Malone, Ellison, Stevens, & Zdeb, 1982; Millar, Strachan, & Wadhera, 1991, 1993; Pharoah & Alberman, 1990). Improvements in pre-natal medical care (e.g., greater availability of prenatal programs, improved maternal diet, better medical management of high-risk pregnancies), as well as medical and technological advances in the field of neonatology, are undoubtedly responsible for this increase (Barrera, Rosenbaum, & Cunningham, 1987; Gardner & Karmel, 1983; Millar et al., 1991; Mitchell, 1979; Molteno, Magasiner, Sayed,

& Karplus, 1990). Although Minde (1993) cautions that most survival estimates are based on well-equipped regional facilities, findings suggest that survival is likely (i.e., > 50%) for infants with birth weights in excess of 750 grams, and that it is probable (i.e., > 90%) for infants whose birth weights exceed 1000 grams (Bauchner et al., 1988).

Studies have estimated that of the 3.7 million annual live births in the United States, approximately 1.1% are VLBW-PT (Behrman, 1985; Bernbaum & Hoffman-Williamson, 1985). This estimate translates into approximately 36,000 - 41,000 such births a year (Behrman, 1985; Bernbaum & Hoffman-Williamson, 1985; Minde, 2000). Similar percentages have been reported in Canada, equaling approximately 3,900 such births yearly (Minde, 2000).

Accompanying the increased survival rate of VLBW-PT infants has been a proliferation of research aimed at determining the effect of their premature birth on subsequent infant development. That VLBW-PT infants are predisposed to a variety of physical, behavioral, and cognitive difficulties that may depress their behavioral competence has been well documented (Barrera et al., 1987; Breslau, Klein, & Allen, 1988; Hack et al., 1979; Hertzig, 1981; Hoy et al., 1988; Kopp, 1987; Minde, Perotta, & Hellman, 1988; Molteno et al., 1990; Rickards, Kelly, Doyle, & Callanan, 2001; Schraeder, Heaverly, & Rappaport, 1990; van Hof-Van Duin, Evenhuis-van Leunen, Mohn, Baerts, & Fetter, 1989; Zelkowitz, Papageorgiou, & Allard, 1994; Zelkowitz, Papageorgiou, Zelazo, & Weiss, 1995). However, considerably less is known about VLBW-PT infants' social interactions with their caregivers. Such studies are important, as Sameroff and Chandler (1975) have asserted that the quality of premature infants' interactions with their caregivers is a better predictor of later outcome than more traditional peri-natal assessments.

In addition to the biological sequelae associated with VLBW-PT birth, a variety of other psychosocial factors may compromise the infant's social development and quality of adaptation within the family. For instance, compared to full-term infants who spend an average of 3.5 days in the hospital following their birth, research has shown that VLBW-PT infants' hospital stays average 57 days (Millar, Strachan, & Wadhera, 1993), the majority of which are likely to be spent in an incubator (Goldberg, 1979; Gottfried, Lande, Brown, King, & Coen, & Hodgman, 1981). As a result, they are likely to experience considerably fewer, and more restricted, opportunities for physical contact and social interaction with their caregivers, thereby limiting the occasions during which they can develop and refine their interactive skills (DeMaio-Feldman, 1994; Goldberg, 1979; Harrison, Leeper, & Yoon, 1990; Hoy et al., 1988). In addition, VLBW-PT infants are approximately 4.5 times more likely to require rehospitalization within the first year of life than are full-terms (Bauchner et al., 1988). Although the average length of these hospitalizations it unclear, it is conceivable that these experiences may result in even more restricted opportunities for interaction and the development of VLBW-PT infants' communicative skills.

In addition, the birth of a VLBW-PT infant represents a significant stressor, particularly for those parents whose infants also experience post-natal complications (Thompson, Oehler, Catlett, & Johndrow, 1993). Research involving VLBW-PT infants has indicated that although the week following delivery is typically the time of greatest anxiety (Gennaro, York, & Brooten, 1990), mothers undergo considerable changes in their distress levels during the period of early infancy, with some mothers of 6-month-old corrected-age VLBW-PT infants experiencing high levels of distress comparable to those evidenced at birth (Thompson et al., 1993). These findings have serious implications for the early parent-infant relationship, as maternal stress has been found to predict the quality of interaction with their infants (Crnic, Greenberg, Ragozin, Robinson, & Basham, 1983; Crnic, Greenberg, Robinson, & Ragozin, 1984; Minde, Whitelaw, Brown, & Fitzhardinge, 1983). For instance, Crnic et al. (1984) reported that maternal stress at one month predicted maternal sensitivity at four months. Maternal stress was also related to differences in infant behavior, including less clarity of infant cues and less responsivity to the mother.

Mothers of pre-term infants have been described as being over-stimulating (e.g., Barnard, Bee, & Hammond, 1984; Field, 1977) in that they have been found to stimulate their infants more than mothers of full-term infants in all sensory modalities (i.e., visual, auditory, tactile, and vestibular) and regardless of whether the infant was attentive or not (Bakeman & Brown, 1980; Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983; Field, 1977). Despite this elevated level of stimulation, however, mothers of premature infants have been shown to demonstrate less playful stimulation with their infants and to show less contingent responding to their signals (Leroux, Malcuit, & Pomerleau, 1999). In contrast, other researchers (e.g., DiVitto & Goldberg, 1979; Stern & Hilderbrandt, 1986) have found that mothers stimulate their pre-term infants less than do mothers of full-terms. Although the factor(s) responsible for this contradiction are not entirely clear, researchers have attributed the discrepant findings to differences in the populations of pre-terms studied (i.e., those differing in birth weight, perinatal medical complications).

Field (1977, 1981) hypothesized that mothers may overstimulate pre-terms in their attempts to elicit the attention of their hypo-responsive infants. However, these attempts are typically counterproductive and result in even greater gaze aversion (Cohn & Tronick, 1987). One possible reason for this finding is pre-term infants' difficulties in arousal regulation. Researchers have found that pre-term infants are more difficult to engage, show more overt signs of aversion to social stimulation, more distress, and more difficulty recovering from distress when aroused (e.g., Bakeman & Brown, 1980; DiVitto & Goldberg, 1979; Field, 1982; Greene, Fox, & Lewis, 1983). Taken together, the results of these studies appear to suggest that greater vulnerability to arousal, greater behavioral disorganization in response to arousal, and longer reactivity to arousal characterize pre-term compared to full-term infants.

Another factor possibly contributing to premature infants' difficulties in social interaction is the ambiguity of their social cues. Compared to full-term infants, pre-term infants have been found to emit less distinctive and codable facial expressions (e.g., Field, Greenberg, Woodson, Cohen, & Garcia, 1984), to receive lower scores for the clarity of their cues (e.g., Crnic, Ragozin et al., 1983), to provide fewer active social cues and less frequent smiles (e.g., Greenspan, 1981; Segal et al., 1995), and to demonstrate more mixed cues of attention and distress (e.g., McGhee & Eckerman, 1983) than full-term infants. Furthermore, the sicker the pre-term, the lesser the likelihood of the infant emitting clear distress signals (DiVitto & Goldberg, 1979; Goldberg, Brachfeld, &

Divitto, 1980). Perhaps one factor contributing to sicker pre-terms' less distinctive signals is the finding that neurological abnormalities are associated with a more restricted repertoire of movements available for use as behavioral cues (Bigsby, Coster, Lester, & Peucker, 1996; Gorga, Stern, & Ross, 1985).

Notably, the signals that pre-term infants do emit also tend to be more qualitatively negative than those of full-terms. More specifically, pre-term infants have been found to look at their mothers less (Field, 1982; Malatesta, Grigoryev, Lamb, Albin, & Culver, 1986), and to more frequently avert their gaze from their mothers (Crnic, Ragozin et al., 1983; Field, 1977). They have also been found to emit more negative facial expressions (Crnic, Ragozin et al., 1983; Field, 1982; Malatesta et al., 1986). However, it is unclear from these studies whether differences in infant responsiveness between pre-terms and full-terms were in any way related to differences in maternal stimulation.

Consequently, studies examining the ways in which mothers modify their nonverbal stimulation to influence their infants' behavior and assist in their arousal regulation are warranted, as are studies examining infants' reactions to such stimulation. It has been argued that the stressors associated with pre-term birth affect infants' abilities to engage in sustained social interactions and to provide clear nonverbal signals to their caregivers (Bakeman & Brown, 1980; Beckwith & Cohen, 1989; Crnic, Greenberg et al., 1983; Field, 1977), thereby impacting caregivers' abilities to read their infants' signals and assist them in regulating the intensity of their arousal.

Although studies involving face-to-face interactions of mothers and their pre-term infants have been conducted (e.g., Field, 1977, 1981), little research has specifically examined the nonverbal behavior of these dyads. Nonverbal behavior is of importance as the stressors associated with pre-term birth have been found to affect infants' abilities to engage in sustained social interactions and to provide clear nonverbal signals to their caregivers (Bakeman & Brown, 1980; Beckwith & Cohen, 1989; Crnic, Greenberg et al., 1983; Field, 1977), thereby impacting caregivers' abilities to read their infants' signals and assist them in regulating the intensity of their arousal. Consequently, studies examining the ways in which mothers modify their nonverbal stimulation to influence their infants' behavior and assist in their arousal regulation are warranted, as are studies examining infants' reactions to such stimulation.

Summary

Research has demonstrated that despite their inability to speak, infants have a variety of means at their disposal (e.g., the direction of their gaze, facial expressions such as smiling and fretting) with which to communicate fundamental information regarding their biological states, motivational needs, and required assistance in emotional regulation. Although many of these behaviors are present from the earliest months of life, developmental competence in the use and expression of these signals is hypothesized to increase with age and interactive experience. As the majority of young infants' experiences with social interactions within the first half-year of life occur in the context of face-to-face dyadic interactions with their caregivers (primarily their mothers), researchers may learn a great deal about infants' social nonverbal communicative development within this context.

Caregivers are believed to assist in the development of their infants' communicative abilities by responding to their nonverbal signals as if they represented intentional attempts to communicate their experiences. Research has demonstrated that mothers are attuned to their infants' nonverbal behaviors, and that such behaviors have considerable influence in directing, sustaining, and terminating maternal stimulation. In turn, maternal nonverbal behavior is argued to be especially significant to infants during this early preverbal period. Studies in which maternal behavior is experimentally manipulated have illustrated young infants' sensitivities to changes in maternal social signals. Furthermore, research has documented that infants are particularly attuned to different aspects of maternal behavior as a function of age, with older infants' responses being influenced to a greater extent by maternal facial expression and slightly younger infants' responses being more dependent on maternal touch.

Research has highlighted the importance of touch to early physical, social, and emotional development. The results of several studies culminate to suggest that touch is capable of influencing infant attention and affect, and of calming infants. Furthermore, mothers appear to interpret instructions to touch their infants as including any movement of the hand, such as hand gestures. However, little is known about mothers' uses of gestural communication in populations other than mothers of hearing-impaired infants or those of older, hearing infants in the context of language acquisition.

Thus, despite considerable advances in this area, many limitations in our understanding of the tactile-gestural modality continue to exist. One of the primary issues that remains to be addressed is the degree to which touch and gesture can be used to communicate, and the way(s) in which mothers' uses of tactile-gestural stimulation, and infants' reactions to these, differ when touch and gesture are presented in isolation versus when they are employed more naturally in conjunction with other communicative modalities (e.g., facial and vocal expression). Such an investigation is required in order to assess the full potential of the tactile-gestural modality in influencing infant behavior, and the way(s) in which mothers' tactile-gestural behavior is itself influenced by the social context in which it is embedded.

Another way of assessing the influence of the social context on the expression of maternal tactile-gestural behavior is to examine its use, and infants' behaviors during interactions involving such stimulation, in contexts where maternal behavior is manipulated. Research specifically examining the way(s) in which mothers employ and adjust their tactile-gestural stimulation when attempting to influence infant arousal is needed, as is research examining infants' nonverbal communicative signals of engagement and disengagement in response to such stimulation during emotionally-arousing contexts in which their mothers' behavior reflects affective disengagement. Such a study is warranted, given suggestions that a primary function of infants' nonverbal signals is to communicate essential information regarding state of arousal and required assistance with arousal regulation, and that touch and gesture may act to influence infants' state regulation abilities, a function that is critical during early development (e.g., Tronick, 1995).

In addition, as duration of touch is but one factor influencing infant responsiveness, studies examining the qualitative dimensions of tactile behavior are required if one is to gain a complete understanding of the capacity of maternal touch to direct and modify infant gaze and affect. Past studies examining the effect of the quality of maternal touch on infant gaze and affect have suggested that mothers adjust the quality of their touching as a function of the context of the interaction. However, further investigation is needed to more precisely examine the type(s) of touch mothers employ when attempting to influence their infants' emotional states, and infants' behavioral responses to these attempts. Such an investigation is warranted, as it has been suggested that touch may communicate different messages to infants, thereby potentially influencing their behavior and arousal (e.g., Tronick, 1995).

Examination of the literature also reveals a paucity of research directly examining developmental differences in the durations of maternal touch and gestures, and the qualitative aspects of maternal touching, in influencing infant behavior as a function of infant age, as well as developmental progressions in infants' reactions to these. This oversight is surprising given the likelihood that mothers will adapt their behavior as infants mature and become more functional in their interactive capabilities (e.g., Kaye & Fogel, 1980).

Moreover, additional research is needed to examine mothers' uses of touch and gesture in VLBW-PT infants. Studies have found that mothers touch pre-term infants less (e.g., Stern & Hildebrandt, 1986) and more (e.g., Als & Brazelton, 1981; Bakeman & Brown, 1980) than mothers of full-terms. However, as VLBW-PT infants are generally smaller and more fragile it remains unclear whether mothers of VLBW-PT infants differ from those of healthy full-term infants in their degree of touching and and/or the qualities of touch they select to employ when interacting with their infants. Given that some VLBW-PT infants may be quite fragile following their birth and/or may possess heightened levels of emotional reactivity (Field, 1981), the possibility exists that their mothers may touch and gesture toward them less and/or use different types of touch (e.g., more limited use of intense and affectively arousing forms of touch such as tickling) with them as a means of modulating their infants' levels of arousal.

The Present Research: Rationale and General Objectives

As the previous review of the literature indicates, there is a paucity of research directly investigating the way(s) in which mothers employ and modify their use of the tactile-gestural modality as a means of influencing infant behavior, and infants' responses to such stimulation, as a function of the context of the interaction, infant age, and infant birth status. The two studies that comprise the present dissertation were designed to examine maternal tactile-gestural stimulation, and infants' nonverbal behaviors as indices of engagement and disengagement to such stimulation (e.g., gaze at the mother's face or hands, gaze away, smiling, fretting), as a function of the social context of the interaction and age.

Two general objectives formed the basis of the present research (the specific objectives applying to each study are outlined in the introductions to these studies located in their respective chapters). The two general objectives of Study 1 were: (1) to examine contextual and developmental influences on the durations of maternal tactile and gestural stimulation, as well as the qualitative aspects of maternal touch employed during face-to-face interactions with infants aged 3½ to 5½ months, as well as (2) infants' behavioral responses to these forms of stimulation. Because the development of caregivers' arousal induction strategies, and infants' responses, are argued to be embedded within the social context of their relationship, face-to-face interactions were employed, as this is the primary interactive context for mothers and their infants from birth to six months of age. The ages of 3½ and 5½ months were selected as they encompass the outer limits of the peak period of face-to-face interactions (e.g., Kaye & Fogel, 1980; Stern, 1977).

It has been hypothesized that the physical proximity established within the face-to-face context permits mothers to more readily detect and react to their infants' signals of engagement and disengagement (e.g., gaze, affective expressions; Gable & Isabella, 1992). Furthermore, through their behavior in this context, mothers are argued to provide their infants with varying sources and levels of external stimulation, and to facilitate their infants' attempts at adapting their behaviors toward the end of successful arousal regulation. In so doing, they structure experiences that foster the development of their infants' arousal-regulating abilities (Gable & Isabella, 1992; Stern, 1974).

In developing the study, it was postulated that situational demands introduced into the social interactive context via experimental perturbations of maternal behavior would influence mothers' uses of touch and gesture in attempting to modify their infants' arousal. Given Masters' (1991) suggestion that emotion regulation involves both arousal attenuation and augmentation, experimental perturbations were created so as to permit an examination of both these processes. Maternal behavior was experimentally manipulated by instructing mothers to either use only touch (i.e., uni-modal interaction) or all forms of communication available to them (i.e., multi-modal interaction). Such manipulations permitted a comparison of mothers' uses of tactile-gestural stimulation when it was the only means of communication available versus when it was more naturally employed in conjunction with other forms of communication (e.g., facial and vocal expression). Furthermore, the inclusion of the multi-modal contextual interaction was important, as it provided a means of assessing ecological validity.

Contextual influences on maternal tactile-gestural behavior were then further achieved through the provision of instructions to mothers in each of these uni-modal and multi-modal interactive contexts to elicit a specific behavior/state from their infants in several perturbation periods. The behaviors of mothers and infants in each of these contexts were then compared to those of dyads in which mothers used the same methods of communication (i.e., touch-only or all modes) but who were not provided with additional instructions on how to interact with their infants. Each of these comparisons (i.e., touch-instruction vs. touch-no instruction; all modes-instruction vs. all modes-no instruction) permitted an examination of the ability of touch to influence infant behavior, as well as infants' sensitivities to more subtle changes in maternal tactile-gestural stimulation within various uni-modal and multi-modal interactions. Taken together, these comparisons were particularly salient, as they permitted an examination both of the influence of modality as well as experimental perturbations within modality.

As in previous studies (e.g., Field, 1977; Gable & Isabella, 1992; Stack & Arnold, 1998; Stack & LePage, 1996; Stack et al., 1998; Symons & Moran, 1988), manipulations of maternal behavior were achieved through the provision of instructions designed to alter their stimulation. Following a baseline period of naturalistic face-to-face interaction (N), mothers were instructed to: (a) get their infants excited and happy (EX); (b) get their infants' relaxed and calm (RL), and (c) attract and hold their infants' attention on their faces with as much eye-to-eye contact as possible (AF). Mothers in the uni-modal condition were instructed to do so while maintaining a still, neutral facial expression and silence, and using only touch (SF+T) whereas mothers in the multi-modal condition were instructed to do so using all modes of interaction.

The instruction to get infants excited and happy was adopted as it was hypothesized to foster a highly positively-arousing interaction in which mothers would attempt to heighten their infants' arousal. The use of this instruction was motivated by Stifter and Moyer's (1991) finding that even positively-charged emotional interactions can contribute to excessive arousal and subsequent visual disengagement. As such, this period afforded an opportunity to examine the nonverbal behavioral strategies (i.e., touch and gesture) that mothers employ when attempting to heighten their infants' arousal, information that is lacking in the literature.

In direct contrast to the excited and happy instruction, the instruction to get infants relaxed and calm was selected because it was anticipated to result in maternal attempts to dampen infant arousal. In so doing, it was possible to examine the quantities of maternal touching and gesturing used when attempting to soothe their infants. The importance of touch in reducing infant stress has previously been noted (e.g., Brown & Tronick, in preparation; as cited in Tronick, 1995; Stack & Muir, 1990). However, in these studies mothers were never specifically instructed to calm their infants, they were simply told to use only touch.

Although the instruction to mothers to elicit and maintain their infants' attention on their faces did not directly require that mothers induce an emotional state in their infants, it was nevertheless retained from previous studies (e.g., Field, 1977; Gable & Isabella, 1992; Stack & Arnold, 1998; Symons & Moran, 1987) as it had the potential to differentially impact infant arousal depending on the manner in which the instruction was carried out. Past studies employing this instruction in naturalistic face-to-face interactions have revealed discrepant findings, with it alternately resulting in greater (Symons & Moran, 1987), lesser (Field, 1977), or equal amounts (Gable & Isabella, 1992) of infant visual engagement compared to a normal interaction. A prior touch-only study (Stack & Arnold, 1998) also revealed higher than normal attention levels. Consequently, the present study extended past research by permitting a direct comparison of mothers' uses of maternal tactile-gestural stimulation in eliciting infant attention within both touch-only and naturalistic face-to-face contexts.

Study 2 was designed to investigate possible differences in maternal tactile-gestural behavior, and infant gaze and affect, between 5½-month-old full-term infants and age-corrected VLBW-PT infants and their mothers. The general objective of this study was to examine whether mothers' uses of tactile and gestural stimulation differed toward full-term and VLBW-PT infants, and to examine infants' nonverbal behaviors as indices of engagement and disengagement in response to these forms of stimulation. Dyads participated in an SF interaction in which mothers were instructed to play with their infants as they normally would at home during the first and third interaction periods and to remain still-faced (i.e., facially neutral and unresponsive), silent, and refrain from touching their infants during the second period.

Both a modified SF+T procedure (Study 1) and the traditional SF procedure (Study 2) were employed, as they offered complementary methods of examining infant nonverbal behavioral indices of engagement and disengagement in contexts in which maternal behavior was perturbed. Furthermore, as both methods incorporated a baseline period of normal interaction, they permitted a comparison of the way(s) in which infant and maternal nonverbal behaviors were embedded within the stream of a normal interaction, as well as the way(s) in which the dyads' nonverbal behaviors were affected when specific instructions were provided to mothers. Importantly, the use of full-term infants in both studies permitted consistency across the two SF approaches. However, the addition of VLBW-PT infants in Study 2 afforded an opportunity to investigate possible differences in gaze and affect between full-term dyads and dyads whose interactions were naturally perturbed due to the infants' neurobehavioral immaturity.

CHAPTER 2: Study 1

Infants' abilities to regulate the intensity of their arousal within the context of social interactions is argued to be among the most important tasks of early infancy (Cole, Michael, & Teti, 1994; Emde, Gaensbauer, & Harmon, 1976; Gable & Isabella, 1992; Kagan, 1994; Sroufe, 1979a, 1979b; Stern, 1974). Beyond the first month of life during which time arousal regulation is primarily endogenously based, infants become increasingly vulnerable to the arousal engendered through external sources of stimulation (e.g., the behaviors of an interactive partner). In their attempts to learn to regulate arousal, infants are argued to develop externally directed regulatory abilities (e.g., gaze, affective expressions) that function to both engage others and elicit behaviors from them (Gable & Isabella, 1992).

In addition to the many self-regulatory strategies that infants acquire and refine to assist them in managing their arousal, extrinsic forces are also crucial to this process (Thompson, 1994). The external management of emotions is most evident in infancy, wherein a primary task of parenting involves monitoring, interpreting, and modulating infants' arousal states (Thompson & Calkins, 1996). In so doing, caregivers assist the development of their infants' emotional regulatory capacities through their alleviation of negative emotions, reinforcement of positive emotions, and structuring of their infants' interactive environments (Thompson, 1994). Indeed, it has been argued that the parent-infant relationship is the primary context in which emotion regulation strategies emerge (Crockenberg & Leerkes, 2000). Moreover, it is within the realm of such relationships that infants learn the parameters of their arousal as well as ways in which to communicate to their caregivers essential information regarding their states of arousal and required assistance in emotion-regulation. Successful experiences in the communication of such needs are believed to contribute to the infant's sense of effectance.

A frequent misconception with respect to caregivers' contributions to emotion regulation is that their efforts are solely directed at dampening or inhibiting experiences of negative arousal (Thompson & Calkins, 1996). Masters (1991) argues that caregivers also facilitate infant emotion regulation by enhancing or heightening emotional arousal. Yet, little is known about mothers' emotion induction strategies (i.e., active behavioral stimulation strategies that mothers use to induce arousal states and to modulate their infants' gaze and affective behavior). Likewise, little is known about possible developmental trends in caregivers' induction strategies and infants' behavioral responses to these. This paucity is surprising given that, as infants age, their burgeoning repertoire of emotions and developing skills in self-regulation are likely to impact both the emotional demands that caregivers place on them, as well as the strategies that caregivers use to manage their arousal (Thompson, 1994). In response to such concerns, Kopp (1989) has called for research examining developmental trends in caregiver strategies for infant arousal regulation, speculating differential use of sensory systems across age. Specifically, given the importance of proximal stimulation in early infancy, she hypothesized that caregiver stimulation involving the near receptors of touch and kinesthesis would be more salient in helping to regulate young infants' arousal than would the distance receptors of vision and audition. Kopp's (1989) assertion directly underscores the need for experimental investigations of the role of maternal tactile-gestural behavior in influencing infant behavior.

In addition to the contribution of the social partner in influencing infant arousal, extrinsic forces such as situational demands inherent in the social context also impact arousal regulation (Stechler & Carpenter, 1967; Sroufe, 1979b; Sroufe, Waters, & Matas, 1974; Thompson & Calkins, 1996). In fact, infants' communicative acts have been found to be highly context specific, with great variability occurring in response to even subtle changes in the social and/or physical characteristics of the setting of an interaction, such as the infant's postural position and developing motor coordination (Fogel, Dedo, & McEwen, 1992; Walker, Messinger, Fogel, & Karns, 1992). Notably, the influence of the immediate context of mother-infant interaction has been found to far outweigh the contributions of a variety of other factors, including maternal mental illness, social status, sex of child, and birth order (Seifer, Sameroff, Anagnostopolou, & Elias, 1992). Indeed, the contribution of the interactive context is so influential that several researchers (e.g., Campos, Campos, & Barrett; 1989; Izard, 1977; Sroufe, 1979b) have suggested that, to be properly investigated, the assessment of emotion regulation and dysregulation must be considered in relation to the context in which they occur. As a result, investigations of infants' responses to subtle contextual variations in maternal tactile-gestural stimulation designed to modify infants' arousal are warranted and would provide important information regarding the importance of the context in modifying the occurrence and organization of mother-infant behavior.

Given the paucity of research addressing the role of maternal touching and gesturing in influencing infant arousal, Study 1 was designed to enrich and extend our knowledge regarding the ability of maternal tactile-gestural stimulation to induce and modulate infant behavioral indices of arousal (i.e., directions of gaze and affective expressions). More specifically, the present study addressed five research objectives pertaining to the ability of maternal tactile-gestural behavior to influence infant behavior, and infants' responses to such stimulation.

Objectives

Objective 1a was to ascertain within the context of uni-modal (i.e., touch-only) and multi-modal interactions whether mothers used different durations of touch and gesture in response to instructions designed to modify their behavior, and whether infants were responsive to such changes as evidenced by differences in their durations of gaze and affect. This objective was addressed via two control comparisons in which maternal behavior was experimentally manipulated by instructing mothers to either use only touch (Tactile Experimental) or all modes of interaction available to them (i.e., face, voice, and touch; All Modes Experimental) in order to elicit a different behavior/state from their infants during several perturbation periods. The behaviors of mothers and infants in each of these two experimental groups were then compared to those of mothers and infants in a respective control group (hence the study included two control groups). Mothers in the Tactile Control group were instructed to be silent, and to pose a neutral facial expression but were permitted to touch their infants. In contrast, mothers in the All Modes Control group were permitted to interact normally with their infants using all modalities of interaction available to them in all periods. Mothers in these control groups were not provided with any further instructions regarding the type of behaviors to elicit from their infants. Differences in maternal tactile-gestural behavior and infant gaze and affect between each Experimental group and its respective Control group were then observed. These within-modality control comparisons were particularly important, as they were the primary means of establishing whether, in fact, mother and infant behavior differed as a result of the instructions provided to mothers. In so doing, they were argued to provide additional evidence for the functional use of maternal tactile-gestural behavior in influencing infant behavior, as well as the sensitivity of the infant to subtle changes in tactile-gestural stimulation.

Objective 1b was to ascertain whether these mother and infant nonverbal behaviors occurred differently as a function of the modalities used to accomplish the instructions (i.e., uni-modal interactions in which mothers were permitted only to use the tactile-gestural modality with their infants vs. multi-modal interactions in which mothers used all modes of interaction available to them). Such an examination not only permitted an assessment of the full potential of the tactile-gestural modality in influencing and directing infants' behavior, but aided in clarifying whether, and in what way, mothers' uses of touch and gesture were influenced by the availability of other modalities (e.g., maternal vocal and facial expression).

Objective 2 was to more precisely examine qualitative aspects of maternal touching by examining whether: (a) mothers elected to employ different types of touch, and (b) they touched different areas of their infants' bodies as a function of the behavior/state they were asked to engender in their infants, the context in which mothers attempted to accomplish the goal (i.e., uni-modal vs. multi-modal), and the age of the infant toward whom the stimulation was being directed.

Objective 3 was to evaluate whether differences existed in mothers' uses of tactile-gestural behavior and infants' responses to such stimulation with infant age. This objective was designed to address a limitation in the literature by permitting the assessment of developmental progressions in mothers' uses of tactile-gestural stimulation with infants of different ages, as well as possible age-related changes in infants' responses to the qualitative aspects of touch.

It was considered important to examine infants' reactions to the various perturbations developmentally because it was hypothesized that mothers' uses of tactile-gestural stimulation as a means of influencing infant arousal might change with age, corresponding to the shift from greater proximal stimulation to more distal stimulation. Even within the tactile modality, the possibility was considered that mothers might use different types of touch or touch different areas of their infants' bodies to accomplish the same goal at different ages. Consequently, the selection of perturbation instructions was also based on developmental considerations.

In addition to its hypothesized ability to engender a positively-arousing interaction, selection of the excited and happy (EX) instruction was motivated by Fogel's (1982) assertion that infants' affective tolerance for such high degrees of positive arousal increases with age, thereby permitting older infants to remain engaged despite the tension occurring therein. The relaxed and calm (RL) instruction was of interest developmentally, as it was possible that mothers might use different strategies in their attempts to reduce their infants' arousal as a function of age, and that infants might display different reactions to such attempts. Differences in infant behavior were anticipated, in particular because mothers' attempts to calm their infants would likely be made even in the absence of their infants' signals requesting such assistance (i.e., attempting to calm an infant who is not excessively aroused or distressed). Thus, it was of interest to investigate how infants would cope with the contradiction posed in this interaction in which mothers' stimulation was calming but their behavior was lacking in contingency. Lastly, the attention to face (AF) instruction was considered important, not only because of the hypothesized greater influence of maternal facial expressiveness with age (e.g., Gusella et al., 1988; Kopp, 1989), but also because the reactions of younger infants to such a perturbation might differ from those of older ones who likely have more means available to cope with the stress engendered by the removal of facial expressiveness (e.g., gaze aversion, Fogel, 1982; Kopp, 1989).

In sum, the perturbation periods selected for investigation permitted the opportunity to examine infants' nonverbal behavioral indices of engagement and disengagement in response to maternal tactile-gestural stimulation developmentally, undertakings that were unique to this study. Evidence that mothers employ greater or lesser durations of a particular behavior, or different types/areas of touch to elicit the same behaviors from their infants at different ages, would underscore arguments put forth by Brazelton (1982) and Weinberg and Tronick (1994) that different behaviors may be used interchangeably to achieve similar outcomes. In addition, it would provide convincing evidence that mothers are attuned and responsive to changes in their infants' maturing interactive capabilities with age (e.g., Kaye & Fogel, 1980).

Objective 4 was to more precisely describe the structure of mother-infant nonverbal behavior by determining whether there existed reliable co-occurrences between (a) different nonverbal indices of infant engagement and/or disengagement such as the direction of their gaze (i.e., at the mother's face, hands, or away), and affective expressions (i.e., smiling, fretting), and (b) between infant and maternal nonverbal behaviors, specifically the co-occurrence between infant gaze and affect with maternal touch and gesture. In so doing, it was possible to examine whether infants' directions of gaze and/or their expressions of affect were associated with periods of stimulation presented by the mother. Additional issues addressed by these analyses included an examination of whether the observed patterns of co-occurrence differed as a function of the type of interaction (i.e., uni-modal, multi-modal) as well as the period of interaction, thereby addressing the question of contextual influences to mother-infant interaction. Co-occurrences were also examined as a function of age, thereby addressing possible developmental progressions in the co-ordination of behavior, both within the infant and between the infant and mother.

Hypotheses Pertaining to Objective 1a: Within-Modality Control Comparisons

Two within-modality control comparisons were conducted to assess whether mothers' uses of tactile-gestural stimulation in influencing infant arousal and infants' responses to these actually differed within the context of uni-modal and multi-modal interactions. In the first comparison, the behavior of mothers and infants in the Tactile

Experimental group was compared to that of infants in the Tactile Control group. A second comparison was then conducted between the All Modes Experimental and All Modes Control groups. These two control comparisons were deemed to be an essential preliminary step, as they were the only means by which to assess whether instructions to modify their infants' behaviors/states directed to mothers in the Experimental group actually resulted in changes in the durations of touching and gesturing, and infants' gaze and affect behaviors.

Consistent with previous research (e.g., Stack and Arnold, 1998), comparison of the Tactile Experimental and Tactile Control groups was expected to reveal greater proportions of maternal touching during all but the N period for both groups, given that it was the only mode of communication available to mothers during these periods. For the same reason, no differences in the amount of touch were expected between the Tactile groups. Comparison of the All Modes Experimental and Control groups was anticipated to reveal more touching by mothers in the All Modes Experimental group during the RL period, as it was expected that mothers would touch their infants more in their attempts to calm them.

Reflecting the hypothesized attention-eliciting and attention-maintaining roles of gesturing (e.g., Schnur & Shatz, 1984; Shatz 1982; Shatz & Graves, 1976, as cited in Schnur & Shatz, 1984; Spencer, 1993), differences in the proportions of gesturing were expected between the Tactile groups. Specifically, mothers in the Tactile Experimental group were expected to gesture more toward their infants than those in the Tactile Control group during the AF period as a means of attracting their infants' attention to their faces.

In contrast, no differences in gesturing were anticipated between the All Modes Experimental and Control groups.

Given that mothers in both the Tactile Experimental and Tactile Control groups were instructed to use only touch during all but the N period, it was anticipated that infants in both groups would gaze at their mothers' faces for greater proportions of time during the N period relative to each of the touch-only periods. Such a finding would be consistent with past literature examining the role of touch in influencing infant gaze (e.g., Stack & Arnold, 1998; Stack & LePage, 1996). In addition, differences in gaze were expected between the groups during the AF period, with infants in the Tactile Experimental group gazing at their mothers' faces for greater proportions of time than their Control group counterparts. Comparison of the All Modes Experimental and Control groups was expected to reveal more gazing at mothers' faces in the AF period by infants in the Experimental group.

Reflecting the dynamic nature of mothers' touching in play periods where touch was the only communicative modality permitted to achieve specific goals, significantly greater proportions of gaze at mothers' hands were expected in each of the touch-only periods relative to the N period for infants in both the Tactile Experimental and Tactile Control groups. Differences were also expected between the groups during the AF period, with infants in the Tactile Experimental group expected to gaze less at their mothers' hands than those in the Tactile Control group, thereby reflecting their increased attention to their mothers' faces. With respect to the All Modes comparison, infants in the Experimental group were expected to gaze more at their mothers' hands during the

RL period, reflecting the reported importance of touch in soothing (e.g., Birns, Blank, & Bridger, 1966; Korner & Thoman, 1972). In addition, it was anticipated that infants in each of the Tactile and All Modes Control groups would gaze away from their mothers more than their Experimental counterparts.

Reflecting the more naturalistic nature of mothers' behavior when face, voice, and touch were permitted, infants in both the Tactile Experimental and Control groups were expected to smile more during the N period than in any of the touch-only periods. However, infants in the Tactile Experimental group were expected to smile more than those in the Control group during the EX period. Infants in the All Modes Experimental group were also expected to smile more than their control group counterparts during the EX period.

Overall, low levels of infant fretting were anticipated. Nevertheless, this measure was included in the study as it represents a salient signal of infant disengagement. Furthermore, given the original direction of this study in comparing infants' affective expressions in response to their mothers' uses of tactile-gestural stimulation in different contexts (i.e., uni-modal vs. multi-modal), the possibility of contextual influences on infant fretting were considered, but no specific predictions were made.

Hypotheses Pertaining to Objective 1b: Cross-Modality Comparison

Consistent with previous studies employing the SF+T procedure (e.g., Stack & Arnold, 1998; Stack & LePage, 1996), mothers in the Tactile Experimental group were expected to touch and gesture toward their infants more than those in the All Modes Experimental group overall.

Infants in the All Modes Experimental group were expected to gaze more at their mothers' faces than those in the Tactile Experimental group during all but the Normal period, reflecting the dynamic and interactive nature of mothers' facial regions when they were permitted to use their voices and facial expressions. In contrast, infants in the Tactile Experimental group were expected to gaze more at their mothers' hands relative to infants in the All Modes Experimental group. However, no differences between the groups were expected during the RL period, reflecting the hypothesized increase in proximal stimulation (i.e., touch to the infants' bodies) by mother in the All Modes Experimental group during this period. No differences in gazing away from the mother were expected between the groups.

Infants in the All Modes Experimental group were expected to smile more than those in the Tactile Experimental group because interactions involving all modalities more closely approximate the form of interaction infants typically experience with their mothers. However, as past studies have revealed that touch reduces infant fretting, no differences in fretting were anticipated between the Tactile Experimental and All Modes Experimental groups.

Hypotheses Pertaining to Objective 2: Qualitative Aspects of Maternal Touch

It was anticipated that the qualitative aspects of maternal touching would differ across the various interaction periods in response to the instructions designed to modify maternal behavior. Specifically, it was expected that mothers in each of the Tactile and All Modes Experimental groups would evidence greater proportions of grasping and tickling compared to their respective control counterparts during the period in which mothers were instructed to get their infants excited and happy (EX period), reflecting the active and dynamic nature of maternal stimulation during this interaction. In contrast, greater proportions of stroking were expected in the period in which mothers were instructed to relax and calm their infants (RL period). Lastly, greater proportions of no touch and/or static touch, were anticipated during the attention to face (AF) period for infants in both Experimental groups relative to Controls.

It was also anticipated that mothers would direct their stimulation to different areas of their infants' bodies when instructed to elicit different behaviors/states from them. However, given the original nature of this investigation, specific predictions were not made.

<u>Hypotheses Pertaining to Objective 3: Cross-Age Comparisons</u>

It was anticipated that mothers would touch 3½- more than 5½-month-old infants, reflecting the greater use of proximal stimulation with infants of younger ages (e.g., Gusella et al., 1988; Kopp, 1989). Greater proportions of maternal gesturing were anticipated toward 5½-month-olds, reflecting an increase in distal stimulation with age.

Generally speaking, infants were expected to gaze less at their mothers' faces with age, reflecting their increasing sophistication in alternating their focus of their gaze from 3 to 6 months (Rothbart et al., 1990). However, no difference between the age groups was anticipated during the AF period, as the goal in this period was specifically for mothers to elicit and maintain infants' attention on their facial regions. This is not to say, however, that mothers of 3½- and 5½-month-olds were expected to use similar strategies to accomplish this goal. Furthermore, infants were expected to gaze more at their mothers' hands at 5½ compared to 3½ months, reflecting their increasing ability to alternate their gaze focus to other stimuli of interest. In addition, they were expected to gaze away more with age (Kopp, 1989).

Previous research has revealed that infant smiling increases with age (Messinger, Fogel, & Dickson, 1999), and has identified developmental progressions reflecting increases in infants' smiling in response to their mothers' smiles, vocalizations, and facial expressions with age (Kaye & Fogel, 1980). Reflecting their higher levels of smiling and more active participation in such social interactions, 5½-month-old infants were expected to smile more than their 3½-month-old counterparts. Furthermore, given that little fretting was expected, no differences in infant fretting were anticipated with age.

Predictions based on age were difficult to make for the measures of type and area of touch. However, it was expected that mothers' uses of touch would be modified with age. For instance, given the increasing influence of distal stimulation with older infants (e.g., Gusella et al., 1988; Kopp, 1989), it was anticipated that mothers in the All Modes groups would engage in less touching with age, and hence greater proportions of the 'no touch' category. This hypothesis did not apply to mothers in the Tactile groups, as they were permitted only the use of touch to communicate and thus high durations of touch were expected in these groups.

<u>Hypotheses Pertaining to Objective 4: Co-Occurrence of Nonverbal Expressive Behaviors</u>

With respect to associations among the various infant measures, consistent with previous research, significant co-occurrences were anticipated between smiling and gazing at the mother's face, thereby reflecting the socially-directed association of these behaviors (Fogel & Thelen, 1987; van Wulfften Palthe & Hopkins, 1984; Weinberg & Tronick, 1994). Furthermore, given previous findings of an association between smiling and gazing at mothers' hands during the Normal baseline period of face-to-face interactions (Stack & Arnold, 1998), it was expected that this finding would be replicated in the present study. In addition, smiling and gazing away were expected to be positively associated in the EX period, given Stifter and Moyer's (1991) finding that highly intense smiles precipitated gazing away, perhaps as a means of regulating excitement. In contrast, they were expected to be negatively associated during the RL period.

With respect to the association between infant and mother nonverbal expressive behaviors, it was anticipated that smiling and maternal touch would be positively associated during the EX period, reflecting the hypothesized pleasurable excitement engendered therein. An association between gazing at the face and maternal gestures was expected in the AF period, reflecting the hypothesized increase in gestures used to attract infants' attention.

Predictions based on age were difficult to make, as prior studies have not investigated developmental trends in the co-occurrence of nonverbal expressive behaviors. However, it was expected that patterns of co-occurrence would differ, both within the infant and between the infant and mother, as a function of infant age.

Method

Participants

The names of potential participants were obtained from the birth records of a major University teaching hospital in the Montreal community (Quebec, Canada). Caregivers of full-term infants who weighed at least 2,750 g at the time of birth and were born between 38 and 41 weeks gestational age with uncomplicated medical histories were contacted and recruited by telephone. Power analyses (Cohen, 1988) conducted prior to data collection determined that a sample size of 100 would ensure high power. Power calculations based on the total sample size for the present investigation are located in Appendix A.

The present study consisted of a cross-sectional design (i.e., different infants were recruited for each of two age groups) with infants at 3½ and 5½ months participating. Infants of 3½ months of age were selected for this study because by this age: (a) infants' visual systems are maturing and, although visual acuity is not yet fully established, infants have developed a focal distance almost as extensive as that of adults (Banks & Salapatek, 1983; Kopp, 1989; Trevarthen, 1974), thereby permitting them to focus on a social partner seated opposite them, (b) infants are capable of visually fixating their caregivers' eyes and of holding their fixation, a milestone which is typically reported by adults as being one of the hallmarks of truly 'social' interactions (Haaf & Bell, 1967), and (c) infants' tonic neck reflexes have weakened, thereby permitting the voluntary activation and modulation of head rotation required for averting their gaze (Kopp, 1989). Five-and-a-half-month-old infants were selected for this study to maintain consistency with previous research in this area and because infants of this age: (a) are becoming more skilled in initiating interactions with adults, and (b) possess the attentional capacities required for sustained social interactions. Together, these ages were selected because they fall near the outer limits of the peak period of mother-infant face-to-face interactions which has been reported to occur between 3- to 6-months of age (Cohen & Beckwith, 1976; Field, 1977; Stern, 1971; Trevarthen, 1974). Only mothers were included in the present study to maintain consistency with previous social interaction studies where predominantly mothers have been observed.

The original sample consisted of 139 infants (81 3½-month-olds; 58 5½-month-olds). Twenty-four of the 5½-month-olds were randomly selected for inclusion from an archival data set of a similar study investigating mother-infant social interactions (Arnold, 1995). Importantly, recruitment and testing procedures were identical for the two samples and all sessions were conducted by the same experimenter to ensure consistency in methodology. Inclusion in the final sample was dependent upon the infant reaching a criterion of 10% smiling during the Normal period. This criterion was used in order to ensure an adequate baseline of infant affect against which to compare affect occurring in the subsequent periods, and has been reliably used in past studies of this nature (Stack & Arnold, 1998; Stack & Muir, 1990, 1992). Twenty-four infants (21 3½-month-olds; 3 5½-month-olds) were subsequently excluded from analyses due to: infant fussiness (15), less than 10% smiling in the Normal period (4), experimenter error (2), equipment failure (1), inability to sit in an upright position (1), and termination of the session due to infant illness (1). The lower rate of attrition among the 5½-month-olds can be attributed to the fact that 24 of the 58 5½-month-old infants included in the study were from an archival data set. Hence, the rate of attrition (n = 3) was based on the number of new 5½-month-olds recruited for the present study (n = 34).

Consequently, the final sample consisted of 115 infants; 60 3½-month-olds (M = 3 months, 18 days; SD = 5.31 days; 30 males, 30 females) and 55 5½-month-olds (M = 5 months, 15 days, SD = 7.95 days; 28 males, 27 females) and their mothers. Although the majority of participating infants were Non-Hispanic White (83%), the sample was also represented by infants who were Black (9%), Asian/Pacific Islander (3%), Native American (2%), Middle Eastern (2%), and Hispanic (1%). With respect to parental educational attainment, 23% of parents were classified as high school graduates without college education, 56% had some college education, and 21% held degrees from programs requiring 4 years of college or more. With regard to occupational status, parents were classified in the domains of Executive, Administrators, Managerial (16%), Professional Specialty (17%), Technical and Related Support (12%), Sales (11%), Administration, Support, Clerical (23%), Precision, Production, Craft, and Repair (6%), Handlers, Equipment cleaners, Helpers, and Laborers (5%), and Service workers not in private households (2%; categories based on US Bureau of the Census, 1996). In addition, there were some students (5%) and those who were unemployed (3%). All participants were randomly assigned to experimental and control groups.

Apparatus

Infants were seated in an infant seat mounted and securely fastened to a custom-made box (75 cm high x 46 cm wide x 51 cm long) facing their mothers who were seated on an adjustable wooden stool at a distance of 70 cm from their infants and at eye level. Semi-circular black partitions, designed to eliminate distraction and noise, encircled each mother-infant dyad. A rectangular mirror (60.3 cm long x 40.3 cm wide) was secured on a tripod and placed behind and to the right of the infant and facing the mother in order to monitor and record her facial expressions. A view of the infant's face and body and the mother's hands was obtained using a color video camera (Hitachi Solid State model VK-C350) located behind, above, and to the right of the mother. A second camera, located behind, above, and to the left of the mother, captured a frontal view of the infant's body and the mother's hands. These were the only objects in the room within the infant's view. Appendix B depicts a schematic diagram of the apparatus and layout of the testing room.

The two camera images were transmitted through a split screen generator and recorded on a Sony 8 mm video recorder located in an adjacent observation room which was separated from the testing room by a one-way mirror. All mother-infant interaction sessions were recorded on Sony 8 mm video cassettes. A time line was recorded on each infant's video record to permit precise calculation of the duration of each dependent measure in minutes, seconds and centiseconds, using a video timer (FOR.A model VTG-22). Frame-by-frame coding of the video records was facilitated by a variable speed wireless remote with shuttle function (Sony VTR/TV).

The onset and offset of each interaction period were timed using a stopclock, and were communicated to the mother by way of a knock on the one-way mirror separating the testing and observation rooms.

Experimental Instructions and Design

Each mother-infant dyad participated in four 90-second interaction periods, separated by 20-second inter-period intervals. All mother-infant dyads first participated in a Normal (N) interaction during which mothers were instructed to play with their infants as they normally would at home. In subsequent periods, mothers in each of the experimental groups were provided with additional instructions to elicit a specific behavior/state from their infants in each period. All instructions were selected on the basis of extensive literature review and pilot testing. Mothers of infants in the All Modes Experimental group were instructed to continue to use all modes of interaction and to: (a) get their infant excited and happy (EX), (b) get their infant relaxed and calm (RL); and (c) attract and hold their infant's attention on their face with as much eye-to-eye contact as possible (AF). Mothers of infants in the Tactile Experimental group were given the same instructions but were instructed to be silent, still, and neutral in facial expression and to use only touch to accomplish these same goals. Periods 2, 3 and 4 were counterbalanced according to a partial Latin Square design to control for time effects. This approach resulted in three orders of presentation of the conditions: Order 1 = EX, RL, AF; Order 2 = RL, AF, EX; Order 3 = AF, RL, EX.

A complete Latin Square design was not employed due to the significantly larger sample size that it would have necessitated (i.e., 6 orders of presentation, thereby requiring double the current sample size or approximately 230 subjects). Nevertheless, extreme care was taken in selecting the orders so that as many infants received the EX instruction followed by the RL instruction as those receiving the reverse pairing. These sequences were considered important, as studies have occasionally shown carryover effects of infants' prior emotional states into their subsequent interaction episodes (e.g., Weinberg & Tronick, 1996). Consequently, the possibility was considered that participating in a positively arousing interaction might impact infants' reactions to stimulation designed to relax and calm them in the subsequent play period and vice versa.

The responses of infants in each of the experimental groups were compared to those of infants in a respective control group (hence the study included two control groups). Mothers of infants in the All Modes Control group were instructed to play with their infants as they normally would at home during all four interaction periods. Mothers in the Tactile Control group were instructed to be silent, still and neutral in facial expression but were permitted to touch their infants during all but the baseline Normal period. However, in neither group were mothers provided with additional instructions to elicit specific behaviors/states from their infants. Furthermore, given that mother-infant dyads in the control groups participated either in three identical Normal interactions (All Modes Control) or three SF+T periods (Tactile Control) following the baseline period (N), the order of presentation of these conditions was not counterbalanced. The detailed instructions provided to mothers are provided in Appendix C.

The SF+T periods for the Tactile Control group were designed to compare a typical SF with touch period with a SF with touch period during which mothers were instructed to elicit a specific behavior from their infants. Consequently, this served as a particularly strong and conservative comparison between the Tactile Experimental and

Control groups given that the only difference between the groups resided in the instructions provided to mothers in the Experimental group.

The final design of the study is illustrated in Table 1 and reflects a 2 (Age) x 2 (Sex) x 2 (Group) x 3 (Order of Presentation of Periods) x 4 (Period) mixed design with four between factors of Age (3½, 5½ months), Sex (Male, Female), and Group (Tactile Experimental vs. Tactile Control; All Modes Experimental vs. All Modes Control; Tactile Experimental vs. All Modes Experimental depending on the set of analyses in question), and Order (1, 2, 3), and one within factor of Period (N, EX, RL, AF).

<u>Experimental Procedure</u>

Upon arrival, the mother and her infant were greeted and escorted into a waiting room. The experimenter reviewed the purpose and procedural details of the study and, barring any further questions, the mother was asked to read and sign an informed consent form in her preferred language of English or French (Appendix D). Once the mother determined that her infant was comfortable and ready to begin, the dyad was escorted to the testing room where the infant was placed in the infant seat. The mother was then seated at eye level facing the infant on an adjustable wooden stool at a distance of 70 cm from the infant. The experimenter provided the mother with instructions for the first period, during which all mothers were asked to interact normally with their infants, following which the experimenter exited the testing room to start the video equipment located in the adjacent observation room.

The experimenter signalled the start of the period to the mother by a knock on the one-way mirror separating the testing and observation rooms and simultaneously set the

Design Table for Study 1 (N = 115)

Group	Period 1	Period 2	Period 3	Period 4
TACTILE:				
Experimental (n = 34) males (17) females (17)	N	SF+T+EX	SF+T+RL	SF+T+AF
Control (n = 24) males (12) females (12)	N	SF+T	SF+T	SF+T
ALL MODES:				
Experimental (n = 33) males (17) females (16)	N	EX	RL	AF
Control (n = 24) males (12) females (12)	N	N	N	N

N = Instruction to play with their infant as they normally would at home
EX = Instruction to get their infant excited and happy
RL = Instruction to get their infant relaxed and calm
AF = Instruction to get their infant's attention
SF+T = Instruction to be silent and neutral in facial expression and to use only touch

stopclock for 90 seconds, following which the experimenter again knocked on the one-way mirror to signal the end of the period. The experimenter then re-entered the testing area for a 20-second period during which time the instructions for the following period were provided to the mother. The same procedure was repeated for all remaining periods. This procedure is consistent with past studies using the face-to-face procedure. The experimenter viewed all portions of the interaction from the television monitor located in the observation room as a reliability check to ensure that mothers in the tactile groups maintained the still-face 100% of the time in all SF with touch periods. Any mother who was facially expressive, vocalized, or made a dramatic posture change during any of the SF with touch periods was excluded from the final sample ($\underline{n}$ = 1).

If, at any time during the session, the infant became distressed or cried for a sustained period of 20 seconds ($\underline{n}$ = 16), or if the mother wished to terminate a period ($\underline{n}$ = 0), the session was interrupted. The mother and infant were then escorted to the waiting room where the infant was given an opportunity to rest, feed, or be changed. Once the mother considered her infant to be ready to continue the session, testing resumed and the period instructions were repeated in the same sequence so as to preserve the original order of presentation.

Following completion of the testing session, the mother and her infant were again escorted to the waiting room where the experimenter asked the mother standardized questions regarding her infant's medical history and general demographic information (Appendix E). The mother was informed that upon completion of the study, she would receive a written summary of the general results of the study by mail. Finally, the mother was thanked for her and her infant's participation and was presented with an "Infant Scientist Award" certificate of merit as a token of appreciation for their participation in the study.

Behavioral Measures and Coding

Multiple infant responses were included as dependent measures in the present study, given that the proximal cues associated with the tactile/gestural modality could be presented to infants in a variety of ways. As a result, infants' response systems could be differentially affected by changes in maternal touch and gesture, resulting in the potential for infants to display asynchronous patterns of gaze and affect. The data were coded using frame-by-frame analyses of the video records for each of the dependent variables of: (a) maternal touch, (b) maternal gestures, (c) infant gaze at the mother's face, (d) infant gaze at the mother's hands, (e) infant gaze away, (f) infant smiling, and (g) infant fretting. All measures have been reliably used in the past (e.g., Stack & Arnold, 1998; Stack & LePage, 1996; Stack & Muir, 1990; 1992).

Maternal touch was defined as any physical contact between mother and infant. Maternal gestures were defined as hand movements that were non-tactile in nature and which occurred within the infant's field of vision. The infant gaze at the mother's face measure was coded when infants looked at their mothers' faces. Infant gaze at the mother's hands was defined as gaze at the mother's hand(s) and/or arm(s) up to the elbow. Infant gaze away was recorded when the infant gazed in a direction away from the mother's face or body, the infant's own clothing or body, or the infant seat. Defined in this manner, the gaze away measure is similar to the Distal Away measure employed by Toda and Fogel (1993). A smile was operationally defined as an upturned mouth, either open or closed. As previously noted, inclusion of an infant in the final sample was dependent upon the infant reaching a criterion of 10% smiling during the N period. This criterion was originally established so as to ensure an adequate baseline of infant affect against which to compare the three other interaction periods, and has been reliably used in past studies of a similar nature (e.g., Stack & Arnold, 1998; Stack & LePage, 1996; Stack & Muir, 1990; 1992). Fretting was recorded when the infant's mouth was turned down or curled, or when the infant was crying.

In addition to the overall duration of maternal touch, the CITS (Stack et al., 1998) was employed to describe the types of touch that mothers used with their infants, as well as the area of the infants' bodies being touched. Whereas the duration of touch measure referred to any tactile contact occurring between the dyad, regardless of whether is was established and maintained by the mother or infant, the quality of maternal touch measure referred specifically to tactile contact initiated by the mother on the infant's body. The qualitative dimensions of the CITS consisted of 8 categories of touch, as well as 5 areas of the infant's body on which these types of touch could be employed, as well as categories labelled 'no touch' and 'no area' to reflect off the body behavior (Appendix F). All categories were stringently selected on the basis of statistical analyses, and inter-rater reliability conducted with individuals both within one laboratory and across two laboratories has revealed acceptable reliability. Although the scale also permits the analysis of a number of other quantitative aspects of touching (e.g., intensity, speed, extent) these were not coded for the purposes of this investigation.

Several precautions were taken to reduce the possibility of biases arising from extraneous contextual cues during coding. The audio portion of the video record was turned off during the coding of all measures. In addition, the portion of the video monitor displaying the mirror image of the mother's face was covered to eliminate the possibility of cues arising from mothers' facial expressions. Furthermore, during the coding of infant smiling and fretting, the portion of the screen displaying the infant's body was covered so that the coder's attention was focused solely on the infant's face, thereby reducing potential observer bias arising from maternal tactile cues. Six passes of each video record were performed using frame-by-frame analyses, one for each of the measures of maternal touch, maternal gestures, infant gaze at the mother's face and hands, infant gaze away, infant smiling and fretting, and the CITS dimensions of type of touch and area of the body being touched.

Reliability coders were trained on videotape examples prior to scoring the present data set until such time as they achieved a high degree of reliability ($r > .90$) with experienced coders. These coders, who were blind to the hypotheses of the study, coded 30% of the video records to assess inter-rater reliability. Intraclass reliability coefficients (Shrout & Fleiss, 1979) were conducted and were above $r = .93$ on all measures. Furthermore, to assess the reliability of onset and offset times (points of transition) for each measure, rather than merely overall duration, Kappa coefficients (Cohen, 1968; Hunter & Koopman, 1990) were also calculated and were above $K = .87$ on all measures. Once coding was completed and reliability assessed, the raw data were reduced to obtain the mean percent durations of each measure as a function of period, which were used for the purposes of statistical analysis.

With respect to the CITS measures, second-by-second analyses were used to code the type of touch and area of the body being touched during each second of interaction. In order to be coded, the tactile contact must have occurred for at least 0.5 of a second. As with the aforementioned measures, the audio portion of the video record was turned off during coding so as to ensure that the coder was blind to the instructions provided to mothers. A naïve coder was then trained on videotape examples of infants not included in the study prior to coding the present data until she achieved a high reliability ($r > .90$) with experienced coders. Kappa coefficients were conducted based on agreement/disagreement regarding the type of touch and area of the body coded during each second of the interaction. These figures indicated reliability of $K = .90$ for type of touch, and $K = .94$ for area of the body.

Data for the co-occurrence analyses were obtained using a computer program that was designed to co-ordinate two behavior streams according to the start and stop times for each period and to calculate the total duration of overlap of the two behaviors of interest during each interaction period (Arnold & Deschênes, 2000). Reliability was not assessed on these data, as they represented the overlap of the individual behavioral measures on which reliability had already been evaluated.

Results

Descriptive statistics, designed to evaluate the normality of the distribution, were calculated on each dependent variable to assess for the presence of significant outliers and/or non-normality of the distribution that would necessitate transformation of any of the variables. Where outliers were present, their influence was reduced by assigning the outlier a value that was one unit larger or smaller than the next most extreme score in the distribution according to the procedure outlined by Tabachnick and Fidell (1996). This approach was undertaken as it has been proposed as a more viable alternative than eliminating subjects from the analyses altogether.

Skewness and kurtosis values were evaluated against the numerical criteria provided by Tabachnick and Fidell (1996), and transformations were conducted when the obtained descriptive statistic exceeded the proposed numerical value in any period for any measure. Conforming to standard statistical procedure, when main effects were qualified by an interaction involving that factor, only the higher-order interaction is reported in the text while significant lower-order effects are located in the appendices outlining the ANOVA results. Furthermore, to facilitate understanding of the results, only significant findings are reproduced in the text, while non-significant results are located in the ANOVA tables summarizing the results of each measure located in Appendices G through R (Study 1) and Appendices W through Z (Study 2). In cases where transformations were required, raw means are reported in the text to facilitate comprehension, while transformed means are located in the appendices. However, when transformations were conducted, the F-scores and p-values cited in the text are taken from the analyses conducted on the transformed data, as these are the findings on which the interpretations were based.

Following descriptive analyses to screen the data set, split-plot analyses of variance (ANOVAs) were conducted to assess for group differences in the mean percent durations of the two maternal and five infant dependent measures using the BMDP statistical package (Dixon, Brown, Engelman, & Jennings, 1990). The specific dependent measures under investigation included: (a) maternal touch, (b) maternal gestures, (c) infant gaze at the mother's face, (d) infant gaze at the mother's hands, (e) infant gaze away (f) infant smiling, and (g) infant fretting. Mean percent durations were obtained by calculating the proportion of time spent displaying a given behavior (i.e., the total time engaged in that behavior divided by the total duration of the play period) and multiplying it by 100.

Three sets of analyses were conducted. In the first two sets, each of the Tactile Experimental and All Modes Experimental groups were compared against their respective control groups (i.e., Tactile Experimental vs. Tactile Control; All Modes Experimental vs. All Modes Control). These comparisons directly addressed Objective 1a of the study which was to ascertain whether mothers employ different durations of touch and gesture in response to instructions designed to modify their behavior, and whether infants are responsive to these changes as evidenced by differences in their durations of gaze and affect. Furthermore, they served as particularly strong and conservative comparisons, as the only difference between each of the Experimental groups and their respective Control groups resided in the instructions provided to mothers in the Experimental group (i.e., to elicit a behavior/state in each period following the baseline) versus SF+T (Tactile Control) or play as they normally would (All Modes Control). Consequently, any differences in infant and maternal nonverbal behavior between the two groups could only be attributed to the impact of the instructions.

The second set of analyses involved comparing the responses of mothers and infants in the Tactile Experimental group to those of mothers and infants in the All Modes Experimental group. The aim of this set of analyses was to address Objective 1b which was to examine mothers' uses of tactile-gestural behavior and infants' social behaviors to such stimulation, when it was the only means available to communicate versus when it was more naturally employed in combination with other communicative modalities (i.e., facial expressions, voice). The third objective of the study, which was to assess for the presence of developmental differences in mothers' uses of tactile-gestural behavior and infants' responses to such stimulation with infant age, was also addressed within the context of each of these comparisons.

Within every set of analyses, each of the aforementioned dependent variables was analyzed using a split-plot ANOVA with Age (3½ months, 5½ months), Sex (Male, Female), Group (Tactile Experimental vs. Tactile Control; All Modes Experimental vs. All Modes Control; Tactile Experimental vs. All Modes Experimental depending on the set of analyses in question), and Order (1, 2, 3) as the between-subjects variables, and Period (N, EX, RL, AF) as the within-subjects variable. Where Sex and Order were significant, results are reported. However, in cases where no significant differences involving these variables were found, analyses were re-run collapsed across these variables. Where the ANOVAs revealed significant main effects, Tukey HSD post-hoc comparisons (Keppel, 1982; Winer, 1971) were performed where applicable. In the event of significant interactions, planned a priori simple effect analyses (Tabachnick & Fidell, 1996) were performed to isolate the source of the significance.

Bonferroni corrections were performed on the clusters of dependent measures by dividing the typical critical alpha level of .05 by the number of measures in that cluster. The corrected alpha rates employed as the criteria for statistical significance were as follows: (a) .025 for maternal touch and gesture, (b) .016 for gaze at face, hands, and away, and (c) .025 for smiling and fretting. In addition, the more conservative Geisser-Greenhouse Adjusted F-score was used to assess the significance of within-subject effects.

The reader is cautioned that the Period acronyms (i.e., N, EX, RL, AF) apply directly to the Experimental groups and do not accurately reflect the experience of infants in the Control groups who received different instructions (i.e., Tactile Control group - N, SF+T, SF+T, SF+T; All Modes Control group - N, N, N, N). However, for ease of communication of the results in the body of the text, the Period acronyms corresponding to the Experimental group instructions will be used in the event of significant Period main effects and/or Period by Group interactions. This issue directly impacts the first two portions of the Results section in which the Tactile Experimental vs. Tactile Control group comparisons, and the All Modes Experimental vs. All Modes Control group comparisons are reported. However, where applicable, reference to the different sets of instructions will appear on the figure(s) illustrating those results.

Results Pertaining to Objectives 1a and 3: Within-Modality Comparison of the Tactile Experimental and Tactile Control Groups and Age Effects

Maternal Tactile-Gestural Behavior

Maternal touch. The presence of moderate skewness and kurtosis necessitated the use of a square root transformation. Subsequent analysis of the transformed data (Table G1) revealed a significant Period main effect, $F(3, 162) = 8.03$, $p < .001$, and Tukey comparisons (Table G2) indicated that mothers touched their infants more during the RL ($M = 89.56\%$) and EX ($M = 85.08\%$) periods relative to the N period ($M = 74.93\%$). A significant difference was also found between the RL ($M = 89.56\%$) and AF ($M = 80.09\%$) periods. A simple effects analysis conducted on an Age by Group interaction, $F(1, 54) = 4.84$, $p < .025$, indicated that, within the Tactile Experimental group, mothers of 3½-month-olds ($M = 89.38\%$) touched their infants more than mothers of 5½-month-olds ($M = 78.55\%$), $F(1, 54) = 3.57$, $p < .05$ (Figure 1). Transformed means for the Period main effect and Age by Group interaction are located in Tables G3 and G4, respectively.

Maternal gestures. Descriptive statistics revealed severe skewness necessitating the use of a log transformation. Subsequent comparison of the Tactile groups' transformed data (Table G5) revealed an Age main effect $F(1, 54) = 12.69$, $p < .001$, whereby mothers of 5½-month-olds ($M = 9.41\%$) gestured more than mothers of 3½-month-olds ($M = 3.68\%$). As illustrated in Figure 2, analyses also revealed a Period by Group interaction, $F(3, 162) = 6.04$, $p < .025$, indicating that mothers in the Tactile Experimental group gestured more toward their infants than those in the Tactile Control

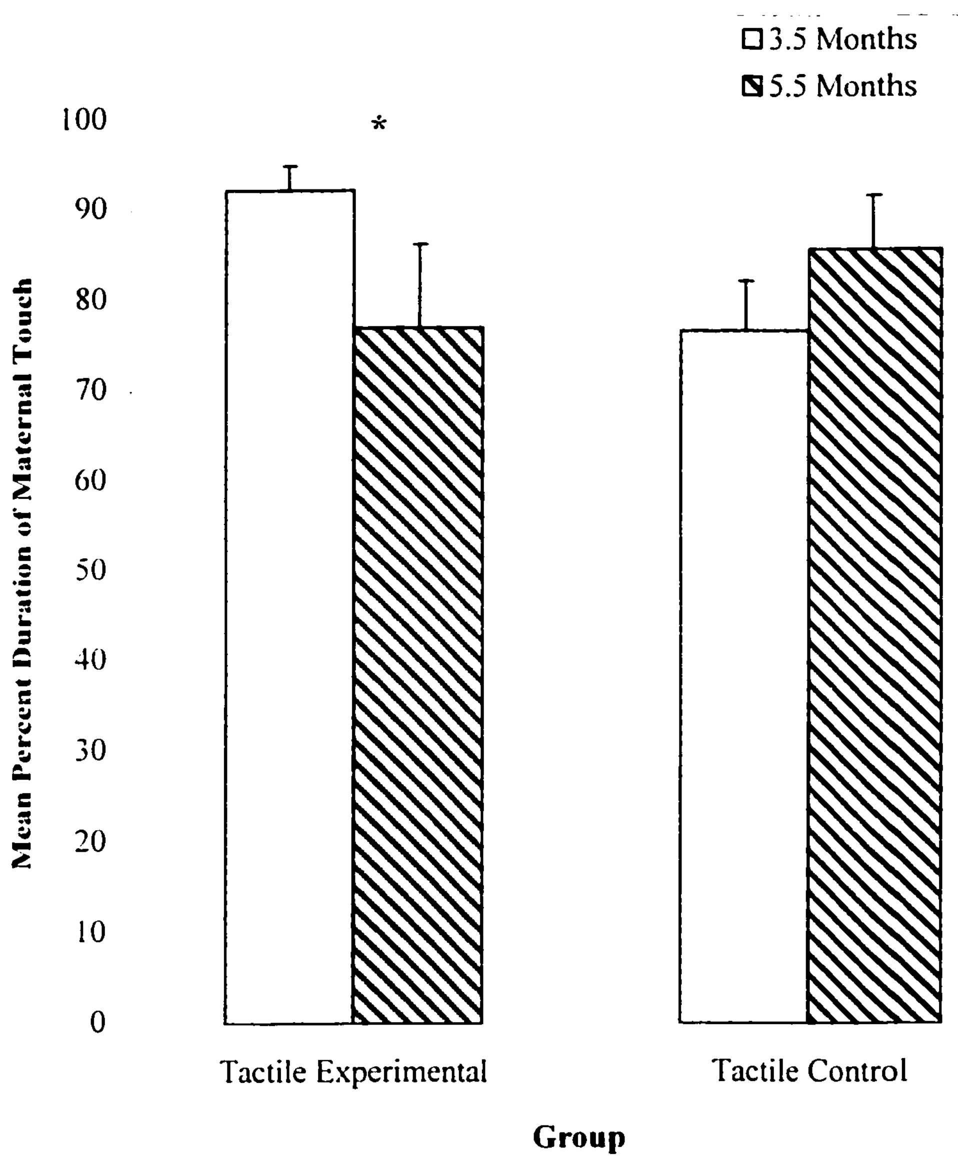


Figure 1. Mean percent duration of maternal touch as a function of Age and Group (Tactile Experimental, Tactile Control). Standard errors are denoted by vertical bars.

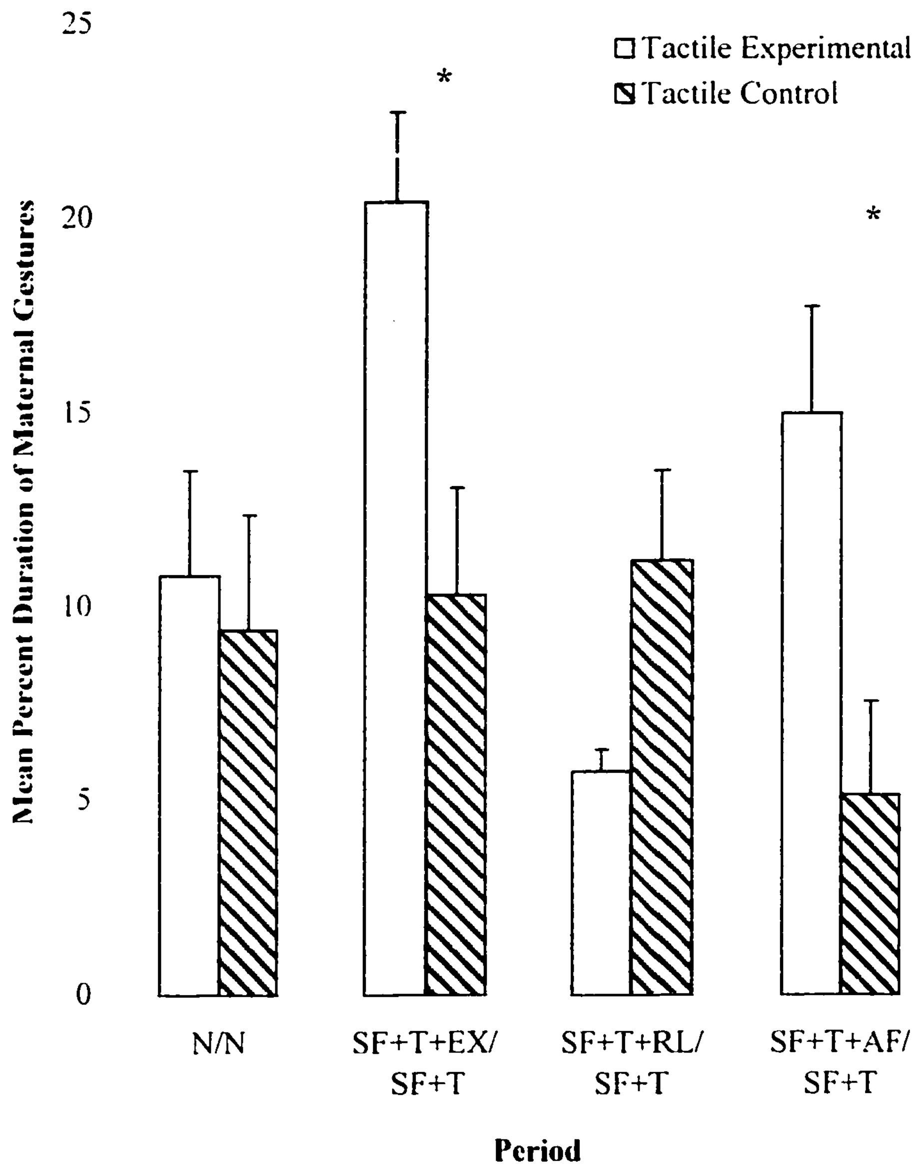


Figure 2. Mean percent duration of maternal gestures as a function of Period and Group (Tactile Experimental, Tactile Control). Standard errors are denoted by vertical bars.

group during both the EX ($\underline{M}$s = 20.44% vs. 10.32%, $\underline{F}(1, 56) = 5.56$, $\underline{p} < .05$) and the AF ($\underline{M}$s = 15.02% vs. 5.15%; $\underline{F}(1, 56) = 7.12$, $\underline{p} < .05$) periods. Transformed means corresponding to the Age and Period by Group effects are provided in Tables G6 and G7, respectively.

Infant Gaze

Infant gaze at face. The results from the comparison of the Tactile Experimental and Tactile Control groups (Table H1) revealed a Period by Group interaction, $\underline{F}(3, 168) = 2.82$, $\underline{p} < .016$. A simple effects analysis designed to isolate the source of the interaction indicated that, as hypothesized, infants in the Tactile Experimental group ($\underline{M}$ = 28.55%) gazed more at their mothers' faces than did those in the Control group ($\underline{M}$ = 16.20%) during the AF period, $\underline{F}(1, 56) = 5.47$, $\underline{p} < .05$ (see Figure 3).

Infant gaze at hands. Comparison of the Tactile Experimental and Control groups (Table H2) revealed a Period main effect, $\underline{F}(3, 171) = 16.04$, $\underline{p} < .001$. Tukey post-hoc comparisons (Table H3) indicated that infants in both groups spent significantly more time gazing at their mothers' hands during each of the touch-only periods ($\underline{M}$s = 48.17%, 37.57%, and 36.02 % for the EX, RL, and AF periods, respectively) relative to the N period ($\underline{M}$ = 24.44%). In addition, among the touch-only periods, infants gazed more at their mothers' hands during the EX period ($\underline{M}$ = 48.17%) relative to either the RL ($\underline{M}$ = 37.57%) or AF ($\underline{M}$ = 36.02%) periods.

Infant gaze away. Results of the ANOVA (Table H4) revealed a Period by Age x Group interaction, $\underline{F}(3, 162) = 12.76$, $\underline{p} < .001$, and a simple effects analysis indicated that within the Tactile Experimental group, 3½-month-old infants gazed away from their

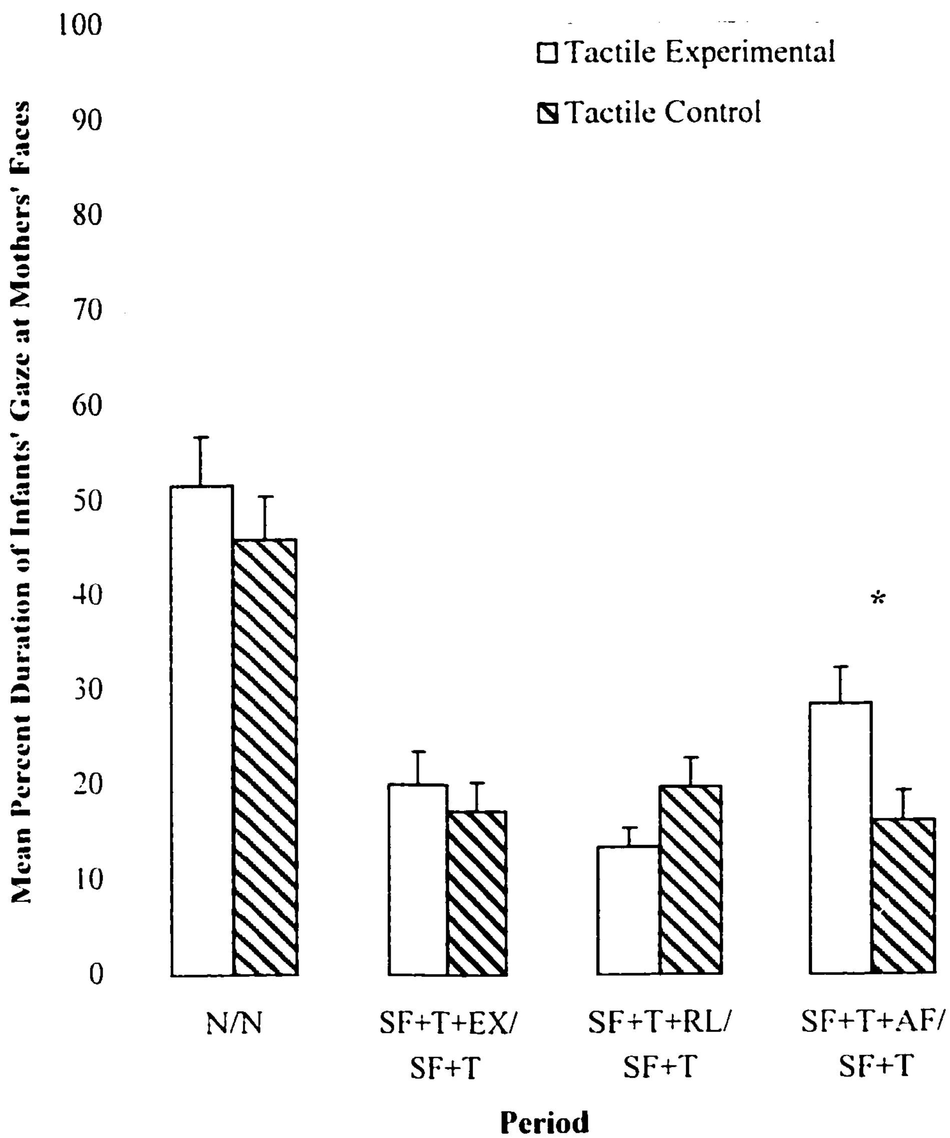


Figure 3. Mean percent duration of infants' gaze at mothers' faces as a function of Period and Group (Tactile Experimental, Tactile Control). Standard errors are denoted by vertical bars.

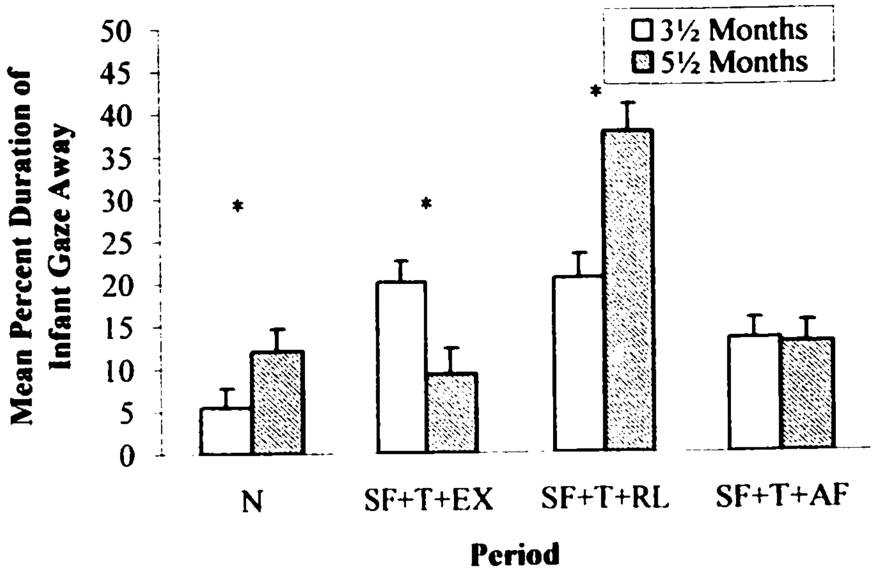
mothers more than did 5½-month-old infants during the EX period ($\underline{M}$s = 19.98% vs. 9.22%; $\underline{F}(1, 63 = 6.97$, $\underline{p} < .001$). In contrast, however, 5½-month-olds gazed away more than their 3½-month-old counterparts during both the N ($\underline{M}$s = 12.01% vs. 5.46%; $\underline{F}(1, 63) = 5.12$, $\underline{p} < .05$) and RL periods ($\underline{M}$s = 37.53% vs. 20.43%; $\underline{F}(1, 63 = 10.56$, $\underline{p} < .001$). Within the Tactile Control group, 5½-month-olds gazed away from their mothers more than 3½-month-olds during the N period ($\underline{M}$s = 14.82% vs. 7.99%; $\underline{F}(1, 63) = 5.44$, $\underline{p} < .05$). This effect is illustrated in Figure 4.

Infant Affect

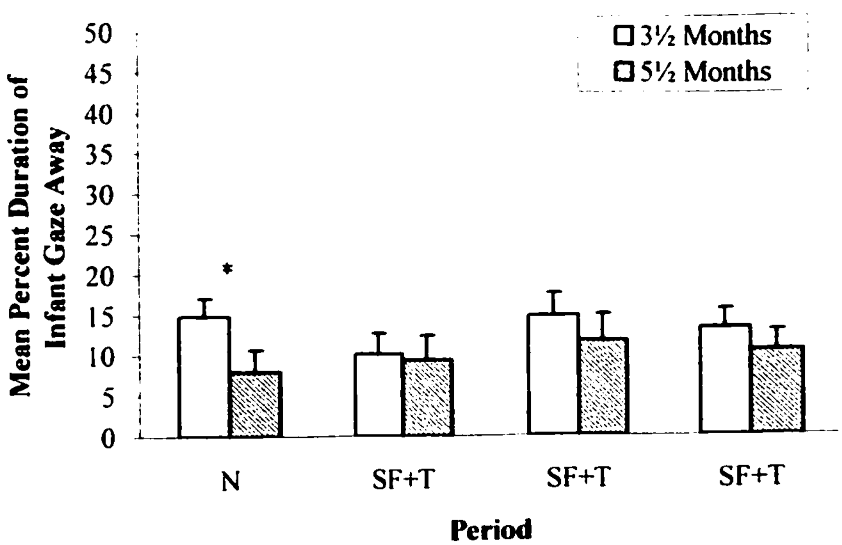
Infant smiling. The data for the infant smiling measure were moderately positively skewed and thus a square root transformation was conducted on this variable. An ANOVA conducted on the transformed data (Table 11) revealed a Period by Age interaction, $\underline{F}(3, 162) = 10.48$, $\underline{p} < .001$, and a subsequent simple effects analysis revealed that the source of the interaction was in the EX period, $\underline{F}(1, 56) = 16.58$, $\underline{p} < .001$, with 5½-month-olds ($\underline{M}$ = 35.77%) smiling more than 3½-month-olds ($\underline{M}$ = 13.94%). In addition, a Period by Group interaction was found, $\underline{F}(3, 162) = 8.12$, $\underline{p} < .001$, and a simple effects analysis revealed that, as predicted, infants in the Tactile Experimental group ($\underline{M}$ = 31.93%) smiled more than those in the Tactile Control group ($\underline{M}$ = 13.93%) during the EX period, $\underline{F}(1, 56) = 9.15$, $\underline{p} < .001$ (Figure 5). Transformed means corresponding to the Period by Age and Period by Group effects are located in Tables 12 and 13, respectively.

Infant fretting. The extremely low occurrence of fretting, reflected in the large number of zeros comprising the distribution, was strongly suggestive of a floor effect. As

a) Tactile Experimental



b) Tactile Control



<u>Figures 4a and 4b.</u> Mean percent duration of infant gaze away as a function of Period and Age for infants in the Tactile Experimental (4a) and Tactile Control (4b) groups.

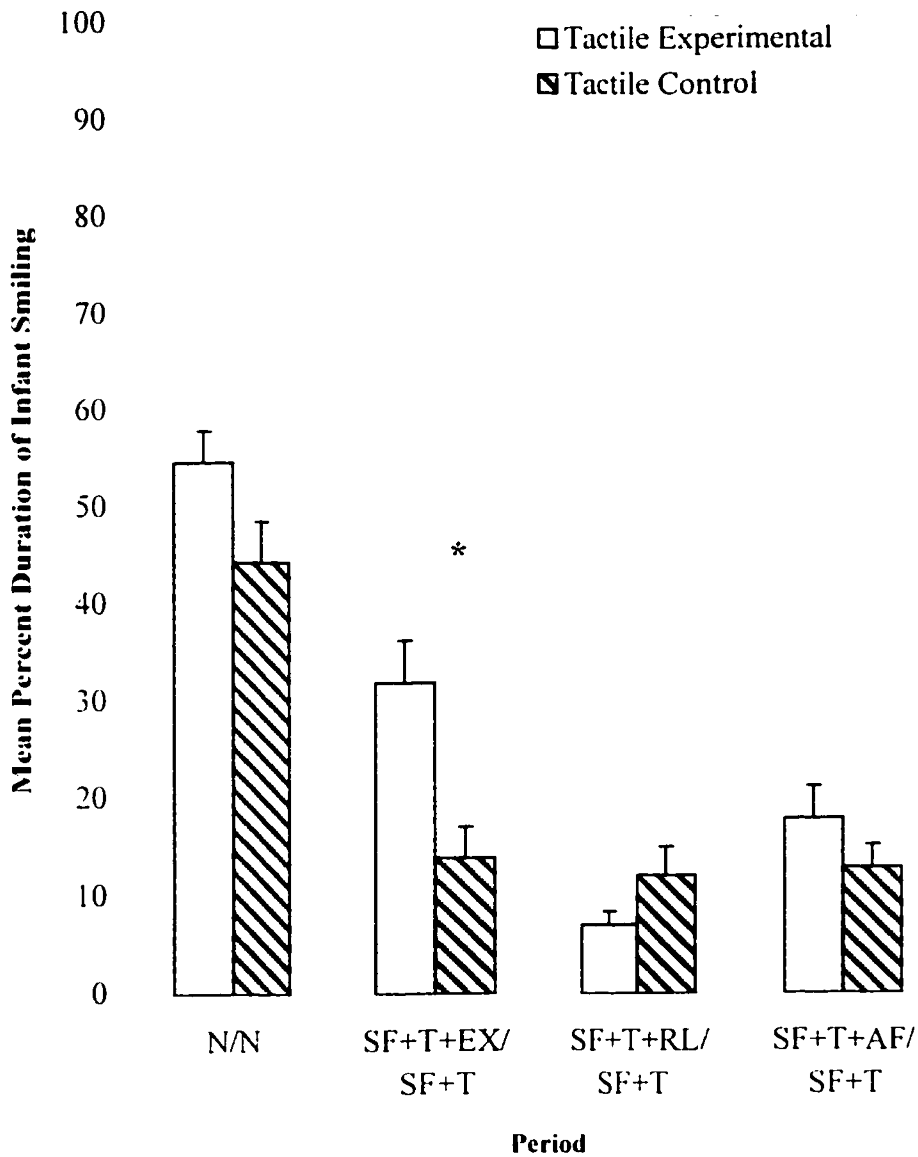


Figure 5. Mean percent duration of infant smiling as a function of Period and Group (Tactile Experimental, Tactile Control). Standard errors are denoted by vertical bars.

these low levels rendered the distribution unsuitable for analyses, the infant fretting measure was not further analyzed. However, the means for the groups were calculated and reported for descriptive purposes. Specifically, infants in the Tactile Experimental group spent an average of 1.57% of the entire play session fretting compared to 3.27% for infants in the Tactile Control group.

Results Pertaining to Objectives 1a and 3: Within-Modality Comparison of the All Modes Experimental and All Modes Control Groups and Age Effects

Maternal Tactile-Gestural Behavior

Maternal touch. The presence of moderate skewness and kurtosis necessitated the use of a square root transformation. Analyses (Table J1) revealed a Period by Group interaction, $F(3, 165) = 9.88$, $p < .001$, and simple effects analyses indicated that mothers in the Experimental group (M = 87.00%) touched their infants more than did those in the Control group (M = 60.49%) during the RL period, $F(1, 55) = 21.47$, $p < .001$ (Figure 6). Transformed means corresponding to the Period by Group effect are located in Table J2.

Maternal gestures. The data for the maternal gestures measure were severely skewed necessitating the use of a log transformation. Subsequent comparison of the All Modes groups' transformed data (Table J3) revealed a significant Age main effect, $F(1, 53) = 7.47$, $p < .025$, whereby, regardless of group membership or play period, mothers of 5½-month-olds (M = 11.79%) gestured toward their infants more than those of 3½-month-olds (M = 5.46%). In addition, a Period by Group interaction, $F(3, 159) = 5.15$, $p < .001$, indicated that mothers in the Experimental group (M = 1.31%) gestured less toward their infants that those in the Control group (M = 11.21%) during the RL period,

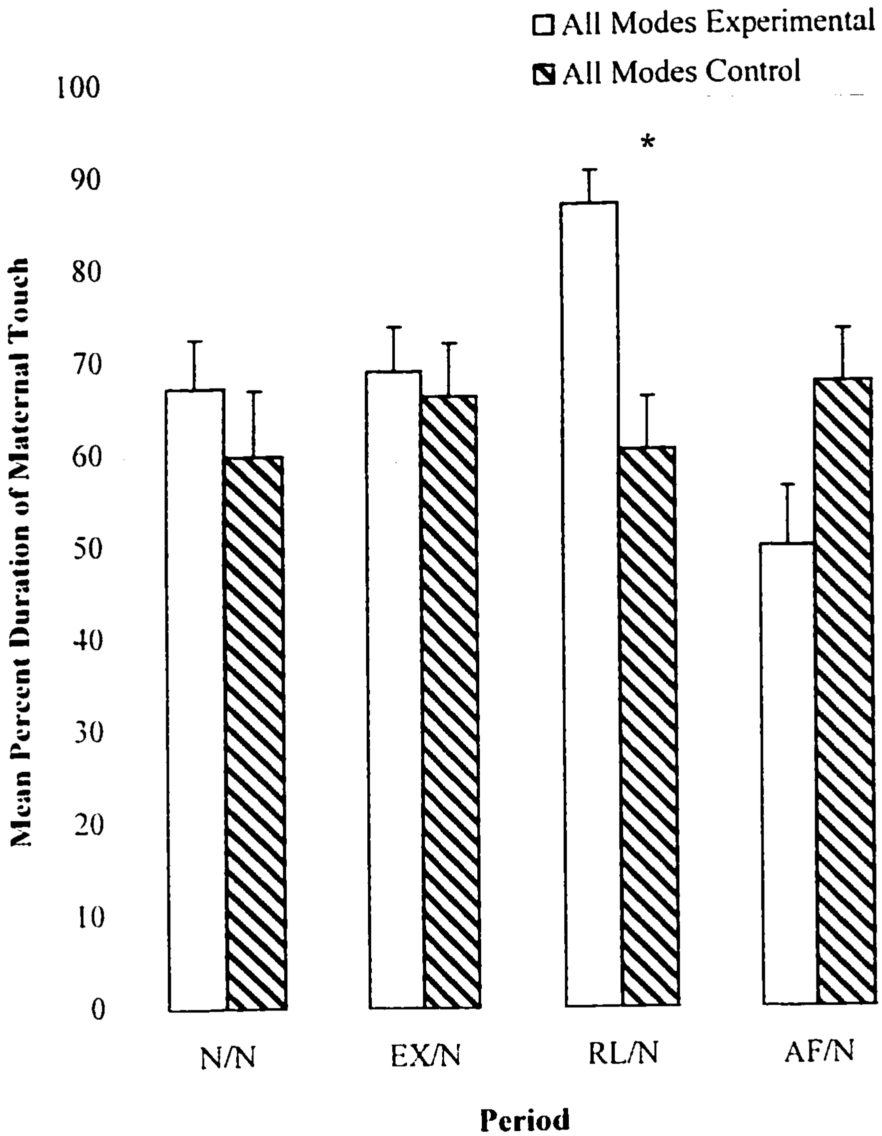


Figure 6. Mean percent duration of maternal touch as a function of Period and Group (All Modes Experimental, All Modes Control). Standard errors are denoted by vertical

$F(1, 55) = 28.02$, $p < .001$). This effect is illustrated in Figure 7. Transformed means associated with the Age and Period by Group effects are located in Tables J4 and J5, respectively.

Infant Gaze

Infant gaze at face. Analysis of the All Modes Experimental and All Modes Control groups (Table K1) revealed a Period by Age interaction, $F(3, 159) = 4.86$, $p < .001$, and a subsequent simple effects analysis indicated that, regardless of group membership, 3½-month-olds ($M = 63.69\%$) gazed more at their mothers' faces than 5½-month-olds ($M = 41.28\%$) during the N period. A simple effects analysis conducted on the Period by Group interaction, $F(3, 159) = 2.51$, $p < .016$, revealed that the sources of the significant differences occurred during the EX, $F(1, 55) = 5.44$, $p < .05$, and AF periods, $F(1, 55) = 9.01$, $p < .001$), where infants in the All Modes Experimental group gazed at their mothers' faces for greater proportions of time than those in the All Modes Control group ($Ms = 60.09\%$ vs. 42.64% for the EX period; $Ms = 57.30\%$ vs. 37.36% for the AF period). This result is illustrated in Figure 8.

Infant gaze at hands. Results (Table K2) revealed a Group main effect, $F(1, 53) = 6.62$, $p < .016$, indicating that overall, infants in the All Modes Control group ($M = 28.33\%$) gazed at their mothers' hands more than those in the All Modes Experimental group ($M = 19.21\%$). The results also revealed a Period by Age interaction, $F(3, 159) = 3.38$, $p < .016$, and a simple effects analysis demonstrated that the source of the interaction was in the N period, $F(1, 55) = 17.54$, $p < .001$, with 5½-months-olds ($M =$

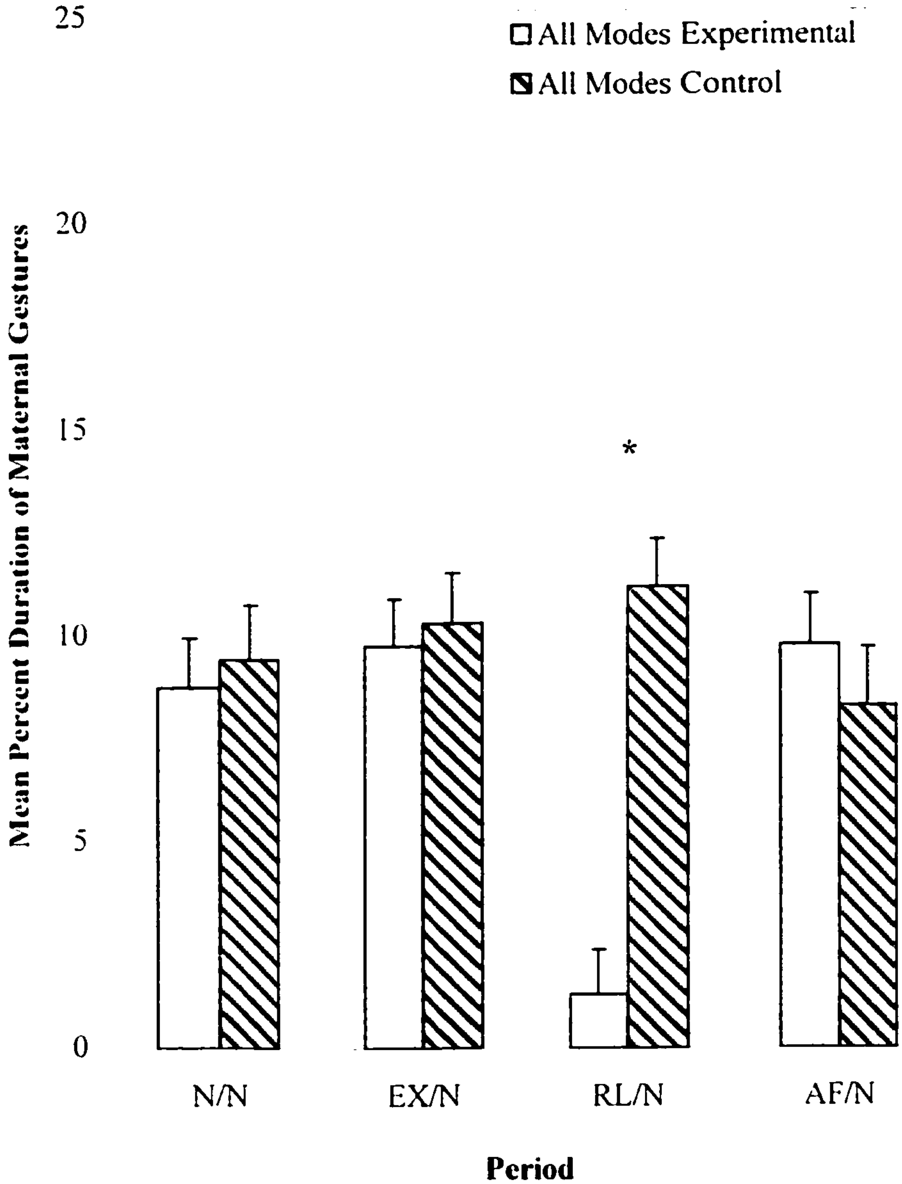


Figure 7. Mean percent duration of maternal gestures as a function of Period and Group (All Modes Experimental, All Modes Control). Standard errors are denoted by vertical bars.

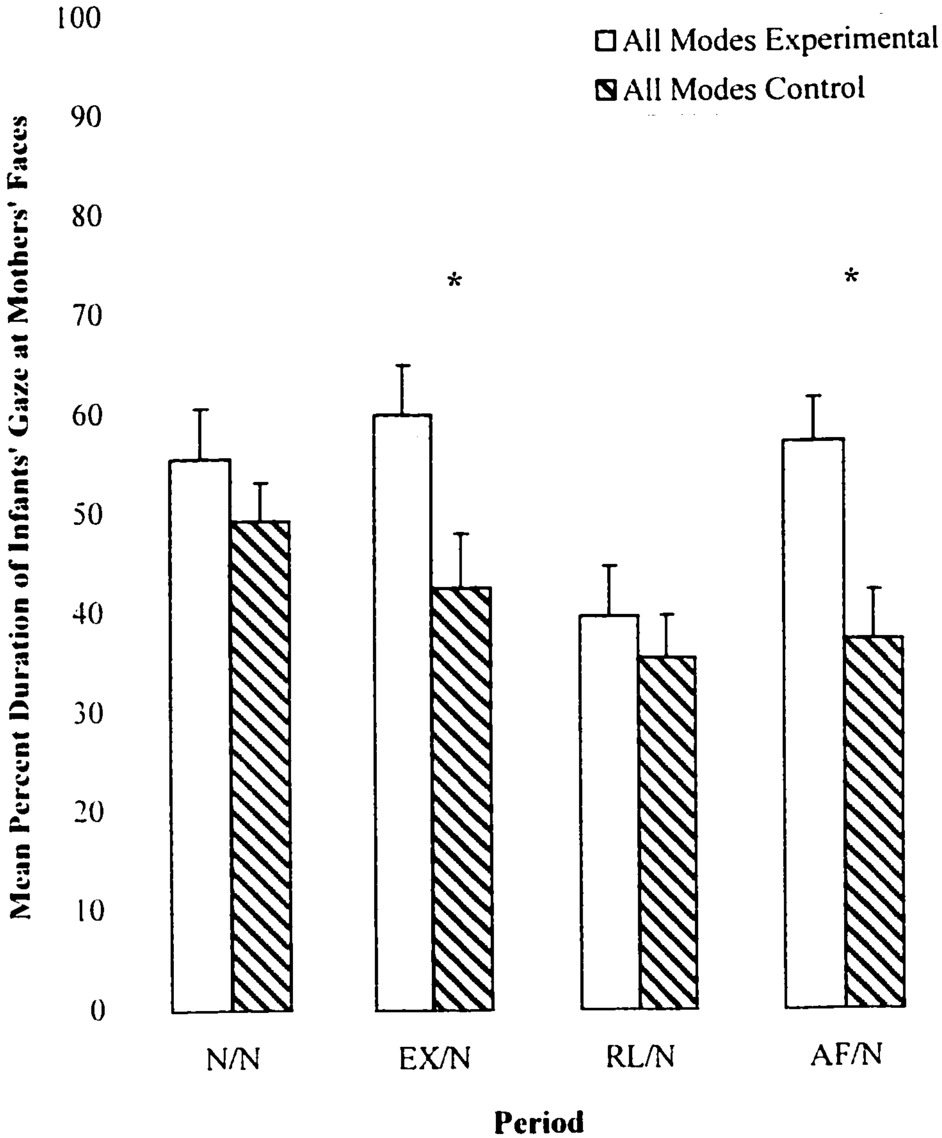


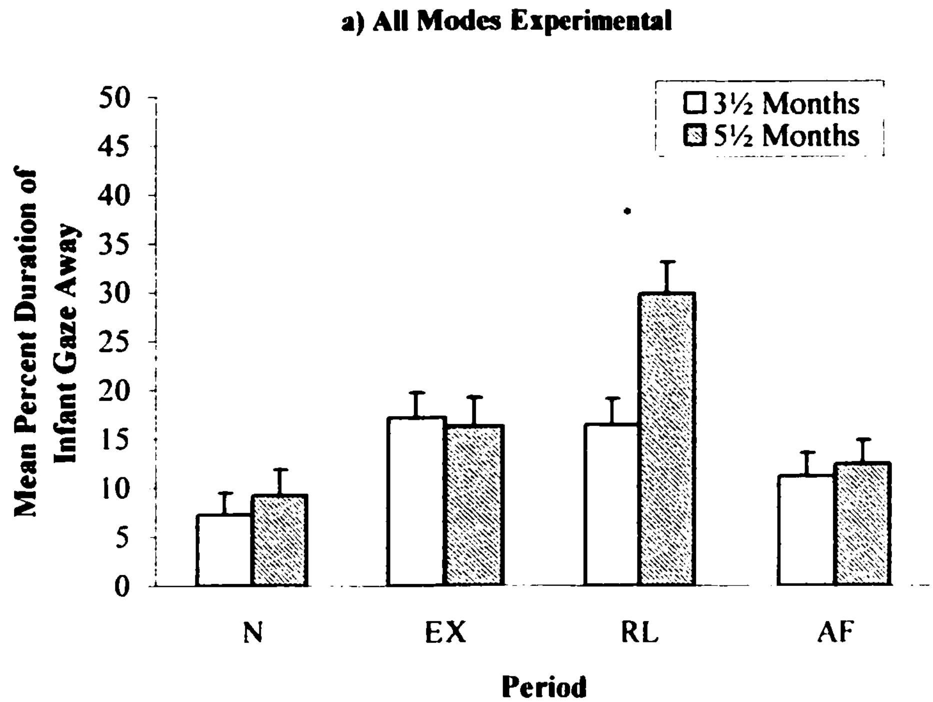
Figure 8. Mean percent duration of infants' gaze at mothers' faces as a function of Period and Group (All Modes Experimental, All Modes Control). Standard errors are denoted by vertical bars.

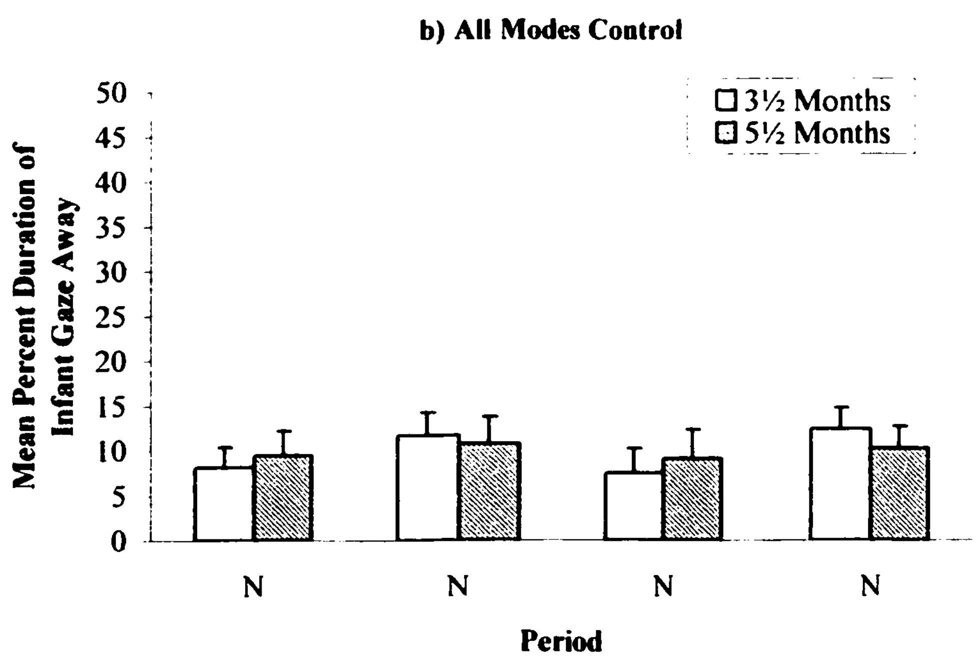
31.88%) gazing at their mothers' hands for greater proportions of time than 3½-month-olds ($\underline{M}$ = 13.94%).

Infant gaze away. Analysis of the All Modes groups' data (Table K3) revealed a significant Period by Age by Group interaction, $\underline{F}(3, 159) = 9.47$, $\underline{p} < .016$, and a simple effects analysis revealed that the source of the significance was within the All Modes Experimental group, with 5½-month-olds ($\underline{M}$ = 29.88%) gazing away from their mothers more than 3½-month-olds ($\underline{M}$s = 16.42%) during the RL period, $\underline{F}(1, 63) = 7.65$, $\underline{p} < .05$. This effect is illustrated in Figure 9.

Infant Affect

Infant smiling. The presence of moderate positive skewness required the use of a square root transformation. Comparison of the All Modes Experimental and Control groups (Table L1) revealed a Period by Age by Sex by Group interaction, $\underline{F}(3, 147) = 4.35$, $\underline{p} < .025$. However, it was deemed inappropriate to interpret this effect due to insufficient sample cell sizes and limited power with which to test a 4-way effect (Cohen, 1988). As a result, it was considered more cautious to interpret the lower-order interactions. Thus, a simple effects analysis conducted on a Period by Age interaction, $\underline{F}(3, 147) = 6.32$, $\underline{p} < .001$, indicated that 5½-month-olds ($\underline{M}$ = 41.61%) smiled more during the AF period than did 3½-month-olds ($\underline{M}$ = 25.41%). An additional simple effects analysis conducted on a Period by Group interaction, $\underline{F}(3, 147) = 4.73$, $\underline{p} < .001$, revealed that the source of the interaction was within the EX period, $\underline{F}(1, 55) = 7.76$, $\underline{p} < .05$, where infants in the All Modes Experimental group ($\underline{M}$ = 52.48%) smiled more than their Control counterparts ($\underline{M}$ = 33.30%). This result is illustrated in Figure 10.





Figures 9a and 9b. Mean percent duration of infant gaze away as a function of Period and Age for infants in the All Modes Experimental (9a) and All Modes Control (9b) groups.

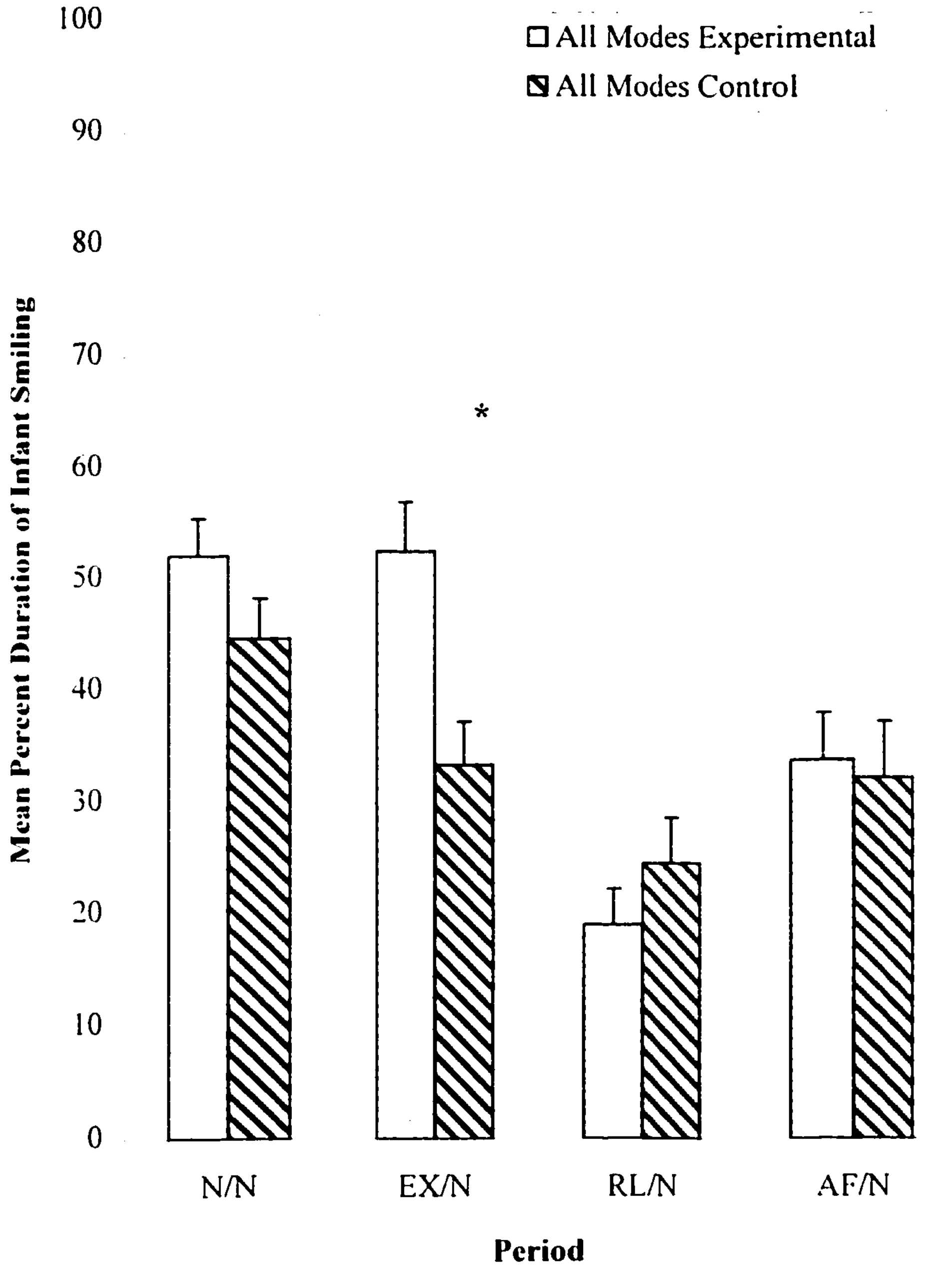


Figure 10. Mean percent duration of infant smiling as a function of Period and Group (All Modes Experimental, All Modes Control). Standard errors are denoted by vertical bars.

Transformed means for the Period by Age, and Period by Group effects are located in Tables L2 and L3, respectively.

Infant fretting. As previously noted, the infant fretting measure was not analyzed due to the extremely low levels of this behavior. Thus, the means listed herein are solely for descriptive purposes. Infants in the All Modes Experimental group spent an average of 1.15% of the entire play session fretting compared to an average of 1.58% for infants in the All Modes Control group.

Results Pertaining to Objectives 1b and 3: Cross-Modality Comparison of the Tactile Experimental and All Modes Experimental Groups and Age Effects

Maternal Tactile-Gestural Behavior

Maternal touch. A square root transformation was conducted to correct for moderate skewess and kurtosis. Subsequent comparison of the Experimental groups' transformed data (Table M1) revealed a significant Group main effect, $F(1, 63) = 11.17$, $p < .001$, with mothers in the Tactile Experimental group (M = 84.28%) touching their infants more than those in the All Modes Experimental group (M = 68.37%). Tukey comparisons (Table M2) conducted on a Period main effect, $F(3, 189) = 20.36$, $p < .001$, indicated that mothers in both groups touched their infants more during the RL period (M = 90.33%) than during any of the other periods (Ms = 64.58%, 72.61%, and 78.26% for the AF, N, and EX period, respectively). A significant difference was also noted between the EX (M = 78.26%) and AF (M = 64.58%) periods. Transformed means for the Group and Period effects are located in Tables M3 and M4, respectively.

Maternal gestures. The presence of severe skewness necessitated the use of a log transformation. Analyses conducted on the transformed data (Table M5) revealed an Age by Order interaction, $F(2, 55) = 7.55$, $p < .001$, indicating that mothers of 5½-month-olds spent more time gesturing toward their infants than mothers of 3½-month-olds when receiving the instructions in Order 2 (i.e., EX, RL, AF; Ms = 9.25% vs. 2.59%; $F(1, 61) = 8.31$, $p < .05$) and Order 3 (i.e., AF, RL, EX; Ms = 13.29% vs. 2.07%; $F(1, 61) = 13.23$, $p < .001$). An additional simple effects analysis conducted on a Group by Order interaction, $F(2, 55) = 4.04$, $p < .025$, revealed that mothers in the Tactile Experimental group (M = 13.39%) gestured more toward their infants than those in the All Modes Experimental group (M = 5.30%) during Order 3 (i.e., AF, RL, EX), $F(1, 61) = 3.97$, $p < .05$ (see Figure 11). A simple effects analysis conducted on a Period by Age interaction, $F(3, 165) = 3.78$, $p < .025$, indicated that the sources of the interaction were in the N, $F(1, 65) = 10.40$, $p < .001$, and EX periods, $F(1, 65) = 7.69$, $p < .05$, where regardless of group membership, mothers of 5½-month-olds gestured more toward their infants than those of 3½-month-olds (Ms = 14.41% vs. 3.27% for the N period; Ms = 13.64% vs. 4.10% for the EX period; see Figure 12). The presence of a Period by Group interaction, $F(3, 165) = 8.12$, $p < .001$, indicated that mothers in the Tactile Experimental group (M = 20.44%) spent more time gesturing toward their infants than those in the All Modes Experimental group (M = 9.77%) during the EX period, $F(1, 56) = 9.15$, $p < .001$ see; Figure 13. Transformed means for the aforementioned effects are located in Tables M6-M9, respectively.

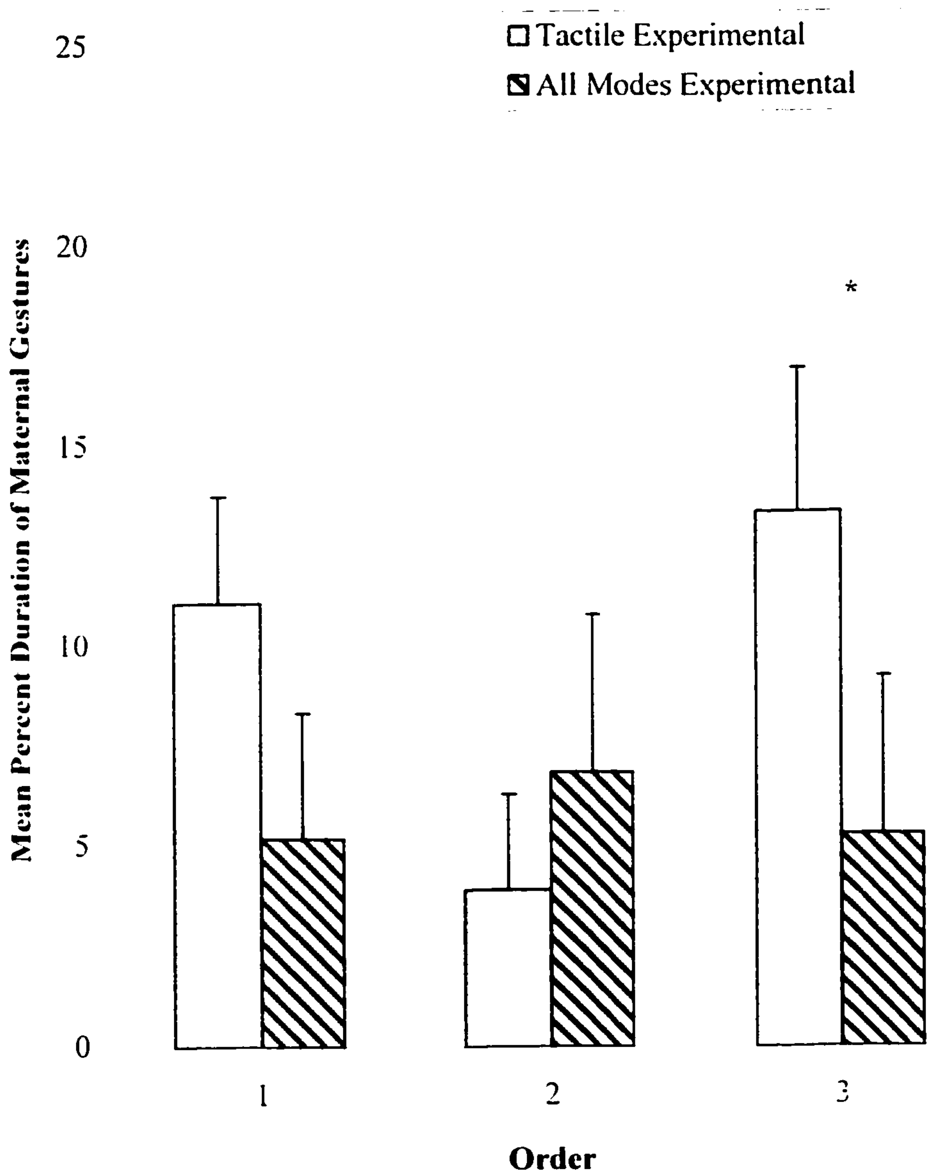


Figure 11. Mean percent duration of maternal gestures as a function of Group and Order (Tactile Experimental and All Modes Experimental groups). Standard errors are denoted by vertical bars.

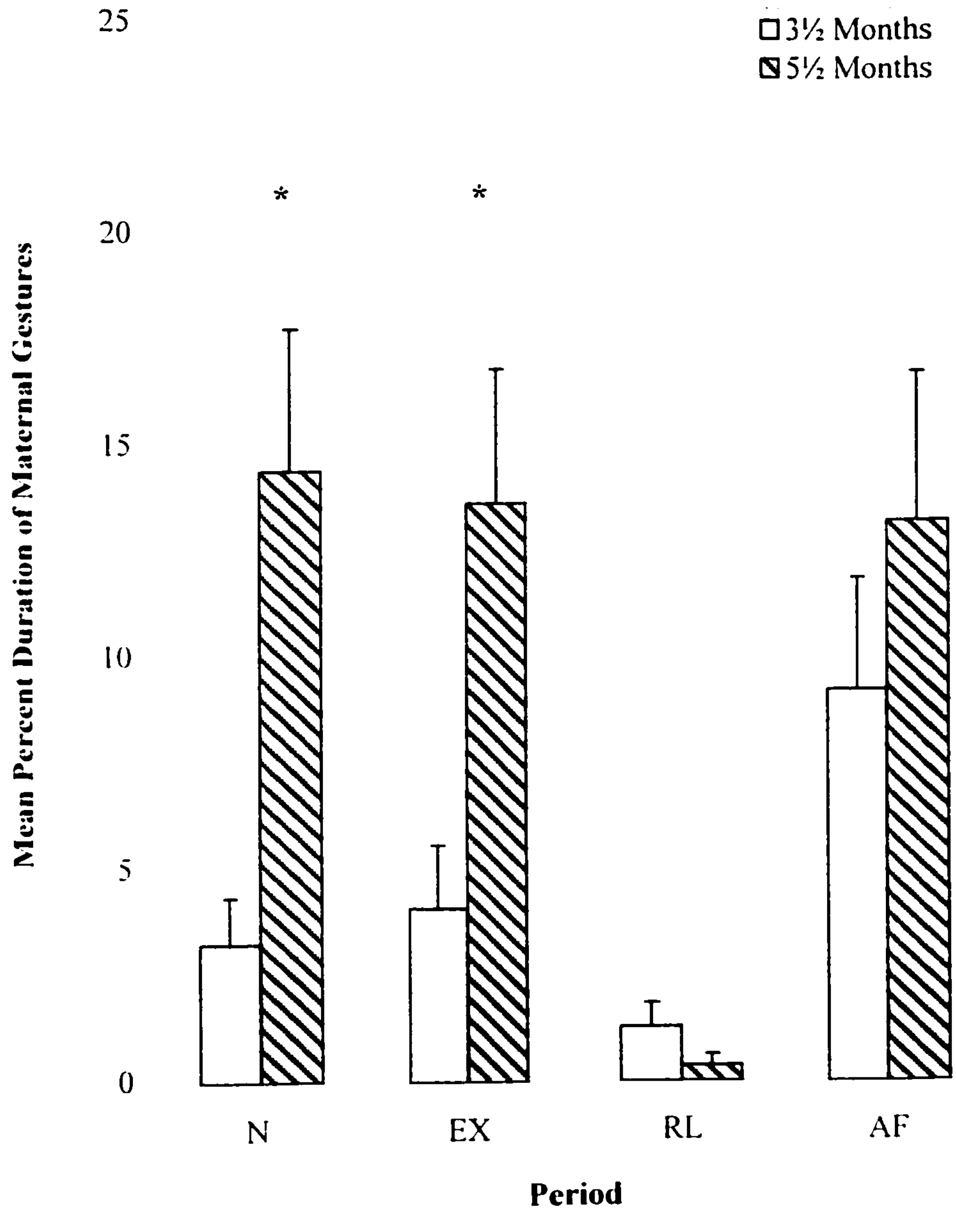


Figure 12. Mean percent duration of maternal gestures as a function of Period and Age, collapsed across infants in the Tactile Experimental and All Modes Experimental groups. Standard errors are denoted by vertical bars.

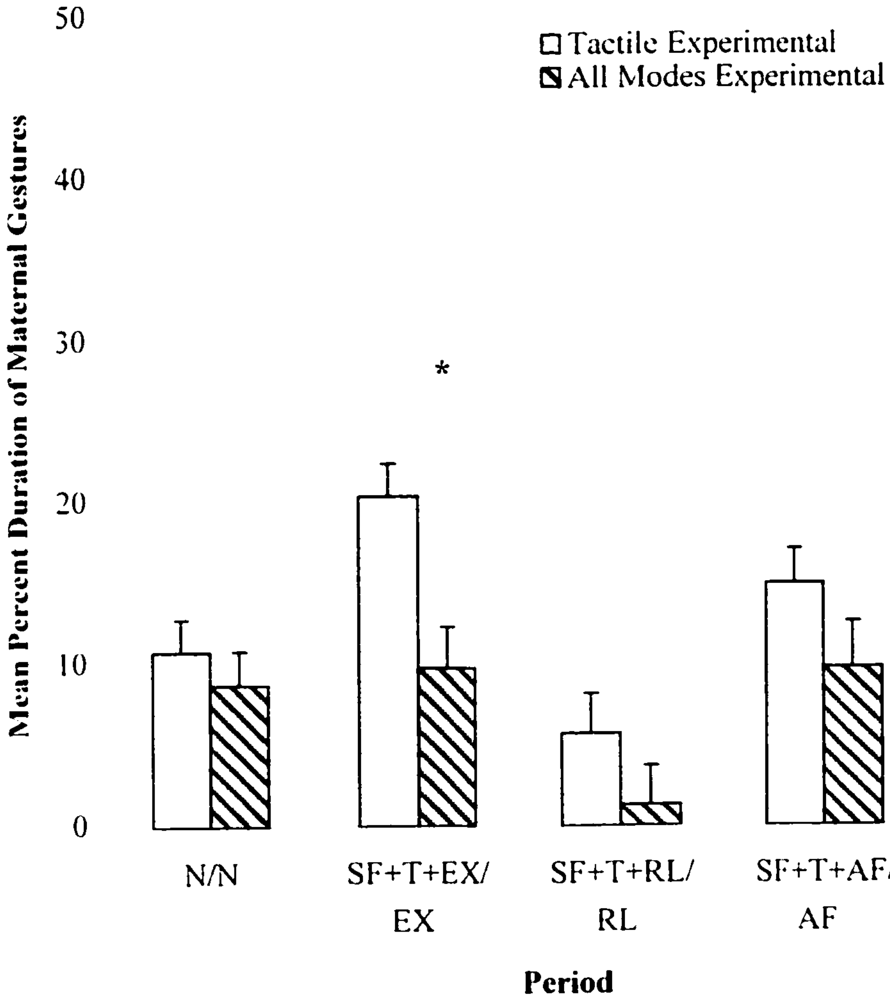


Figure 13. Mean percent duration of maternal gestures as a function Period and Group (Tactile Experimental. All Modes Experimental). Standard errors are denoted by vertical bars.

Infant Gaze

Infant gaze at face. As illustrated in Figure 14, comparison of the Tactile Experimental and All Modes Experimental groups (Table N1) revealed a Period by Group interaction, $F(3, 177) = 9.79$, $p < .001$, indicating that infants in the All Modes Experimental group gazed more at their mothers' faces than their Tactile Experimental counterparts during the EX (Ms = 60.09% vs. 20.06%; $F(1, 65) = 43.69$, $p < .001$), RL (Ms = 39.73% vs. 13.49%; $F(1, 65) = 23.98$, $p < .001$), and AF (Ms = 57.30% vs. 28.55%; $F(1, 65) = 24.41$, $p < .001$) periods.

Infant gaze at hands. Comparison of the two Experimental groups (Table N2) revealed a Period by Group interaction, $F(3, 129) = 11.97$, $p < .001$, indicating that infants in the Tactile Experimental Group gazed more at their mothers' hands than did those in the All Modes Experimental group during both the EX (Ms = 50.39% vs. 13.11%; $F(1, 65) = 63.33$, $p < .001$), and AF (Ms = 33.32% vs. 16.71%; $F(1, 65) = 11.40$, $p < .001$) periods (Figure 15).

Infant gaze away. An ANOVA comparing the Tactile and All Modes Experimental groups (Table N3) revealed no differences in infant gazing away.

Infant Affect

Infant smiling. A square root transformation was conducted on the data from the infant smiling measure to correct for moderate positive skewness. Analyses on the transformed data (Table O1) revealed a Period by Age interaction, $F(1, 63) = 5.68$, $p < .001$. A simple effects analysis revealed that the source of the significance was in the EX period, where 5½-month-olds (M = 53.99%) smiled more than 3½-month-olds (M =

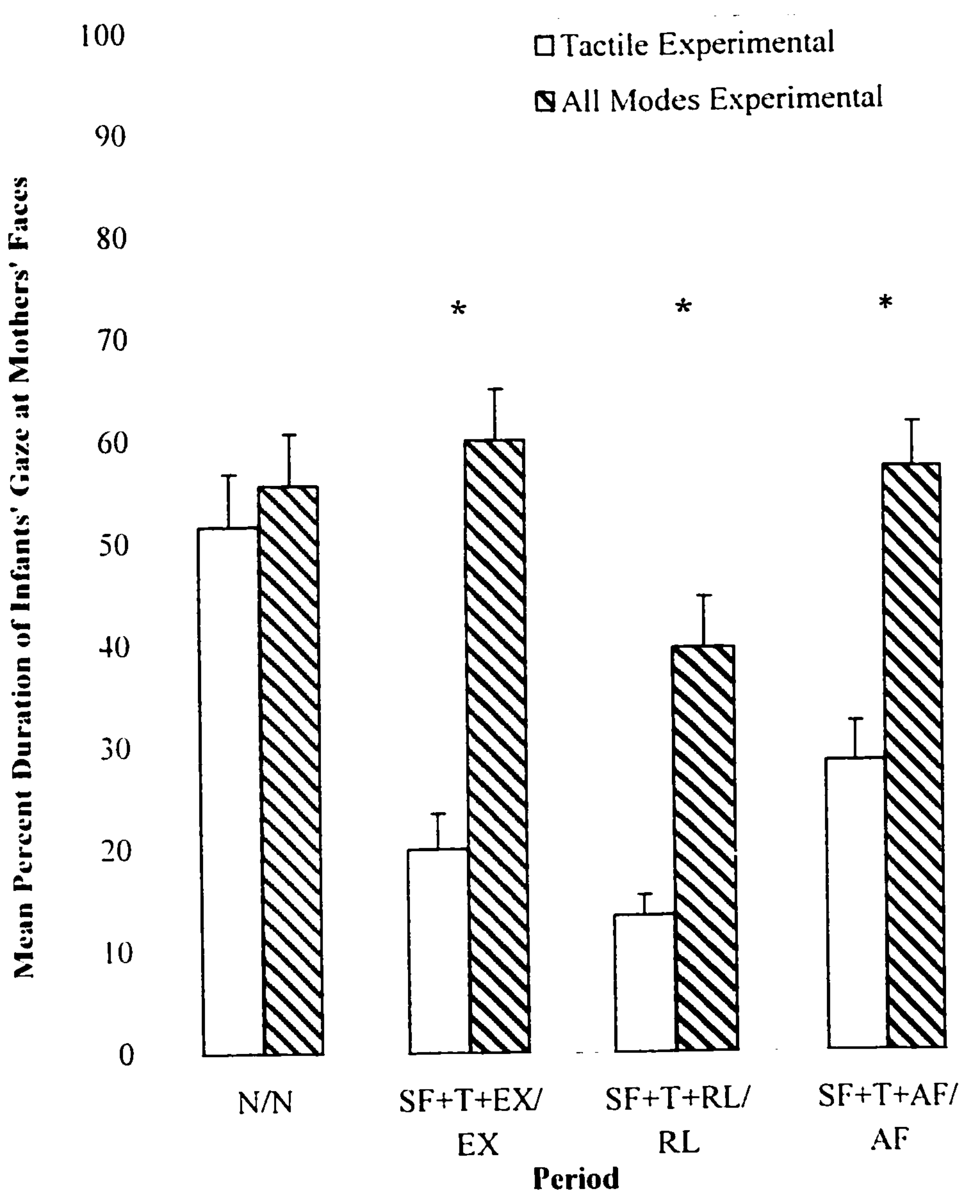


Figure 14. Mean percent duration of infants' gaze at mothers' faces as a function of Period and Group (Tactile Experimental, All Modes Experimental). Standard errors are denoted by vertical bars.

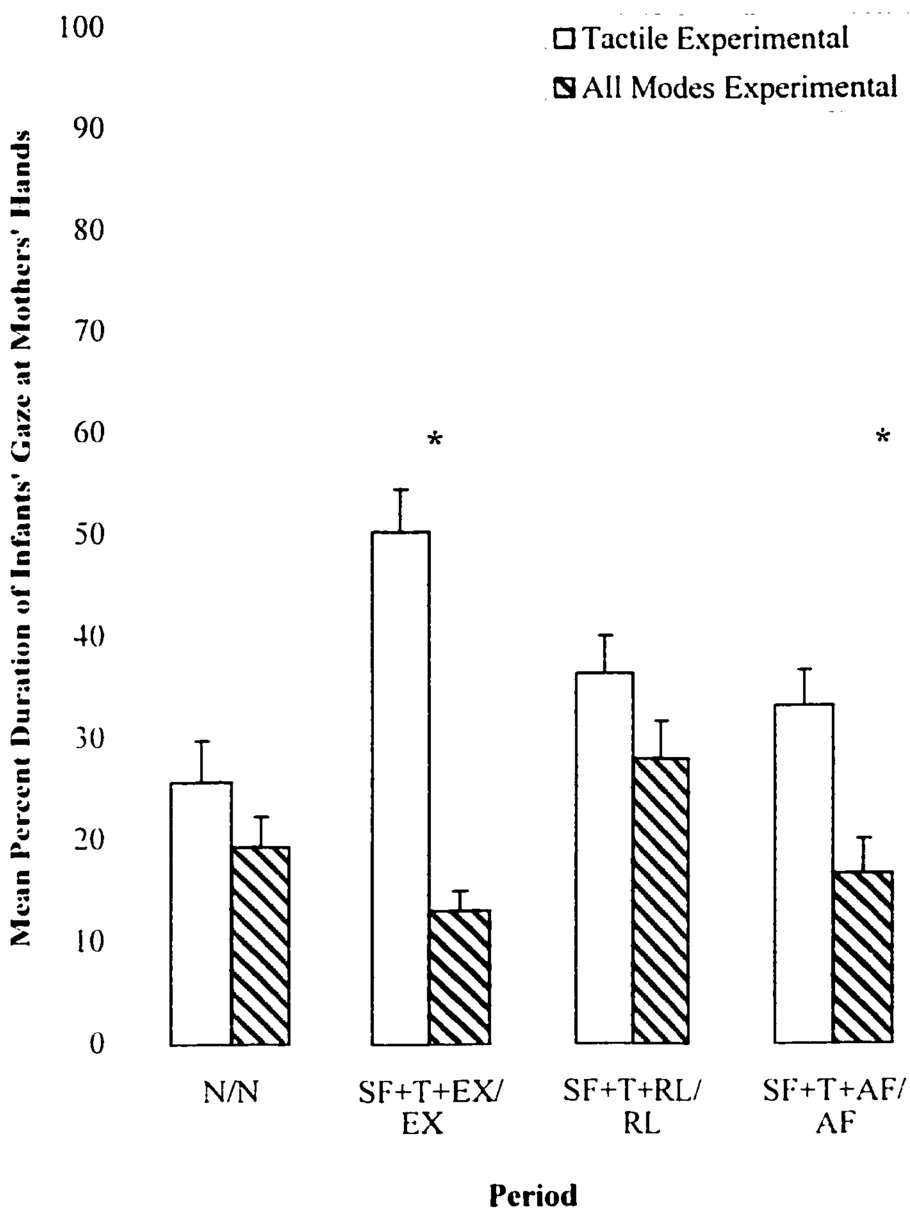


Figure 15. Mean percent duration of infants' gaze at mothers' hands as a function of Period and Group (Tactile Experimental, All Modes Experimental). Standard errors are denoted by vertical bars.

31.76%), $F(1, 65) = 11.90$, $p < .001$ (see Figure 16). Moreover, a simple effects analysis conducted on a Period by Group interaction, $F(3, 189) = 6.23$, $p < .001$ indicated that infants in the All Modes Experimental group smiled more in each of the experimentally manipulated periods compared to those in the Tactile Experimental group (Ms = 52.48% vs. 31.93% for the EX period, $F(1, 65) = 11.03$, $p < .001$; Ms = 19.00% vs. 7.08% for the RL period, $F(1, 65) = 11.01$, $p < .001$; Ms = 33.76% vs. 17.94% for the AF period, $F(1, 65) = 10.53$, $p < .001$). This effect is illustrated in Figure 17. Transformed means for these effects are located in Tables O2 and O3, respectively.

Infant fretting. Examination of the means for descriptive purposes revealed that infants in the Tactile Experimental group spent an average of 1.57% of the entire play session fretting compared to 1.15% for infants in the All Modes Experimental group.

Results Pertaining to Objectives 2 and 3: Qualitative Aspects of Maternal Touch and Age Effects

Descriptive analyses revealed the presence of moderate skewness and outliers in the data for both Type and Area within all three comparisons (i.e., Tactile Experimental vs. Tactile Control; All Modes Experimental vs. All Modes Control; Tactile Experimental vs. All Modes Experimental). Consequently, a square root transformation was conducted throughout. Subsequent analyses were conducted using a split-plot ANOVA with Age (3½ months, 5½ months) and Group (Tactile Experimental vs. Tactile Control; All Modes Experimental vs. All Modes Control; Tactile Experimental vs. All Modes Experimental depending on the set of analyses in question) as the between-subjects variables, and Type of Touch (No touch, Static, Stroke, Pat, Squeeze, Tickle,

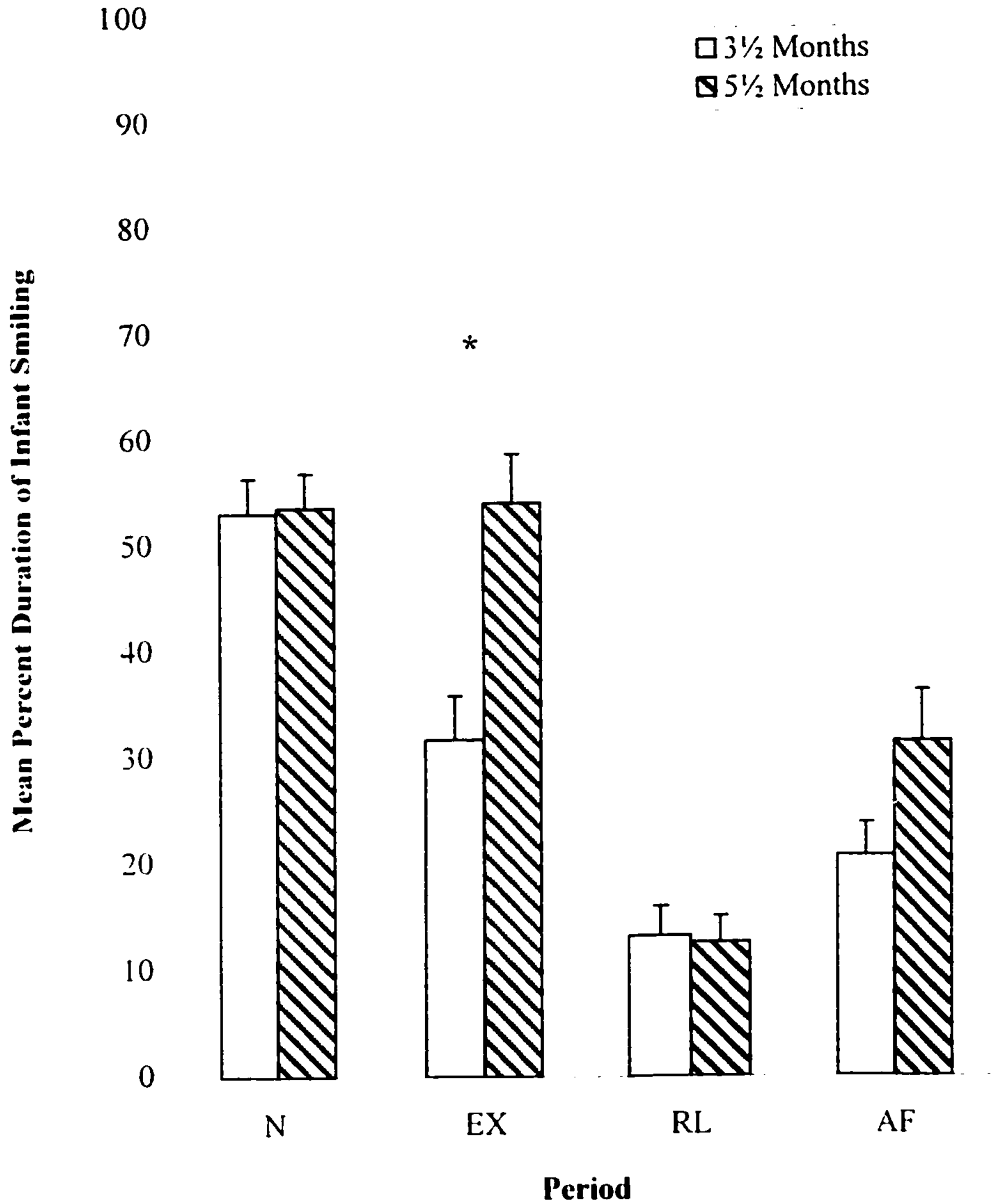


Figure 16. Mean percent duration of infant smiling as a function of Period and Age, collapsed across infants in the Tactile Experimental and All Modes Experimental groups. Standard errors are denoted by vertical bars.

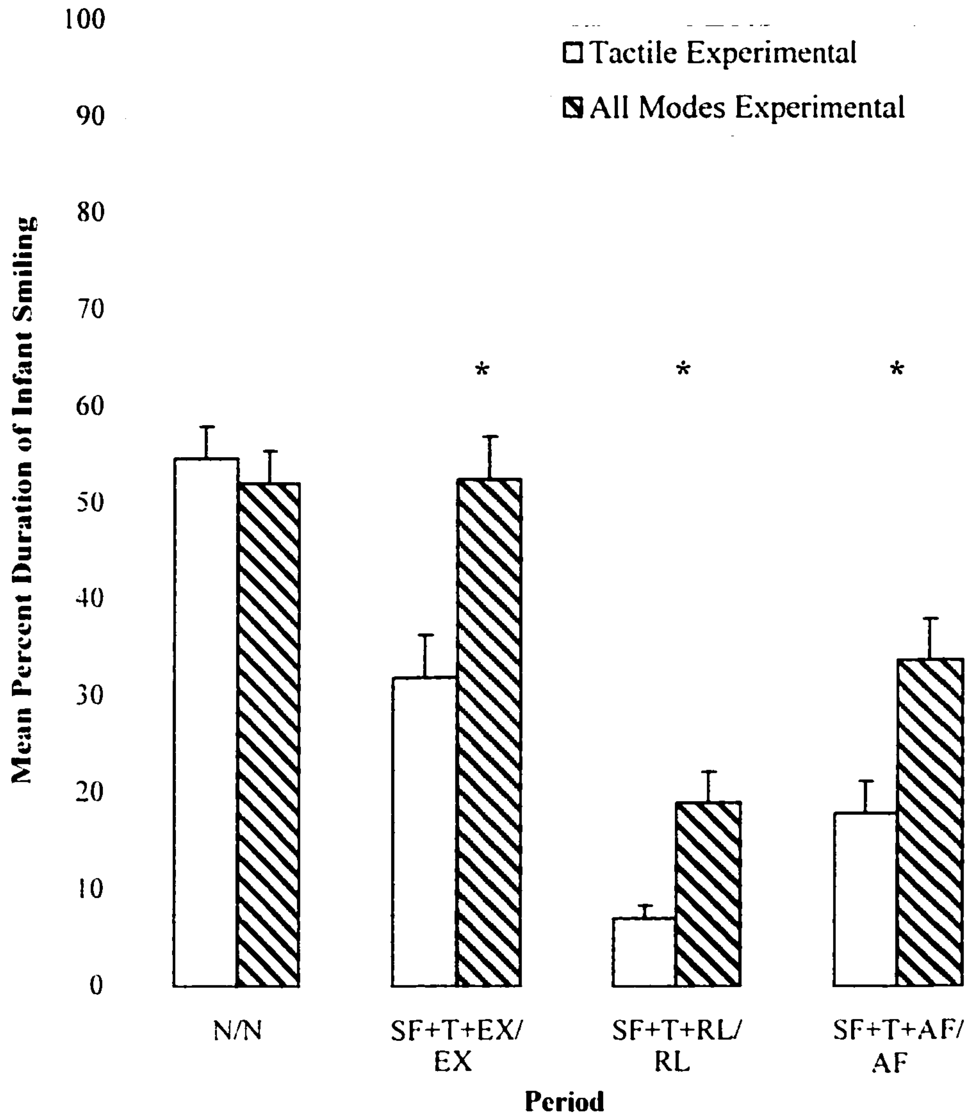


Figure 17. Mean percent duration of infant smiling as a function of Period and Group (Tactile Experimental, All Modes Experimental). Standard errors are denoted by vertical bars.

Shake, Lift, Other), and Period (N, EX, RL, AF) as the within-subjects variables. For the analysis examining the areas of the infants' bodies to which the touch was delivered, Area of Touch (No area; Feet, Trunk, Hands, Shoulders, Face) was substituted for Type of Touch as a within-subjects variable.

As in the analyses reported above, a Bonferroni correction was performed by dividing the standard alpha level of .05 by 2 to correct for the number of measures being investigated (i.e., Type and Area of touch). As such, the corrected alpha level employed in all analyses was .025, while .05 was again maintained as the critical value for all follow-up comparisons.

Comparison of the Tactile Experimental and Tactile Control Groups

Type of touch. Analyses conducted on the transformed data (Table P1) revealed an Age by Group interaction, $F(1, 54) = 7.05$, $p < .025$, indicating that within the Experimental group, mothers of 3½-month-olds (M = 26.44%) touched their infants more compared to mothers of 5½-month-olds (M = 11.17%). Again, as these means were specifically based on tactile contact initiated by the mother on the infant's body rather on the overall tactile contact between the dyad, they do not correspond to the duration of touch means previously reported. A Type by Age interaction, $F(3.97, 214.58) = 2.35$, $p <$ .025, indicated that mothers of 3½-month-olds shook their infants' limbs more (Ms = 4.79% vs. 2.35%) and lifted them less (Ms = 17.08% vs. 24.69%) than mothers of 5½-month-olds (see Figure 18). As illustrated in Figure 19, follow-up analyses conducted on a Type by Period by Group interaction, $F(9.09, 491.19) = 4.42$, $p < .001$, revealed no differences in the types of touch used by the two groups during the N period, thereby

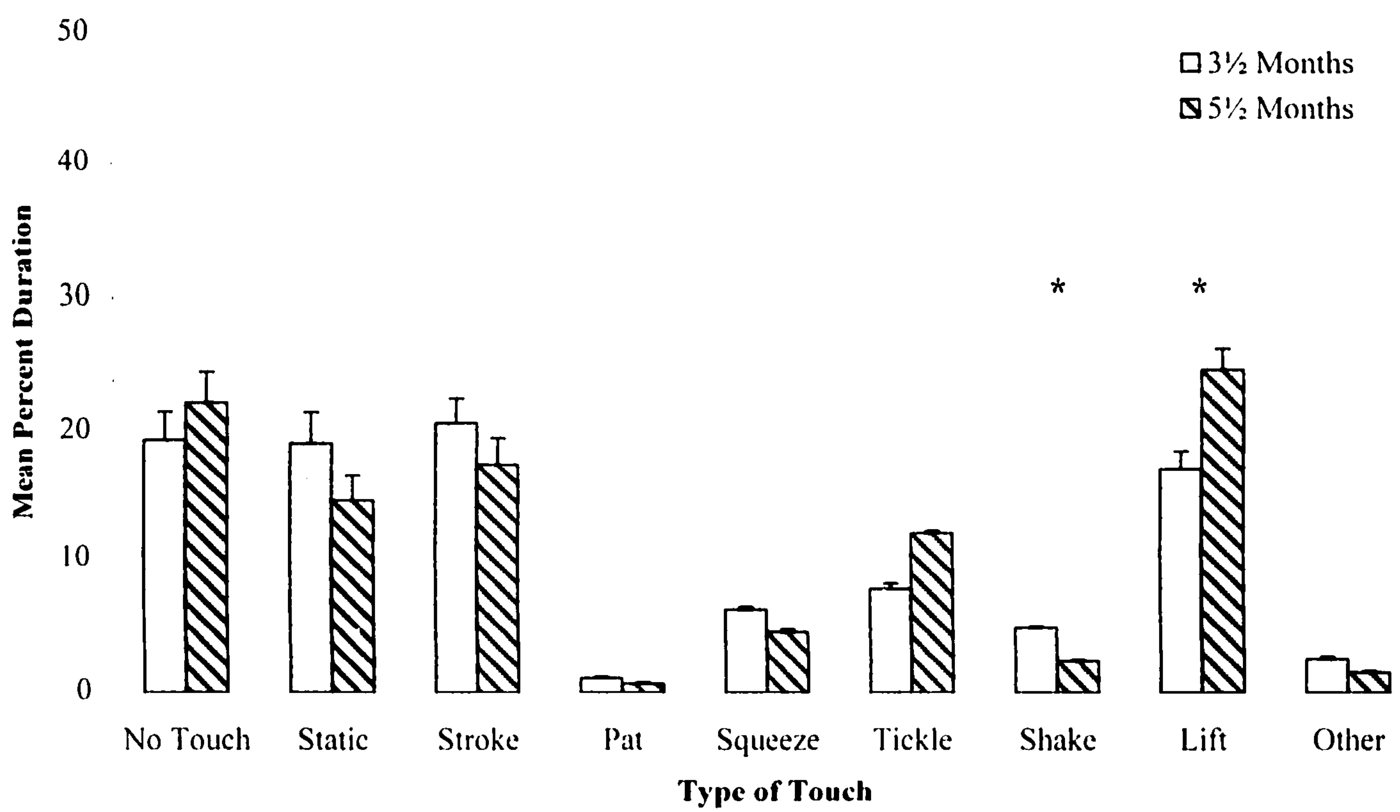


Figure 18. Mean percent duration of touch as a function of Type and Age collapsed across the Tactile Experimental and Tactile Control groups.

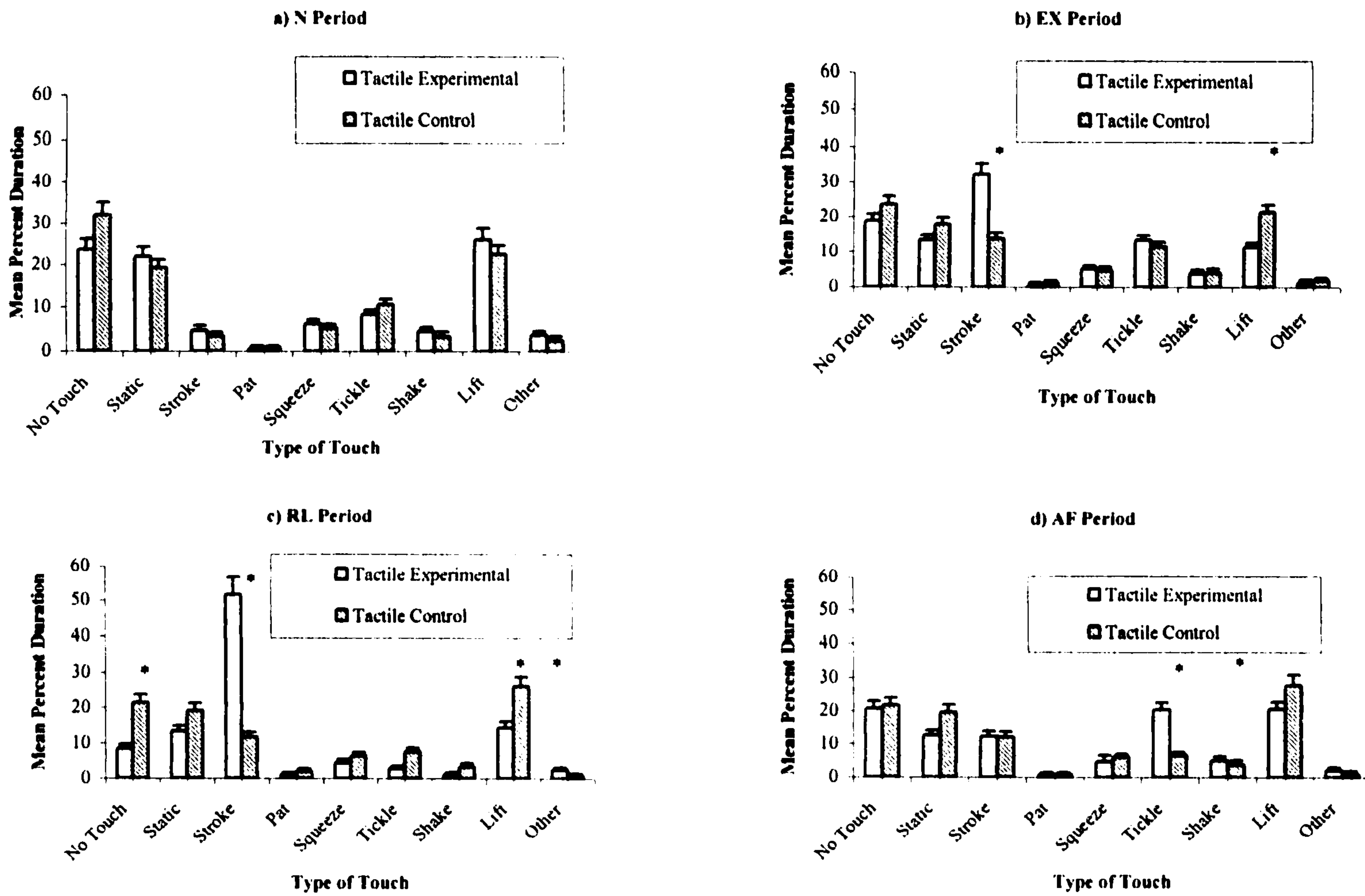


Figure 19. Mean percent duration of maternal touch as a function of Type and Group for the N (a), EX (b), RL (c), and AF (d) periods for infants in the Tactile Experimental and Tactile Control groups.

indicating that the groups behaved similarly at the outset of the study. However, during the EX period, mothers in the Experimental group spent more time stroking their infants and less time lifting their limbs than Controls (Ms = 32.25% vs. 13.84 % for stroking; 11.49% vs. 21.39% for lifting). During the RL period, mothers in the Experimental group spent less time engaged in 'no touch' (i.e., they touched their infants more) and in lifting, and spent more time stroking their infants, and engaging in 'other' forms of touch (e.g., wiping, adjusting posture) than Controls (Ms = 8.53% vs. 21.52% for no touch; 14.44% vs. 26.34% for lifting; 51.70% vs. 11.76% for stroking; 2.48% vs. 0.65% for 'other'). Lastly, during the AF period, mothers in the Experimental group spent more time tickling and shaking their infants than Controls (Ms = 20.42% vs. 6.66% for tickling; 5.11% vs. 3.79% for shaking). Transformed means for the aforementioned effects are located in Tables P2-P4, respectively.

Area of touch. Analyses on the transformed data (Table P5) revealed an Area by Age interaction, $F(3.58, 193.56) = 3.65$, $p < .025$, and follow-up analyses indicated that mothers of 3½-month-olds touched their infants' feet and shoulders less than mothers of 5½-month-olds (Ms = 26.99% vs. 35.11% for feet; 0.86% vs. 2.17% for shoulders) but touched their hands and faces more than those of 5½-month-olds (Ms = 32.61% vs. 22.50% for hands; 11.35% vs. 8.83% for face). An Area by Period by Group interaction, $F(9.29, 501.43) = 3.20$, $p < .001$, was also found, and follow-up analyses conducted to isolate the sources of the interaction revealed differences between the groups in all periods. Although the reason for this difference is unclear, mothers in the Experimental group touched their infants' hands more during the N period (Ms = 38.69% vs. 19.86%).

They also touched their infants' faces more during the EX period than Controls ($\underline{M}$s = 13.34% vs. 5.05%). During the RL period, mothers in the Experimental group spent less time engaged in off the body behavior (i.e., they touched their infants more, $\underline{M}$s = 8.59% vs. 21.48% for 'no area'). Experimental group mothers also touched their infants' faces more and their feet less than Controls during this period ($\underline{M}$s = 31.11% vs. 5.69% for face; 21.73% vs. 40.3% for feet). Lastly, mothers in the Experimental group touched their infants' trunks more than Controls during the AF period ($\underline{M}$s = 14.54% vs. 7.73%). Transformed means for these effects are located in Tables P6 and P7, respectively.

Comparison of the All Modes Experimental and All Modes Control Groups

Type of touch. Analyses on the transformed data (Table Q1) revealed a Type by Period by Group interaction, $\underline{F}(9.46, 501.27) = 3.83$, $\underline{p} < .001$, and follow-up analyses indicated that during the RL period mothers in the All Modes Experimental group engaged in less 'no touch', shaking, and lifting than those in the Control group ($\underline{M}$s = 21.55% vs. 41.53% for no touch; 1.08% vs. 4.49% for shaking; 7.64% vs. 17.50% for lifting). In contrast, however, they spent more time stroking and squeezing their infants during this period relative to Controls ($\underline{M}$s = 26.33% vs. 3.93% for stroking; 5.82% vs. 4.21% squeezing). During the AF period, mothers in the Experimental group spent less time lifting compared to those in the Control group ($\underline{M}$s = 13.60% vs. 23.43%). This effect is illustrated in Figure 20. Transformed means for this effect are located in Table Q2.

Area of touch. Analyses on the transformed data (Table Q3) revealed an Area by Age interaction, $\underline{F}(2.52, 133.55) = 2.72$, $\underline{p} < .025$, whereby mothers of 3½-month-olds

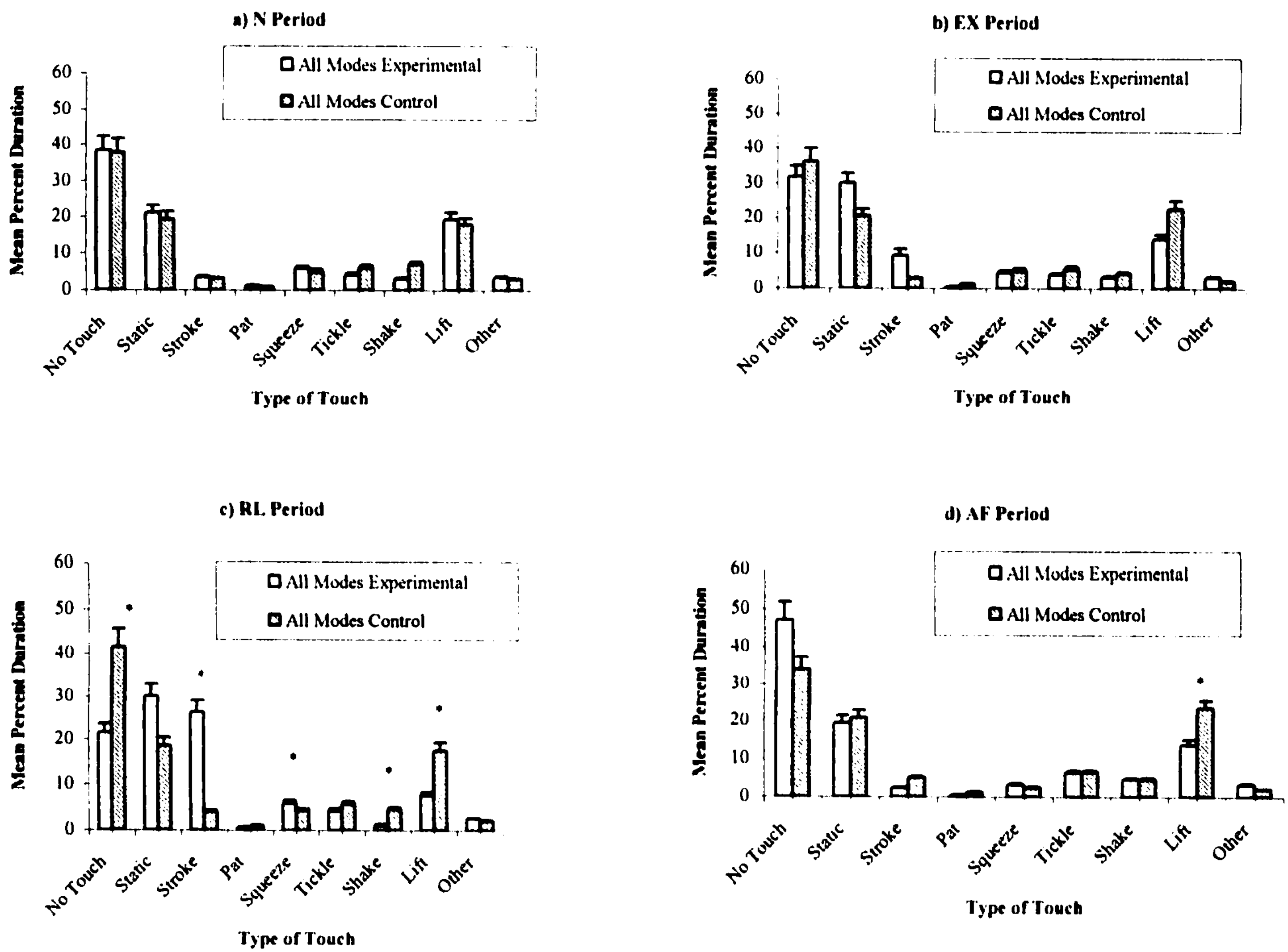


Figure 20. Mean percent duration of maternal touch as a function of Type of Touch and Group for the N (a), EX (b), RL (c), and AF (d) periods for infants in the All Modes Experimental and All Modes Control groups.

touched their infants' faces more than those of 5½-month-olds ($\underline{M}s$ = 6.30% vs. 4.19%). An additional Area by Period by Group interaction, $\underline{F}(8.13, 431.05) = 2.92$, $\underline{p} < .001$, was found and follow-up analyses indicated that during the RL period mothers in the Experimental group spent less time engaged in 'no area' (i.e., they touched their infants' bodies more) and touched their infants faces more than mothers in the Control group ($\underline{M}s$ = 21.55% vs. 41.44% for 'no touch'; 13.10% vs. 3.84% for face). Transformed means are located in Tables Q4 and Q5, respectively.

Comparison of the Tactile Experimental and All Modes Experimental Groups

Type of touch. Analyses on the transformed data (Table R1) revealed an Age by Group interaction, $\underline{F}(1, 63) = 6.14$, $\underline{p} < .025$, indicating that within the Tactile Experimental group, mothers of 3½-month-olds touched their infants more overall than did mothers of 5½-month-olds ($\underline{M}s$ = 26.44% vs. 11.17%). Follow-up analyses conducted on a Type by Period by Group interaction, $\underline{F}(8.80, 554.66) = 2.81$, $\underline{p} < .001$, revealed differences between the groups in all periods. As illustrated in Figure 21, mothers in the Tactile group spent more time tickling than those in the All Modes group during the N period, ($\underline{M}s$ = 8.30% vs. 4.10%). In the EX period, mothers in the Tactile group spent less time engaged in static and 'other' forms of touch, but more time stroking and tickling their infants than mothers in the All Modes group ($\underline{M}s$ = 13.40% vs. 30.03% for static touch; 1.37% vs. 3.13% for 'other'; 32.25% vs. 9.19% for stroking; 13.53% vs. 3.91% for tickling). In the RL period, mothers in the Tactile group spent less time in 'no touch' and static touch and more time stroking their infants ($\underline{M}s$ = 8.59% vs. 21.55% for 'no touch'; 13.50% vs. 30.03% for static touch; 51.70% vs. 26.33% for stroking) than

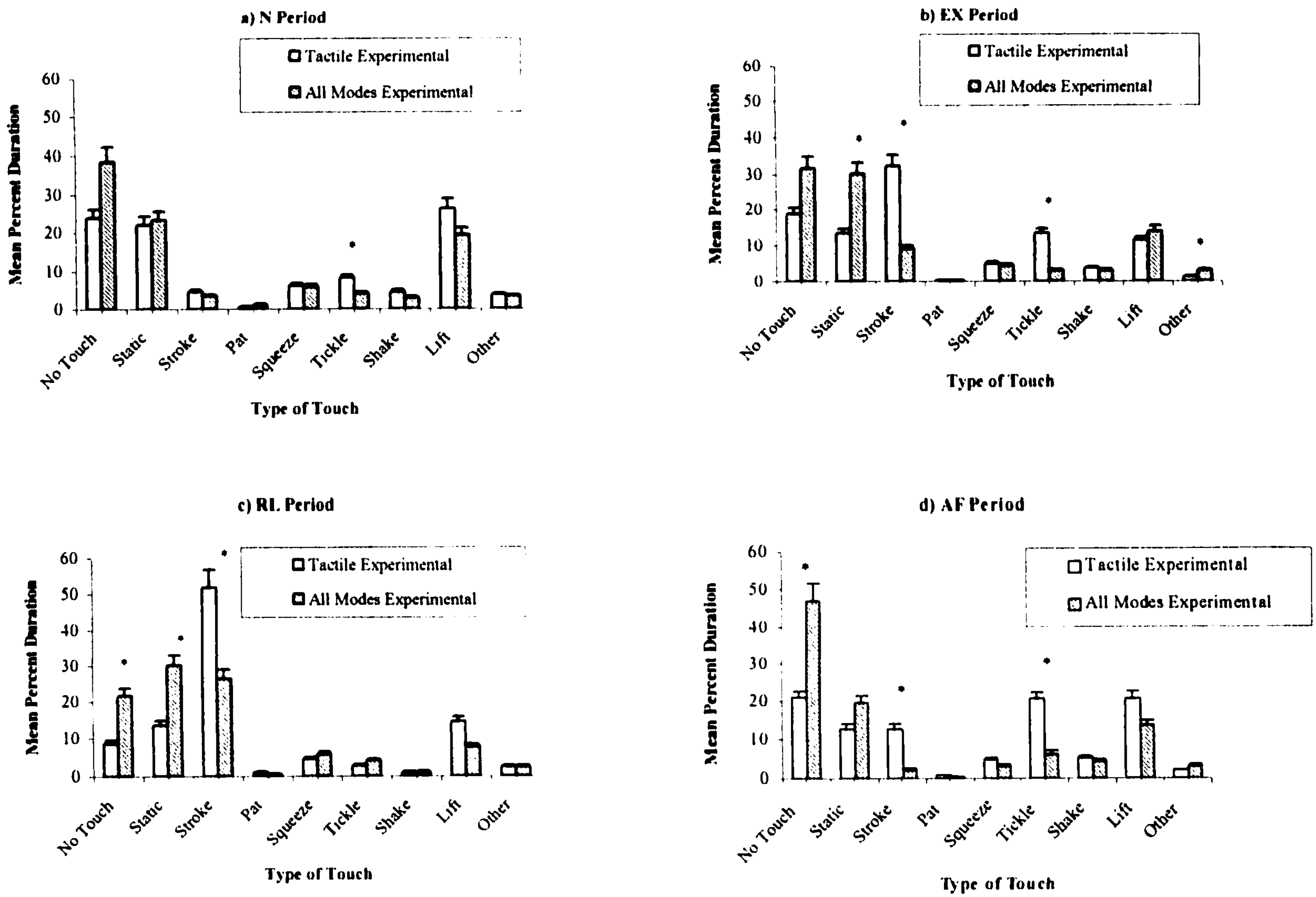


Figure 21. Mean percent duration of maternal touch as a function of Type of Touch and Group for the N (a), EX (b), RL (c), and AF (d) periods for infants in the Tactile Experimental and All Modes Experimental groups.

those in the All Modes group. Lastly, the results of the AF period revealed that Tactile group mothers spent less time in 'no touch', and more time stroking and tickling their infants than mothers in the All Modes group (Ms = 20.72% vs. 47.04% for 'no touch'; 12.42% vs. 2.26% for stroking; 20.42% vs. 6.26% for tickling). Transformed means for these effects are located in Tables R2 and R3, respectively.

Area of touch. Results (Table R4) revealed an Area by Period by Group interaction, $F(9.01, 567.39) = 2.03$, $p < .025$, and follow-up analyses indicated that mothers in the Tactile group touched their infants' feet and faces more than those in the All Modes group during the EX period (Ms = 31.08% vs. 23.20% for the feet; 13.35% vs. 5.45% for the face). Furthermore, mothers in the Tactile group engaged in less off the body behavior and touched their infants' faces more than those in the All Modes group during both the RL (Ms = 8.53% vs. 21.55% for 'no touch'; 31.11% vs. 13.10% for the face) and AF (Ms = 20.72% vs. 47.04% for 'no touch'; 8.24% vs. 3.37% for the face) periods. Mothers in the Tactile Experimental group also touched their infants' trunks more than those in the All Modes Experimental group during the AF period (Ms = 14.54% vs. 4.11%). Transformed means for this effect are located in Table R5.

Results Pertaining to Objectives 4 and 3: Co-Occurrence of Nonverbal Behaviors and Age Effects

Wilcoxon signed ranks tests were conducted on pairs of dependent measures to address the fourth objective of the study, which was to assess for the presence of significant co-occurrences between nonverbal expressive behaviors during mother-infant interactions. These analyses permitted an evaluation of whether each behavior pair overlapped to a greater, lesser, or equal extent to that predicted by chance alone. Several such analyses were conducted between infants' nonverbal behaviors with the aim of determining whether: (a) infants displayed patterns of co-occurring nonverbal behaviors, (b) these patterns of co-occurring nonverbal behaviors differed as a function of the interaction period, suggesting the presence of behavioral configurations that were specific to the context of the interaction, and (c) they differed for infants of different ages, suggesting developmental differences in infants' expressions of, and co-ordination of, nonverbal behaviors. Co-occurrences were derived for each of the infant gaze measures of Gaze at mothers' faces, Gaze at mothers' hands, and Gaze away, and the infant affective behavior of Smiling. Additional analyses were performed to assess for the presence of co-occurrences between each of the aforementioned infant gaze and affect measures and the maternal measures of Touch and Gestures to assess for reliable co-occurrences between infant and mother nonverbal communicative behaviors.

In order to account for slight variations in period lengths, the total duration of each dependent measure was transformed into a proportional duration (i.e., total duration of a behavior divided by the total duration of a period). Following the procedures outlined by Fogel and Hannan (1985) and Legerstee, Corter, and Kienapple (1990), Wilcoxon matched pairs signed-ranks tests were performed on each of the behavior pairs to assess whether observed co-occurrence values differed significantly from expected co-occurrence values. Observed co-occurrence was determined by calculating the proportion of the total session time during which the two behavior categories of interest occurred simultaneously. Expected co-occurrence was defined as the joint probability of each behavior category occurring (i.e., the product of the proportional session durations for each category). Observed and expected values were derived for each infant for each period using a computer program specifically designed and created for this purpose (Arnold & Deschênes, 2000). Table 2 illustrates the significant co-occurrences between the infant gaze measures with infant smiling for each of the four Periods as a function of Group and Infant age.

Infant Nonverbal Behaviors

Smiling and gaze at face. Infants were likely to smile while gazing at their mothers' faces to a degree exceeding chance in all periods, and this result was true for infants of both ages and in all groups.

Smiling and gaze at hands. Infants of both ages and in all groups were prone to smile while gazing at their mothers' hands during the N period. Co-occurrence values in the EX period also revealed a similar positive association between the behaviors for both 3½- and 5½-month-olds in the Tactile Experimental group, as well as 3½-month-olds in the All Modes Experimental group. In contrast, during the RL period 3½- and 5½-month-olds in the Tactile Experimental group were not likely to smile when looking at the hands, as were 3½- and 5½-month-olds in the All Modes Experimental group. Lastly, values in the AF period indicated that infants of both ages in the Tactile groups were prone not to smile when looking at their mothers' hands, whereas no association between the behaviors was found for infants in the All Modes groups.

Smiling and gaze away. The N period was characterized by chance level co-occurrence between smiling and gazing away for all infants. With respect to the EX

Table 2

Co-occurrence Analyses for the Infant Gaze Behaviors and Infant Smiling Behavior as a Function of Group, Age, and Period for Study 1: Wilcoxon Matched-Pairs Signed-Ranks Test

	Period			
	N	EX	RL	AF
Gaze Behaviors	Smiling			
Tactile Experimental				
3.5 Months				
Face	16/1***	12/2*	8/0*	10/0**
Hands	11/4*	10/3*	2/8 *	3/9*
Away	6/7	8/1*	3/11**	4/10*
5.5 Months				
Face	13/1***	15/1**	7/1*	11/1**
Hands	11/1**	9/2*	3/9*	3/10*
Away	5/8	4/5	2/8*	3/9*
Tactile Control				
3.5 Months				
Face	12/0**	7/1*	7/1*	8/1*
Hands	11/1**	2/5	2/5	2/6
Away	1/4	5/3	3/6	4/4
5.5 Months				
Face	9/3*	9/0**	8/2*	7/1*
Hands	7/1*	2/5	2/3	1/5
Away	5/3	4/4	1/4	3/6
All Modes Experimental				
3.5 Months				
Face	15/2***	12/2**	12/3*	12/3**
Hands	10/2**	6/0*	4/8*	3/11
Away	5/5	12/2**	3/11**	10/2*
5.5 Months				
Face	15/0***	9/3**	9/0**	13/0***
Hands	8/2*	2/9	1/6*	4/8
Away	7/4	6/4	2/8*	5/4
All Modes Control				
3.5 Months				
Face	11/1**	11/0**	10/2**	7/1*
Hands	10/1**	4/3	3/7	1/7
Away	4/2	3/5	1/4	3/2
5.5 Months				
Face	10/1**	10/0**	10/0**	9/1**
Hands	8/1*	4/4	1/5	3/8
Away	3/3	4/3	2/5	4/4

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

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

period, 3½-month-olds in the Tactile and All Modes Experimental groups smiled while gazing away more than would be predicted by chance. During the RL period, infants of both ages in the Experimental groups were prone not to smile when gazing away. Moreover, examination of the AF period revealed that 3½- and 5½-month-olds in the Tactile Experimental group were not likely to smile when gazing away. In contrast, the 3½-month-old, but not 5½-month-old, infants in the All Modes Experimental group were likely to smile when gazing away during the AF period.

Infant and Mother Nonverbal Behaviors

The results of the analyses assessing for possible co-occurrences between infants' nonverbal behavioral indices of engagement and disengagement with mothers' touching and gesturing are located in Table 3.

Gaze at face and maternal touch. During the N period, 5½-month-old infants in all groups gazed at their mothers' faces while being touched more than predicted by chance. In contrast, 5½-month-old infants in the Tactile Experimental group were likely not to gaze at their mothers' faces when being touched during the EX period. The two behaviors were also negatively associated during the RL period for both 3½- and 5½-month-old infants in the Tactile and All Modes Experimental groups. During the AF period, infants of both ages and in both of the Experimental groups were likely to gaze at their mothers' faces when touched.

Gaze at hands and maternal touch. Only 3½-month-old infants in all groups gazed at their mothers' hands when touched more than predicted by chance during the N period. The two behaviors were similarly likely to co-occur at greater than chance level

Table 3

Co-occurrence Analyses for the Infant Gaze and Smiling Behaviors with Maternal Touch and Gesture as a Function of Group, Age, and Period for Study 1: Wilcoxon Matched-Pairs Signed-Ranks Test

	Period							
	N		EX		RL		AF	
	Maternal Behaviors							
Infant Behaviors	Touch	Gesture	Touch	Gesture	Touch	Gesture	Touch	Gesture
Tactile Experimental								
3.5 Months								
Face	5/2	2/1	3/2	1/0	2/10**	1/0	8/0*	7/1*
Hands	7/3*	1/2	10/0**	2/2	8/2	0/1	11/2*	7/0*
Away	2/11*	3/2	7/1*	1/8*	11/3*	0/0	2/2	8/1*
Smiling	8/4	4/1	11/1**	10/1*	1/9*	0/2	0/7*	0/2
5.5 Months								
Face	7/0*	2/9	3/11**	1/9*	1/9**	0/0	7/0*	12/3**
Hands	4/2	5/1	9/1*	8/1*	11/0***	0/0	7/3	6/3
Away	1/7*	1/1	4/4	2/12***	8/2*	3/1	3/2	8/0*
Smiling	10/3***	3/0	9/0*	9/0**	2/10*	1/2	1/9*	1/7*
Tactile Control								
3.5 Months								
Face	4/2	3/1	4/4	0/2	1/3	0/2	3/3	1/1
Hands	8/0*	1/2	8/0*	4/1	4/4	1/1	5/2	2/0
Away	0/7*	2/2	2/0	1/3	2/4	0/0	4/4	3/3
Smiling	4/0	1/1	3/2	2/2	0/3	2/2	4/2	1/4
5.5 Months								
Face	8/1*	2/5	3/2	0/2	3/3	2/0	4/0	0/3
Hands	5/2	6/0	5/3	5/0	4/0	3/3	5/1	4/0
Away	2/8*	3/2	4/1	1/6	5/3	2/1	0/1	2/1
Smiling	8/3*	5/3	2/0	3/1	0/1	2/1	2/2	1/3
All Modes Experimental								
3.5 Months								
Face	4/5	3/1	5/5	2/4	2/9*	0/4	7/1*	8/2*
Hands	9/3*	2/1	11/3**	5/0	5/2	3/0	3/2	3/1
Away	3/10*	2/4	7/1*	4/4	6/1*	2/0	3/3	2/2
Smiling	5/1	6/1	9/0*	4/0	1/7*	2/1	5/1	4/1

Table 3 (cont'd)

	Period							
	N		EX		RL		AF	
	Maternal Behaviors							
Infant Behaviors	Touch	Gesture	Touch	Gesture	Touch	Gesture	Touch	Gesture
All Modes Experimental								
5.5 Months								
Face	10/2**	3/3	4/2	3/4	1/10*	1/0	9/1**	10/2**
Hands	6/5	4/1	4/4	9/1*	9/3*	0/1	4/2	3/2
Away	2/9*	2/2	3/5	2/0	10/2***	2/2	2/0	4/2
Smiling	10/4**	5/0	8/1*	8/0*	2/2	1/1	6/1	6/2
All Modes Control								
3.5 Months								
Face	1/3	2/4	3/3	2/2	4/2	3/4	2/0	0/2
Hands	8/1*	3/2	6/2*	3/3	6/2	3/3	3/4	2/0
Away	0/7*	1/4	4/3	3/3	3/4	4/1	3/0	1/1
Smiling	6/4	2/2	5/2	2/1	2/3	3/0	7/2	2/2
5.5 Months								
Face	9/0**	1/5	2/2	1/5	3/3	2/6	1/0	2/6
Hands	6/5	5/1	7/4	4/2	7/2	8/0	2/3	5/3
Away	1/9*	2/3	1/0	0/3	2/5	3/0	2/2	2/0
Smiling	8/0*	3/1	3/3	3/1	3/4	5/1	6/1	4/0

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

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

during the EX period for 3½-month-olds in all groups, as well as for 5½-month-olds in the Tactile Experimental group. Analysis of the RL period revealed that 5½-month-old infants both of the Experimental groups, as well as 3½-month-olds in the Tactile Control group were likely to gaze at their mothers' hands when touched. A positive relationship between the behaviors was also noted for 3½-month-old Tactile Experimental infants in the AF period.

Gaze away and maternal touch. Infants of all ages and in all groups were prone not to gaze away when touched during the N period. In contrast, the two behaviors co-occurred at greater than chance level during the EX period for 3½-month-old infants in both of the Experimental groups, as well as during the RL period for 3½- and 5½-month-olds in both of the Experimental groups.

Smiling and maternal touch. Five-and-a-half-month-old infants in all groups smiled while being touched by their mothers more than chance predicted during the N period. In addition, infants of both ages in the Tactile and All Modes Experimental groups smiled when touched at greater than chance level during the EX period. In contrast, negative associations were found for 3½-month-olds in both Experimental groups, as well as 5½-month-olds in the Tactile Experimental group during the RL period. Negative associations were also evidenced for both 3½- and 5½-month-old infants in the Tactile Experimental group during the AF period.

Gaze at face and maternal gestures. Analyses revealed that in the EX period, 5½-month-olds in the Tactile Experimental group actually looked less at their mothers' faces when they gestured than would be predicted by chance. In contrast, both 3½- and 5½-

month-old infants in the Tactile and All Modes Experimental groups gazed at their mothers' faces when they gestured more than predicted by chance during the AF period.

Gaze at hands and maternal gestures. Analyses revealed that during the EX period, 5½-month-olds in the Tactile and All Modes Experimental groups gazed more at their mothers' hands while they were gesturing than chance would predict. A positive association was also found for 3½-month-olds in the Tactile Experimental group during the AF period.

Gaze away and gestures. Both 3½- and 5½-month-old infants in the Tactile Experimental group were prone not to gaze away when gestured toward during the EX period. However, both 3½- and 5½-month-olds in the Tactile Experimental group were likely to gaze away when their mothers gestured during the AF period.

Smiling and gestures. Both 3½- and 5½-month-old infants in the Tactile Experimental group, as well as 5½-month-old infants in the All Modes Experimental group were prone to smile when their mothers gestured during the EX period. However, 5½-month-olds in the Tactile Experimental group were likely not to smile when their mothers gestured during the AF period.

Discussion

Objective 1a of Study 1 was to ascertain within the context of both uni-modal (i.e., touch-only) and multi-modal interactions whether mothers would use different durations of touch and gesture in their attempts to comply with the instructions provided them, and whether infants were responsive to such changes as evidenced by differences in their durations of gaze and affect. It was hypothesized that the instructions to mothers to elicit specific behaviors/states from their infants would result in changes in maternal touching and gesturing and, correspondingly, observable and measurable changes in the durations of infant gaze and affect suggestive of differences in arousal regulation.

With respect to the uni-modal comparison, no differences between the Tactile Experimental and Tactile Control groups were found during the first, Normal period for any of the measures, indicating that mothers and infants in both groups responded similarly at the outset of the study. However, as hypothesized, maternal touch and gesture, and infant gaze and affect, differed between the groups as well as across the various periods for infants in the Tactile Experimental group. Taken together, the results highlight the effectiveness of manipulations of instructions provided to mothers in influencing their behavior, as well as infants' sensitivities to subtle manipulations of maternal tactile-gestural stimulation.

Replicating previous research within our laboratory (Stack & Arnold, 1998), the duration of maternal touching was not found to differ between the Tactile Experimental and Control groups, presumably because it was the only method of communication available to mothers. Indeed, mothers in both groups touched their infants more than

75% of the time during each interaction period, a finding that is consistent with previous research examining mothers' uses of touch during social interactions with their infants (e.g., Field, 1984; Kaye & Fogel, 1980; Stack & Muir, 1990; Symons & Moran, 1987; Weinberg, 1994, as cited in Tronick, 1995). In contrast, mothers differed in their durations of gesturing, with mothers in the Tactile Experimental group gesturing more toward their infants than those in the Control group during both the EX and AF periods. Thus, as predicted, mothers increased their use of gestural stimulation when asked to elicit and maintain their infants' visual attention on their faces. This finding supports the results of other researchers who have suggested that maternal gesturing serves attention-eliciting and attention-maintaining functions (Koester, 1995; Mcnamara, 1977; Murphy & Messer, 1977; Schnur & Shatz, 1984; Shatz, 1982; Shatz & Graves, 1976, as cited in Schnur & Shatz, 1984; Spencer, 1993). In addition, however, the present study extends this finding to normally developing infants below one year of age, a population that has been neglected in the literature to date. Mothers in the Tactile Experimental group also gestured more than their Control group counterparts during the EX period, possibly reflecting their increased uses of visual interactive hand movements to incite excitement and happiness in their infants.

Differences in infant gaze and affect between the groups were also revealed, thereby highlighting the effectiveness of subtle manipulations of maternal tactile-gestural behavior in influencing infant behavior and responsiveness. Consistent with expectations, infants in the Tactile Experimental group gazed more at their mothers' faces during the AF period than their Control counterparts, indicating that mothers were successfully able to elicit and maintain their infants' attention using only their hands to do so. In contrast, Experimental group infants were found to visually disengage themselves from their mothers more than Controls during the RL period, as exhibited by their greater durations of gazing away. Notably, the absence of indices of motor activity as dependent variables may have rendered possible differences in the EX period undetectable.

Although the exact reason for the greater gazing away exhibited by infants in the Tactile Experimental group during the RL period is not entirely clear, there exist several plausible interpretations. One possibility is that mothers typically calm and comfort their infants only in contexts in which infants exhibit behavioral cues indicating the appropriateness of such an action (e.g., in situations of discomfort or pain, when overstimulated etc.). As a result, mothers' soothing behavior is usually contingent upon their infants' signals. Past research has revealed that infants expect adults to react to their signals requesting assistance in regulating their arousal. For instance, Lamb and Malkin (1986) reported that from approximately 3-5 months of age infants evidenced behavioral cues indicating that they expected responses to their cries. However, in the present study, the instruction to relax and calm their infants required that mothers do so in the absence of such signals. Consequently, mothers' actions may have appeared inappropriate to their infants, and their noncontingent stimulation may have contributed to their infants' gazing away. This suggestion is supported by past research indicating that infants hold expectations for how their mothers will behave with them, and that violations of these expectations achieved through manipulations of maternal behavior are accompanied by increases in visual disengagement (Cohn & Tronick, 1983; D'Entremont & Muir, 1997; Gusella et al., 1988; Lamb et al., 1987; Mayes & Carter, 1990; Toda & Fogel, 1993; Tronick et al., 1978).

In addition, the very strategies that mothers used in attempting to soothe their infants may have contributed to their infants' disengagement. Past research by Korner and Thoman (1972) demonstrated that although physical contact alone was effective in soothing, the magnitude of success in reducing crying was greatest when contact included vestibular-proprioceptive stimulation (i.e., movement associated with touch). Additional research with younger infants has revealed that rocking on the shoulder in the upright position was more effective in quieting distressed newborns than merely holding or no intervention (Byrne & Horowitz, 1981). Thus, the positioning of infants in an infant seat may have limited mothers' uses of such vestibular-proprioceptive strategies in soothing their infants, thereby violating infants' expectations for the types of stimulation they would receive.

Yet another possible explanation for the greater visual disengagement exhibited by infants in the Tactile Experimental group during the RL period, is that the type of stimulation employed by mothers may simply have been redundant and/or understimulating (e.g., repetitive stroking), and infants' gazing away permitted them to seek out more enticing stimulation in their surroundings. Such a suggestion would be consistent with Kagan's (1971) assertion that visual disengagement from familiar or redundant stimulation and subsequent visual engagement with more active or novel sources of stimulation may serve to reduce infants' boredom and increase their arousal to an optimal level. Thus, although the duration of touch may have been similar, the quality of touch may have played a key role in the observed infant response.

Supporting the validity of the EX instruction, infants in the Tactile Experimental group smiled more than Controls during this period, a finding that is consistent with previous research in our laboratory. The results of these studies (i.e., Stack & Arnold, 1998; Stack & LePage, 1996) revealed that infants whose mothers were instructed to elicit maximal smiling from their infants using only touch exhibited greater smiling than a group of control infants whose mothers were not similarly instructed. This result is particularly salient, given that mothers were instructed to use only touch to accomplish this goal, thereby highlighting the capacity of touch to induce positive arousal, even when used in isolation and in contexts in which mothers' other communicative channels (e.g., face and voice) are still.

Greater durations of smiling were accompanied by consistently low levels of fretting in infants of both ages, and across both groups, suggesting that infants were able to successfully regulate their affect during these brief play sessions, even in contexts involving perturbations of maternal behavior (i.e., the mother's still and expressionless face) and where only one modality of interaction (i.e., touch) was used. This finding is compatible with the results of several studies examining the contribution of touch during face-to-face social interactions. For instance, Stack and Muir (1990) reported low levels of fretting during mother-infant interactions involving a modified still-face interaction in which touch was permitted, suggesting that touch attenuated the negative reactions typically exhibited by infants during the traditional SF procedure. Peláez-Nogueras et al.

(1996) reported that depressed mothers' tactile stimulation compensated for the negative effects resulting from their lack of facial and vocal expressivity. In addition, Brown and Tronick (in preparation, as cited in Tronick, 1995) found lower levels of infant fussing and crying during a condition in which mothers interacted with their infants using only touch compared to conditions in which they interacted normally with their infants or with only their faces.

In sum, it appears that mothers in both Tactile groups touched their infants least during the N interaction, possibly reflecting their greater uses of facial and vocal expressiveness during this period. Across the perturbation periods, mothers in the Tactile Experimental group changed the durations of their touching and gesturing as a function of the instructions provided therein. Specifically, they touched their infants the most and gestured toward them least when asked to relax and calm their infants (i.e., RL), possibly reflecting mothers' greater uses of proximal (i.e., direct body contact) stimulation. In addition, relatively lower levels of touch and higher levels of gesture were exhibited during the AF period, potentially reflecting the greater use of visual attention-getting strategies in this period. Taken together, these results indicate that mothers changed the durations of their touching and gesturing in the various periods to accomplish the goals provided therein. Moreover, the directions of these effects differed, suggesting that touch and gesture serve a functional communicative role, but that the functions they serve and messages they communicate to infants may be distinct. Such disparate patterns of touching and gesturing were also reported by Stack and Arnold (1998) who found that mothers touched less and gestured more during an interaction period in which they were instructed to imitate their infants. Taken together, these results combine to suggest that mothers tailor the type of nonverbal stimulation they employ to the context of the interaction.

With respect to infant behavior, infants gazed more at their mothers' hands during the EX than during either the RL or AF periods. Infants also gazed away the most, and smiled the least, during the RL relative to all of the other periods, suggesting that something about mothers' stimulation during this period was negatively arousing, thereby contributing to their visual disengagement and sobering. As discussed earlier, either noncontingent or redundant maternal stimulation may well have been responsible for the observed effects. Nevertheless, the minimal durations of fretting exhibited by infants suggested that their gazing away may have prevented even greater upset and disengagement, and that the use of touch alone was capable of preventing fretting during a series of interaction periods that were designed to be arousing.

The second control comparison (i.e. All Modes Experimental vs. All Modes Control) comprised within Objective 1a was conducted to ascertain whether mothers' durations of touch and gesture differed within multi-modal face-to-face interactions. Mothers received the same instructions as in the first control comparison but were permitted to use facial, vocal, and tactile expression to achieve these goals. Results revealed that mothers in the All Modes Experimental Group touched their infants more and gestured toward them less than mothers in the Control group, but only during the RL period, suggesting that the instruction to relax and calm their infants inflated their use of proximal, and depressed their use of distal, gestural stimulation. The finding of greater maternal touching in the RL period was not surprising, given that tactile contact is a recognized means of effectively soothing infants (Birns, Blanks, & Bridger, 1966; Kopp, 1989; Korner & Thoman, 1972).

Accompanying differences in infant gaze and affect were also found. Specifically, infants in the Experimental group gazed less at their mothers' hands overall, and gazed more at their mothers' faces during the EX and AF periods compared to Controls, suggesting that mothers' facial regions may have been more dynamic and expressive in these periods. With respect to their affective expressions, infants in the Experimental group were found to smile more than those in the Control group during the EX period again reflecting mothers' success in eliciting behavior reflective of positive arousal when instructed to do so (Stack & Arnold, 1998; Stack & LePage, 1996).

Taken together, these results suggest that when all modalities of interaction were available, mothers used more varied communicative strategies with their infants. The findings of greater gazing at the mother's face in the EX and AF periods and less looking at her hands overall suggests that mothers likely increased the duration and/or changed the quality of their facial and vocal expressions during these periods. However, given that these maternal measures were not specifically investigated in the present study, this explanation is speculative. Notably, however, despite the availability of other salient modes of communication, instructions to mothers designed to reduce infants' arousal (i.e., RL period) resulted in an increase in their use of touch. The corresponding decrease in gesturing during this period suggested that the instruction to calm infants resulted in the occurrence of more proximal contact in the dyad. However, infants did not appear to respond favorably to such stimulation, as reflected in their behavioral indices of disengagement (i.e., gazing away, limited smiling). As in the first control comparison, this result may reflect noncontingency or redundancy in maternal stimulation. Nevertheless, the low durations of fretting that occurred suggests that infants may have successfully used gazing away as a strategy to regulate their arousal and prevent even greater behavioral disorganization.

Objective 1b of the present investigation was to directly compare these mother and infant nonverbal behaviors during uni-modal versus multi-modal interactions. As might be expected, direct comparison of the Experimental groups revealed more touching by mothers in the Tactile group overall, thus replicating previous work (Arnold et al., 1996). Nevertheless, mothers in the All Modes Experimental group were found to frequently employ touch as a component of their interactions (i.e., over 68% of the time), a finding that is consistent with prior studies incorporating maternal tactile stimulation (e.g., Field, 1984; Kaye & Fogel, 1980; Stack & Muir, 1990, 1992; Symons & Moran, 1987; Weinberg, 1994, as cited in Tronick, 1995)

Mothers in the Tactile group also gestured more toward their infants during the EX period, suggesting that the use of only their hands motivated them to use more visual interactive hand movements to engender excitement and happiness in their infants. Notably, however, the absence of group differences in the AF period suggests that, despite the availability of face and voice, mothers in the All Modes group employed gestures as an attention-getting strategy, and did so to an equal extent as mothers in the Tactile group. This result is particularly salient, as it reflects a role for gesturing considerably greater than was once believed. The importance of gesture in nonhearing dyads and older infants in the context of language acquisition has previously been reported (Schnur & Shatz, 1984; Shatz, 1982; Shatz & Graves, 1976, as cited in Schnur & Shatz, 1984; Spencer, 1993). However, these results extend the influence of gestures to hearing mother-infant dyads during the preverbal period of infancy, well before the onset of linguistic communication. Thus, it appears that gestures form part of the natural interactive repertoire of the mother-infant dyad even within the first year of life, and that infants respond to these overtures with increased gazing. Furthermore, the finding of equal amounts of gesturing by mothers in both Experimental groups specifically in the AF period supports prior assertions that visual interactive hand gestures serve an important, and possibly undervalued, communicative function (e.g., Koester, 1995), and that one of their primary roles is that of eliciting, maintaining, and directing infant attention (Mcnamara, 1977; Murphy & Messer, 1977; Schnur & Shatz, 1984; Shatz, 1982; Shatz & Graves, 1976, as cited in Schnur & Shatz, 1984; Spencer, 1993).

Results revealed that the order of presentation of the periods also distinguished the groups. Specifically, when receiving the AF as the first perturbation followed by the RL and EX periods, mothers in the Tactile Experimental group gestured more than those in the All Modes group overall. Combined with the prior result indicating more gesturing in the AF period by mothers in the Tactile Experimental group, this finding suggests that when mothers began with an interaction in which they gestured toward their infants, they appeared to carry this strategy into their subsequent interactions.

Infants in the All Modes group looked more at their mothers' faces than infants in the Tactile group during all but the N period. The absence of differences in the N period indicated that infants responded similarly at the outset of the study, suggesting that the differences in gazing were experimentally driven and not due to unexplained variation in the groups' responding. Notably, the gazing results from the AF period suggest that gesturing was successful in attracting infants' attention to their mothers' faces, a finding that has been demonstrated elsewhere (Stack & Arnold, 1998; Symons & Moran, 1987). However, not surprisingly, it was not as successful in doing so when used in isolation as when it was combined with facial/vocal expression. Lastly, the absence of group differences in gazing away suggests that infants did not visually disengage more as a result of participating in an interaction involving only touch. Rather, it appears that they simply directed their attention to the most stimulating source of the mother's behavior, namely her hands. This finding replicates previous results of touch-only interactions (e.g., Stack & Arnold; 1998; Stack & LePage, 1996; Stack & Muir, 1990, 1992) and suggests that touch alone is capable of maintaining infants' visual regard, at least during brief periods of interaction.

Analysis of cross-period differences indicated that across both the Tactile and All Modes Experimental groups, the most touching and least gesturing occurred during the RL relative to the other periods. The most gazing at mothers' faces occurred during the N period, with significantly greater looking during this period than during any of the perturbation periods. In contrast, the least looking at mothers' hands was found in the N period. Moreover, the period with the greatest touching (i.e., RL) was actually accompanied by the least gazing at mothers' faces and most gazing at the hands.

The second objective of Study 1 was to assess for possible differences in the qualities of maternal touch employed with infants. Contrary to expectation, the results of the Tactile comparison indicated that mothers in the Experimental group did not tickle their infants more than Controls. Instead, they were found to spend more time stroking and less time lifting their infants' limbs than Controls. One possible explanation for this finding is that the stroking may have been delivered with greater intensity and speed in this period. However, as these measures were not formally coded, this suggestion is merely speculative and will require further investigation. Supporting the hypotheses, the RL period was characterized by more bodily contact, in particular stroking of the face, reinforcing the suggestion that the instruction to mothers to soothe their infants motivated an increase in their proximal contact (Kopp, 1989). Interestingly, when mothers in Stack and LePage's (1996) study were instructed to touch their infants on only one area of the body, they also were reported to show more stroking of the face, possibly suggesting an association between the type of touch employed and area of the infants' bodies to which it was delivered. Mothers also engaged in less lifting suggesting that this instruction may have motivated a reduction in more active forms of kinesthetic stimulation. In the AF period, mothers tickled more and directed their stimulation more to the trunk than Controls.

Comparison of the All Modes groups revealed no differences in the time spent in the different forms of touch in either the N or EX periods. The absence of differences in the EX period was particularly interesting and implied that mothers may have used other means than touch to excite their infants (e.g., facial expressions, vocal noises). However, as these components of maternal behavior remain to be investigated, no firm conclusions can be reached at this time. The findings of the RL period were particularly salient and indicated that mothers in the Experimental group increased their tactile contact, particularly stroking, and decreased their uses of more active forms of touch (e.g., shaking and lifting).

The final comparison between the Tactile and All Modes Experimental groups revealed more tickling by mothers in the Tactile Experimental group during the N period. Although the magnitude of the effect was small (i.e., 4%), the reason for the difference is unclear as both groups received the identical instruction to play normally with their infants. Conforming to expectations, mothers in the Tactile Experimental group used less static touch and spent more time tickling their infants than those in the All Modes Experimental group during the EX period. In addition, they stroked their infants more, and delivered their touching to their infants' feet and faces more than those in the All Modes Experimental group during this period. Also supporting the hypotheses, mothers in the Tactile group engaged in more bodily contact, particularly stroking of the face during the RL period. Notably, however, mothers in the All Modes Experimental group spent a considerable amount of time stroking their infants (i.e., 26% of the period) suggesting that such contact continues to contribute to the interaction despite the addition of other modalities. The results of the AF period revealed more stroking and tickling by mothers in the Tactile group. Perhaps mothers used more tickling to attract their infants attention but, once attentive, shifted to stroking in an effort to maintain their infants' gaze.

When interpreted in light of all the findings, investigation into the qualitative aspects of maternal touching revealed different patterns of touching as a function of the communicative context (i.e., uni-modal vs. multi-modal). Mothers in the uni-modal condition engaged in more bodily contact with their infants, and engaged in more stroking during all three interaction periods. Compared to mothers in the All Modes Experimental group, those in the Tactile Experimental group used more active forms of touch (e.g., ticking) to excite their infants. They also focused their touch on different areas of their infants' bodies, appearing to concentrate more on their infants' feet and particularly their faces than mothers who had all available modes of communication at their disposal.

The third objective of the investigation was to examine possible developmental changes in mothers' uses of tactile-gestural stimulation, and infants' responses to such. Supporting the hypothesis of greater uses of proximal stimulation with younger infants, mothers in the Tactile Experimental group touched their 3½-month-olds more than they did their 5½-month-olds. This result, combined with the lack of significant age-related findings in the Tactile Control group suggests that, when asked to accomplish specific goals using only touch, mothers increased their use of this modality and, more specifically, they increased its use to a greater extent in their attempts to influence the behavior of younger infants.

Supporting the increasing importance of distal forms of communication with age (Gusella et al., 1988; Kopp, 1989), differences in maternal gesturing were evidenced between the age groups, with mothers gesturing more toward 5½- compared to 3½-month-olds. However, the absence of differences between the ages during the AF period suggests that, when specifically attempting to elicit their infants' attention, even mothers of younger infants employed gestures as an attention-getting strategy, and they employed them to an equal extent as mothers of slightly older infants.

At first glance, this finding appears to contradict the findings of a previous study (Shatz & Graves, 1976) in which it was found that mothers gestured more toward younger than older hearing infants. However, the youngest infants sampled were 1 year and 7 months of age, considerably older than the infants sampled in the present study. Taken together, the results of the two investigations combine to suggest that maternal gesturing may follow an inverse curvilinear developmental pattern, increasing during early infancy with the transition from more proximal to more distal forms of communication and subsequently declining toward the end of the second year of life, presumably at an age when language assumes a more primary communicative role. If supported, such a transition would strengthen the assertion that different behaviors may be used to achieve similar outcomes (Brazelton et al., 1974; Weinberg & Tronick, 1994).

The types of touch and areas of infants' bodies to which mothers delivered their tactile stimulation were also found to differ with age. More specifically, mothers of 3½-month-olds shook their infants limbs more and lifted them less than mothers of 5½-

month-olds. They also touched their infants' feet and shoulders less and their hands and faces more than mothers of 5½-month-olds.

Interestingly, age-related changes in mothers' uses of touch and gesture in the Tactile groups did not translate into observable age differences in the durations of infants' gaze, either toward the mother's face or her hands. In contrast, supporting the hypothesis that infants' increased proficiency at alternating the focus of their gaze would result in more gazing away with age, 5½-month-olds gazed away from their mothers more than did 3½-month-olds overall. However, this result must be interpreted in the light of another finding that revealed clear age-related differences in gazing away as a function of the period of interaction. Specifically, 3½-month-olds in the Tactile Experimental group gazed away from their mothers more during the EX period, whereas 5½-month-olds in this group gazed away more during the N and RL periods. Within the Tactile Control group, increased gazing away by 5½-month-olds was found only during the N period. Taken together, the greater durations of gazing away by 5½-month-olds in the N period for infants in both groups suggests that infants became more likely to look away from their mothers with age. Furthermore, the disparate age results as a function of perturbation period suggests that 3½- and 5½-months-olds were differentially impacted by contextual influences introduced into the social interactive environment. That is, younger and older infants responded differently as a function of type of interaction in which they were involved, suggesting possible developmental changes in infants' arousal regulation capacities even over a brief two-month period of time.

With respect to infant affect, in keeping with the developmental literature suggesting that older infants smile more and are more proficient in their interactive capabilities than younger infants (e.g., Kaye & Fogel, 1980; Messinger et al., 1999), comparison of the Tactile groups revealed greater smiling by 5½-month-olds compared to 3½-month-olds in general, and particularly during the EX period, a period that was designed specifically to engender excitement and happiness in the infant.

Examination of the All Modes groups revealed no age differences in the duration of maternal touching. However, as with the Tactile comparison, mothers touched the their infants' faces more at 3½ than at 5½ months. Also mirroring the results of the Tactile comparison, mothers of 5½-month-olds gestured more toward their infants than those of 3½-month-olds. This result suggests that even in the presence of other salient modalities of communication, mothers of older infants employed gestures as a means of influence, possibly in their attempts to gain their infants' attention. Perhaps corresponding to this increase in visual interactive hand gestures, 5½-month-olds gazed more at their mothers' hands overall than did 3½-month-olds, and this difference was most pronounced in the N period. In contrast, younger infants looked more at their mothers' faces than older ones during the N period. However, the reason for this age difference in the N period is unclear, as no difference between the age groups was found in the Tactile comparison, despite the fact that infants of both ages in the Tactile groups received the same instruction for the N period. Older infants also gazed away more than younger ones during the RL period, possibly indicating that the redundancy or understimulation present in this period impacted older infants to a greater extent.

Although speculative, a finding of greater reactivity to noncontingent stimulation in older infants would not be surprising, as their longer interactive histories of appropriate and contingent stimulation might render them more sensitive to noncontingent alterations in their mothers' typical patterns of responding (Tronick, 1989).

Taken together, these findings suggest that mothers' visual interactive stimulation during these periods was enticing and contributed to older infants' greater attentiveness to the source of the stimulation, namely mothers' hands. In addition, the age difference implies developmental changes in the temporal organization of mother-infant behavior, with infants' gazing becoming more closely associated with mothers' stimulation with age. Evidence for age-related changes in the organization of mother-infant behavior have been reported in several other investigations (e.g., Kaye & Fogel, 1980; Messer & Vietze, 1984; Messinger, 1994).

Confirming the results of the within modality control comparisons, comparison of the two Experimental groups revealed greater touching by mothers of 3½-month-olds. They also revealed greater gesturing by mothers of 5½-month-olds, with differences being most pronounced in the EX and AF periods. The results for the infant nonverbal behaviors indicated that 3½-month-olds gazed more at their mothers' faces than 5½-month-olds during the N period. The fact that this gaze direction occurred during the naturalistic interaction preceding the perturbation periods suggests that younger infants may naturally look more at their mothers' faces. However, it is unclear, then, why such a finding was not revealed in the Tactile comparison, as these infants participated in an identical interaction during the first N period. This was the only age difference in responding by infants in the Experimental groups.

Taken together, the results of the present investigation revealed clear age-related changes in mothers' uses of tactile-gestural stimulation, and infants' nonverbal behavioral indices of engagement and disengagement to these forms of behavior. That such changes were evidenced even over the course of a brief two-month period suggests rapid development in infants' arousal modulation capacities, as well as their responsiveness to tactile-gestural stimulation. However, although examination of the various individual indices of nonverbal behavior were strongly suggestive of an association between mother and infant responding, it was not possible to conclude from these analyses whether mothers' and infants' behaviors were truly associated with one another. For instance, although infants may have gazed more at their mothers' hands in periods where mothers gestured more, their gaze at the hands may have occurred at points when the mothers' hands were not, in fact, gesturing. Thus, the explanatory power of duration measures is somewhat limiting.

In response to this limitation, the fourth objective of the present research was to assess for possible associations between infant signals of engagement/disengagement, as well as between maternal tactile-gestural stimulation and such infant signals. In an attempt to concisely discuss the results of these analyses, the findings will be divided according to the individual interaction periods.

During the N period, co-occurrence analyses revealed different patterns of infant gaze in conjunction with mothers' touching for infants of different ages. Only 5½-

month-olds in all groups looked at their mothers' faces while being touched more than chance would predict, a finding that is not surprising given the hypothesized greater influence of maternal facial and vocal stimulation with age (Gusella et al., 1988). In contrast, mothers' touching was likely to co-occur with gazing at hands in 3½-month-olds in all groups, possibly confirming the greater importance of tactile-kinesthetic stimulation to younger infants (Gusella et al., 1988; Kopp, 1989). Regardless of the direction of their gaze toward the mother, results revealed that infants of all ages and in all groups were likely not to look away from their mothers when touched. With respect to their affective expression, older infants were likely to smile when touched, supporting the notion that infants become more socially directed with age, and that the expression and organization of their smiling appears to become more co-ordinated with their mothers' stimulation (Kaye & Fogel, 1980; Messinger, 1994).

During the EX period, both younger infants in all groups and older infants in the Tactile Experimental group were likely to gaze at their mothers' hands when touched. Notably, that 3½-month-olds were likely to look at their mothers' hands even in contexts in which their mothers were facially expressive and vocalizing, again suggests that tactile stimulation is salient to infants in general, but that it may hold particular significance in directing and maintaining the attention of younger infants (Gusella et al., 1988). The differing responses of 5½-month-olds as a function of the context of the interaction (i.e., uni-modal vs. multi-modal) suggests that older infants' attention may be directed more by maternal face and voice. However, in the absence of these modalities, touch and gesture become increasingly important in directing infants' visual attention, with infants attending to the most stimulating aspect of maternal behavior, namely the hands. Results also indicated that infants of both ages and in both Experimental groups smiled while being touched by their mothers more than chance would have predicted during the EX period, suggesting that this represented a pleasurable interaction for infants. This finding is particularly salient for infants in the Tactile groups, as their mothers used only touch to accomplish this goal.

Older infants in the Tactile Experimental group were prone to look at their mothers' hands and to not look at their mothers' faces. Moreover, for infants of both ages in the Tactile Experimental group, mothers' gesturing was positively associated with infants' gazing away. However, as the co-occurrence results do not permit an assessment of the causal direction of the association, it remains unclear whether infants gazed away as a result of their mothers' gesturing, or whether mothers used gestures in an attempt to recapture their already visually-disengaged infants.

The finding that 3½-, but not 5½-month-olds, in both of the Experimental groups showed an association between smiling and gazing away, and that this gazing away was likely to co-occur with their mothers' touching in a manner designed to get them excited, is not surprising. Research has suggested that younger infants are less able than older ones to tolerate even positively-charged emotional arousal during interactions with their caregivers, and respond by averting their gaze in an attempt to regulate themselves (Fogel, 1982). Consequently, the gaze aversion exhibited by 3½-month-olds in this study may have reflected their need for brief periods of reprieve in response to the arousal generated by their mothers' stimulation. In contrast, reflecting their increased ability to tolerate such arousal, infants at 5½ months of age were not more likely to gaze away from their mothers when touched. In addition, both 3½- and 5½-month-olds in the Experimental groups were likely to smile when gestured toward, suggesting that gestures may be associated with affect indicative of pleasurable engagement.

During the RL period, infants of both ages and groups were actually inclined not to look at their mothers' faces when touched. Instead, there appeared to be age-related differences in infants' responses, with younger infants in both Experimental groups being prone to gaze away, and older infants in these same groups alternating between gazing away and gazing at mothers' hands. The finding that 3½-month-olds in the Control groups also looked more at the hands again suggests that younger infants may be more drawn to this form of stimulation (Gusella et al., 1998; Kopp, 1989).

Infants of all ages and groups were also likely not to smile when touched in the RL period. Co-occurrences between the infant behaviors also indicated that they were likely not to smile when they gazed away from their mothers, suggesting that they did not perceive the interaction to be pleasurably engaging. However, results indicated that when infants did smile, it was likely to be in the direction of their mothers' faces.

Results of the uni-modal and cross-modal comparisons revealed more gazing at mothers' faces during the AF period, reinforcing the success of this instruction. However, important questions not addressed by this finding included whether the infant's looking at the face was actually related to maternal stimulation, and how infants reacted to the contradiction posed by this instruction, namely maternal tactile engagement and concomitant facial disengagement. In response, co-occurrence analyses indicated that gazing at the face overlapped with periods of maternal touching and gesturing to a greater extent than expected by chance for infants of both ages in the Experimental group. In other words, looking at the face was positively associated with maternal stimulation. Touch and gesture were also found to positively co-occur with gazing at mothers' hands, but only in younger infants. Gestures were also positively related to infant gazing away at both ages, possibly suggesting that mothers used this strategy to re-attract the visual attention of their disengaged youngsters.

Notably, infants in the Tactile Experimental group were inclined not to smile when touched during the AF period, possibly suggesting that they had difficulty processing the stimulation thus requiring added concentration, or that they did not derive pleasure from this contact. In addition, 5½-month-olds in the Tactile Experimental group were prone not to smile when gestured toward, suggesting that gestures were able to attract the infants' attention but not to engender positive engagement during this period. The limited smiling in response to both touch and gesture at 5½ months may be related to the greater influence of facial expression with age. More specifically, co-occurrence results in the N period indicated that 5½-month-old infants were significantly likely to smile when touched, whereas younger infants showed only chance-level association of these measures. Thus, in older infants, smiling and looking at the mother's face appeared to be naturally socially connected, lending additional support to the assertions of other researchers (e.g., Fogel & Thelen, 1987; van Wulfften Palthe & Hopkins, 1984; Weinberg & Tronick, 1996). Consequently, when mothers made overtures to attract their infants' attention in the AF period, infants likely expected a facially responsive mother to greet their attention. Mothers' lack of smiling may have violated infants' expectations of their typical interactions with their mothers, leading to similar responses as in the traditional SF procedure (i.e., gaze aversion and decreased smiling), suggesting that this episode was negatively arousing (Lamb et al., 1987; Mayes & Carter, 1990; Stoller & Field, 1982; Toda & Fogel, 1993; Tronick et al., 1978). This interpretation receives support from the results of the two other perturbation periods in which no, or negative, associations between touching and gazing at their mothers' faces were found for infants in the Tactile groups.

Taken together, these results suggest that when mothers use only touch, infants do not readily engage in gazing at their faces but, rather, look more at their hands. When specifically encouraged, infants will gaze at their mothers' faces, but appear to derive little pleasure from doing so, and the arousal generated by the facially unresponsive mother motivates them to visually disengage. Again, however, the positive co-occurrence between smiling and gazing at face indicated that when infants did smile, they were inclined to do so while looking at their mothers' faces.

Two cross-period comparisons are particularly revealing in terms of disparate patterns of behavioral configurations. The first pertains to the comparison of gazing away and maternal touch in the EX and RL periods. In both periods, increased gazing away was evidenced in conjunction with mothers' touching. However, when we examine the co-occurrence between smiling and touch, we find that the reason for the gazing away may have been very different in the two periods. In the EX period, infants smiled when touched and smiled when gazing away, suggesting the presence of positive arousal. In contrast, examination of the RL period revealed that infants were not likely to smile when touched or when gazing away, suggesting negative arousal. The brevity of the period may have contributed to the low amounts of fretting observed.

The next comparison of interest involves maternal gesturing and infants' gaze and affect in the EX and AF periods. In both periods, infants were likely to gaze away when gestured toward. However, the smiling results indicated that infants were likely to smile when doing so during the EX period, possibly reflecting positive arousal or excitement. In contrast, infants in the AF period either remained neutral or tended not to smile when doing so, possibly reflecting negative arousal or wariness. Taken together, the results of these two cross-period comparisons highlight the considerable utility of examining associations between nonverbal expressive behaviors. Furthermore, they provide additional support for the assertion that behavioral configurations characterize mother-infant social interactions (e.g., Weinberg & Tronick, 1994), that they provide additional information not available through the study of individual indices of infant and mother behavior (Symons & Moran, 1988), and that these configurations are sensitive to the context of the interaction (Weinberg & Tronick, 1994).

In summary, the results of Study 1 revealed differences in the durations of maternal tactile-gestural stimulation, and qualitative aspects of maternal touching, that were associated with variations in the interactive context. Reflecting the flexibility of the tactile-gestural modality, touch and gesture were found to differ as a function of the instructions to mothers requesting them to alter their infants' arousal, the context within which these instructions were attempted (i.e., uni-modal vs. multi-modal), and infant age.

Moreover, infants displayed their remarkable sensitivity to modifications of their mothers' nonverbal signals with shifts in their gaze and affect, reflecting their engagement/disengagement and possible changes in their arousal states. The discovery of associations between various infant behaviors suggested the existence of more complex behavioral configurations that provided an additional level of information not available through the individual indices of infant responsiveness. Furthermore, the finding of additional associations between maternal touch and gesture and infant gaze and affect served to highlight the mutual influence and bi-directionality inherent in the mother-infant dyad.

CHAPTER 3: Study 2

In Study 1, healthy full-term infants' behavioral responses to maternal tactile-gestural stimulation were examined during experimentally contrived interactions in which maternal touch and gesture were manipulated by directly instructing mothers to alter their infants' behavior/states. Study 2 was designed to complement and extend the findings of Study 1 by comparing mothers' uses of touch and gesture in full-term infants and a high-risk sample of VLBW-PT infants. The study of VLBW-PT infants provided a unique opportunity for the study of the tactile-gestural modality due to the possibility of naturally existing differences in mothers' uses of, and VBLW-PT infants' reactions to, such stimulation. Given that such differences may be one factor contributing to these dyads' reported interaction difficulties, it was considered important to assess for differences in mothers' uses of touch and gesture and infants' behavioral indices of engagement and disengagement to such forms of stimulation.

It has been suggested that diminished CNS integrity resulting from compromised nervous system development at birth may impact premature infants' abilities to properly process sensory stimulation, thereby contributing to distortions in their perceptions of stimuli, including touch (DeMaio-Feldman, 1994). Studies of VLBW-PT infants prior to term age have highlighted their reactivity (i.e., more exaggerated behavioral responses) to such simple forms of stimulation as being talked to with infant-directed talk, having their arms lightly held or stroked, or the combination of being talked to and touched when in an awake state (Eckerman, Oehler, Medvin, & Hannan, 1994; Eckerman, Oehler, Hannan, & Molitor, 1995). Such stimulation processing difficulties are of particular concern for VLBW-PT infants whose low birth weight and increased risk for perinatal medical complications places them at even greater risk for compromised CNS functioning than those of pre-term infants whose weights are appropriate for their gestational ages.

Whereas touch is typically a gratifying experience for young full-term infants, VLBW-PT infants' exposure to touch may consist to a large extent of nonhuman medical devices (DeMaio-Feldman, 1994), thereby restricting the number and quality of their interactions with their social environments. For instance, Anderson (1986) reported that pre-term infants in the NICU receive one-third less human caregiving touch per day compared to full-term infants cared for within the home. Consequently, Sammons and Lewis (1985) have described the NICU environment as one of stimulus overload and simultaneous stimulus deprivation.

The role of touch in the care of premature infants has been somewhat controversial. Studies investigating the contributions of massage and tactile stimulation to pre-term infant development have reported beneficial effects, including increased caloric intake and weight gain, increased time spent in awake and active states, and earlier discharge from hospital (Helders, Cats, & Debast, 1989; Phillips & Moses, 1996; Scafidi et al., 1986; Watt, 1990). In a review of 24 studies examining the effects of supplemental stimulation on pre-term infants, Harrison (1985) found evidence supporting the beneficial effect of supplemental tactile stimulation, as well as extra auditory, gustatory, and visual stimulation. In addition to the beneficial effects outlined above, Harrison (1985) found evidence of decreased irritability and more advanced social and neurological development. However, she cautioned that the reviewed studies contained a number of limitations, including small sample sizes and large variations in sample composition.

Despite the reported benefits of tactile stimulation to pre-term infant development, Harrison et al. (1990) reported that within the NICU environment, parents have often been discouraged from touching their infants because of their fragile health status and the increased risk of hypoxia and intra-ventricular hemorrhage that accompany excessive handling (Long, Philip, & Lucey, 1980; Lucey, 1981; Tardy & Volpe, 1982). Such concerns have prompted some facilities to adopt 'minimal handling' policies that limit contact primarily to essential medical procedures and cleaning rituals (Weiss, Wilson, Hertenstein, & Campos, 2000). Thus, medical concerns have often superceded parent-infant social contact, despite parents' perceptions that early opportunities for tactile contact facilitates their coping and the development of feelings of closeness toward their infants (Nance, 1982). However, Harrison et al. (1990) reported that pre-term infants' responses to parent touch (as indexed by O_2 saturation and heart rate) were variable and concluded that minimal handling policies that limit contact in the early weeks of life may be inappropriate. Instead, the authors recommended that parents be taught to modify the amounts and types of touch they provide based on the infants' physiologic and behavioral cues. Unfortunately, however, there is a relative paucity of research examining the characteristics of maternal tactile stimulation that are associated with infant engagement and disengagement in pre-term infants. Furthermore, all pre-term infants may not respond similarly to maternal touching. Specifically, VLBW-PT infants whose compromised CNS functioning contributes to difficulties modulating their physiological and behavioral responses and results in ambiguous or exaggerated behavioral cues to caregivers may respond very differently to such stimulation compared to higher birth weight pre-term infants whose physiological functioning is less compromised.

Very low birth weight pre-term infants may be particularly vulnerable to the effects of tactile stimulation because of their experiences involving invasive and painful medical procedures during the hospitalization period. Such infants have limited control over the number and variety of noxious stimuli to which they are exposed (DeMaio-Feldman, 1994), including frequent probing, pricking, and quick handling that are characteristic of the NICU environment (Anderson, 1986; Newman, 1981). Studies have suggested that the experience of pain in infancy may have untold long-term behavioral and physiological consequences, and may increase the potential for touch to be experienced as aversive (Fitzgerald, Millard, & MacIntosh, 1988; Rovee-Collier & Hayne, 1987; Weiss et al., 2000). Repeated exposure to such procedures has been found to distort VLBW-PT infants' somatosensory perception (i.e., sensory input to the brain from the body), with healthy children who were born VLBW-PT continuing to differ from those born full-term on a variety of measures of somatosensory processing at age 7 (DeMaio-Feldman, 1994).

Weiss and colleagues (2000) examined whether the quality of maternal touching (i.e., nurturing versus harsh touch) at 3 months of age was associated with low birth weight (LBW) infants' security of attachment to their mothers at 1 year. Importantly, although the authors labeled their sample of infants LBW, the sample included infants whose birth weights ranged from 570-2,500 g, thereby encompassing both the LBW and VLBW-PT classifications. Results indicated that maternal touch did appear to significantly influence the development of LBW infants' security of attachment to their mothers. However, the degree of infant biological vulnerability appeared to moderate the relationship between the quality of maternal touch and infant attachment. That is, when nurturing touch represented over 75% of mothers' total touching it was associated with more secure attachment, but only for robust LBW infants of larger weight and minimal perinatal risk. In contrast, the results actually showed an opposite effect for highly vulnerable infants (i.e., those with VLBW, minimal responsiveness, and perinatal complications), with extensive nurturing touch being associated with *less* secure attachment. On the basis of these findings, the authors concluded that vulnerable infants (i.e., VLBW-PT infants, those with perinatal complications) may be more susceptible to overstimulation and distress from large amounts of kissing and caressing as a result of their fragile and underdeveloped nervous systems.

Similar findings have been reported by other researchers. For instance, Powell (1974) noted that many of the smallest LBW infants in her study responded to stroking as if it were aversive. Eckerman and colleagues (1994) found that whereas mothers' use of motherese with their VLBW-PT infants during face-to-face interactions prior to term age (i.e., 35 weeks postconceptional age) resulted in increased eye opening and more time in an attentive state, the addition of touch to talking appeared to tax the infants' regulatory capacities and led to changes suggestive of distress, including decreased eye opening and more facial grimacing. Unfortunately, given that the authors did not include a touch-only condition, it is not possible to determine whether behavioral changes exhibited with the onset of tactile stimulation were the result of the touching itself or the combination of talking and touching.

In summary, the aforementioned literature combines to suggest that pre-term and VLBW-PT mother-infant dyads face unique challenges that may negatively impact their social interactive capabilities when compared to full-term infants (Goldberg, 1979; Gorski, 1984). Although it has been suggested that part of the reason for observed differences between these groups and healthy full-term infants may result from differences in maternal behavior (e.g., Bakeman & Brown, 1980; Field, 1977, 1981; Stern & Hildebrandt, 1986), the precise characteristics of this behavior have remained largely unexplored. Furthermore, although research findings appear to indicate that pre-term infants differ from full-term infants in their arousal and signals of engagement and disengagement during social interactions with their mothers, very little research has explored such phenomena in VLBW-PT infants, despite the increased likelihood of difficulties in arousal regulation posed by their very low birth weight and greater neurodevelopmental immaturity.

Results combine to suggest that VLBW-PT infants may experience and react to maternal tactile stimulation differently from higher birth weight pre-term and full-term infants. As touch is frequently employed by mothers during interactions with their young infants, differences in VLBW-PT infants' perceptions of tactile stimuli may place them at increased risk for inconsistent and less satisfying interactions with their caregivers. Although VLBW-PT infants' responses to touch have been investigated, the focus of these investigations has generally been on the consequences of touch to the infant's health and physical well-being (e.g., Harrison et al., 1990; Scafidi et al., 1986). In contrast, few studies have sought to examine VLBW-PT infants' social responsiveness (e.g., Eckerman et al., 1994; 1995; McGhee & Eckerman, 1983; Minde et al., 1983; Oehler, Eckerman, & Wilson, 1988) despite the fact that these infants are likely to be the most different, and potentially problematic, social partners (Eckerman & Oehler, 1992). Furthermore, the two studies in which tactile stimulation has been examined (i.e., Eckerman et al., 1994, 1995) involved neonates prior to term age in the NICU environment. Consequently, we continue to know little about VLBW-PT infants' signals of engagement and disengagement in response to tactile stimulation later in infancy and in contexts other than the NICU.

Thus, Study 2 was designed to explore how mothers use touch and gesture with VLBW-PT and normal birth weight, full-term (NBW-FT) infants, and infants' gaze and affect during social interactions. Several motivations prompted this study, one of which was the contradictory findings of studies that have alternately found that mothers touch their infants more (e.g., Als & Brazelton, 1981; Crnic, Ragozin et al., 1983) and less (e.g., DiVitto & Goldberg, 1979; Stern & Hildebrandt, 1986) than those of full-terms. In addition, as studies have suggested that VBLW-PT infants may process tactile stimulation differently than full-term infants, it was of particular interest to assess for possible differences in VLBW-PT and NBW-FT infants' responses to such stimulation.

Mothers and their VLBW-PT and NBW-FT infants participated in a traditional still-face (SF) interaction. Specifically, mothers were instructed in the first and third interaction periods to interact normally with their infants, whereas in the second (SF) period, they were requested to remain still-faced (i.e., facially neutral and unresponsive), silent, and to refrain from touching their infants. In so doing, it was possible to examine infant arousal in the context of a brief period of maternal unavailability.

The present study extends the existing knowledge base in at least four distinct ways. First, although mothers have been found to over- and under-stimulate pre-term infants, the specific characteristics of their stimulation remain largely unclear. Consequently, the present study sought to delineate possible differences in durations of maternal tactile-gestural stimulation, as well as two important qualitative aspects of maternal touch that might be responsible for the observed differences in infant behavior, namely type and area of touch.

Whereas Study 1 examined mothers' and infants' nonverbal communicative signals during interaction sequences that were themselves designed to be arousing, Study 2 complemented this procedure by examining nonverbal behaviors during two naturalistic interactions occurring prior, and subsequent to, a brief period of maternal unavailability achieved through use of the SF procedure. In so doing, it permitted observation of mothers' and infants' nonverbal communicative signals during a normal interaction sequence with those occurring subsequent to a brief period of arousal. Thus, whereas in Study 1 maternal touch and gesture were manipulated in attempts to modify infant arousal, observation of these behaviors following the SF in Study 2 permitted an evaluation of the way in which these behaviors were naturally employed to cope with arousal.

Second, much of the existing literature continues to pertain to pre-term infants, with considerably less research being devoted to VLBW-PT infants. Research efforts devoted to this population have generally focused on VLBW-PT infants' physiological, biological, and cognitive outcomes with considerably less attention being aimed at delineating their social capabilities. The increasing survival rate of such infants underscores the need for research specifically devoted to the unique challenges facing the VLBW-PT population. More specifically, as arousal modulation difficulties have been found to characterize infants born prematurely, it was of great interest to determine whether the VLBW-PT population is susceptible to similar, or even more severe challenges precipitated by their premature birth and concomitant very low birth weight.

Third, infant arousal has been studied in a handful of studies involving VLBW-PT infants (e.g., Eckerman et al., 1994, 1995; Eckerman, Hsu, Molitor, Leung, & Goldstein, 1999). However, to the author's knowledge, this study represents the first use of the SF procedure with VLBW-PT infants, a finding that is surprising given that it has been an important method of assessing infants' arousal and regulatory responses. Given that this is the first study of its kind, it was considered important to study infant arousal using a well-established method of investigation. Consequently, the SF procedure was adopted as it has been used extensively to evaluate young infants' communicative abilities, responsivity to manipulations of maternal behavior, and capacity to regulate their affective states (e.g., Kogan & Carter, 1996; Lamb et al., 1987; Mayes & Carter, 1990; Tronick et al., 1978). It was deemed more appropriate to employ the traditional SF procedure as opposed to the modified SF procedure employed in Study 1, as it allowed for a baseline measurement of infant arousal not possible to evaluate when touch is incorporated. Furthermore, it permitted comparisons with prior SF studies involving pre-term infants.

Fourth, this study is unique in its evaluation of VLBW-PT infant-mother social interactions within the home setting. The participants' homes were selected as they were believed to represent a more ecologically valid context of investigation, given that young infants spend the preponderance of their time in this setting. The majority of previous SF studies involving pre-term infants have been conducted in the laboratory. However, the laboratory setting was postulated to pose additional challenges to infant arousal.

Generally speaking, it was anticipated that lower positive arousal, more negative arousal, and distinct patterns of behavioral organization would characterize the interactions of VLBW-PT as compared to NBW-FT infants. More precisely, it was hypothesized that VLBW-PT infants would smile less than NBW-FT infants, reflecting their diminished expression of positive arousal. In addition, VLBW-PT infants were expected to gaze less at their mothers' faces, to gaze away more, and to fret more than NBW-FT infants, reflecting their increased expression of negative arousal. With respect to Type and Area of touch, given the contradictory findings with respect to the literature on maternal stimulation, specific predictions for these variables were not made.

Method

Participants

Subsequent to ethics approval and in collaboration with the chief Neonatologist, VLBW-PT infants were pre-screened for medical status variables by the nurse in charge of the follow-up clinic of a major community teaching hospital (Montreal, Quebec) during their 3-4 month clinic visit. Caregivers of VLBW-PT infants who met inclusion criteria were provided with a letter outlining the general description of the study and, if interested, were contacted by telephone by the principal experimenter who sought their voluntary participation.

Inclusion of infants in the VLBW-PT sample was dependent upon them weighing between 800-1500 g at the time of birth and having gestational ages ranging from 26 to 32 weeks. Additional selection criteria limited the study population to healthy infants who were living with their biological mothers and who did not fit any of the following exclusionary criteria: infants who suffered from a Grade IV intra-ventricular hemorrage or other major medical complications, illnesses, or syndromes (e.g., hydrocephalus, severe neurological impairment, hearing loss, retinopathy); infants who had been diagnosed with a congenital abnormality; infants who had experienced prolonged and/or repeated hospitalizations since the neonatal period; infants of diabetic or teenage mothers (< 18 years); and mothers at psychosocial risk due to a history of inadequate prenatal care, drug-abuse, mental illness, or rape. These criteria are similar to those employed in past studies of this nature (e.g., Segal et al., 1995).

Normal birth weight full-term infants were recruited from the same hospital as the VLBW-PT infants in an attempt to ensure similarity in socio-economic status (SES) and ethnic backgrounds. Mothers of NBW-FT infants who met the same criteria as reported in Study 1 were contacted and recruited by telephone. Appointments were made to visit the families' homes at times convenient to them when their infants reached 5½ months of age. To correct for prematurity in the VLBW-PT group, corrected age (i.e., postnatal age less the number of weeks the infant was premature) was employed.

The VLBW-PT and NBW-FT dyads were matched on infant sex, maternal age (within 5 years) and maternal education. Both VLBW-PT and NBW-FT infants were selected for inclusion in the sample from among a larger study of mother-infant interactions conducted in our laboratory. Consequently, there was no attrition in sample size. Table 4 presents the key medical and demographic characteristics of the VLBW-PT and NBW-FT birth status groups. Additional demographic characteristics pertaining to ethnicity and parental occupation are located in Appendix S. The sample consisted of 30 infants (15 VLBW-PT, 15 NBW-FT), with the majority of participating families being White, two-parent, intact, and middle-class.

Apparatus

All infants were seated in an infant seat (Century Rock-A-Kanga-Roo) rather than the infant's typical infant seat which may have had toys or other distracting objects attached. Mothers were seated on a chair or pillow facing their infants. A view of the infant's face and body and the mother's hands was obtained using a Video Camera (Sony Handycam) which was mounted on a tripod and located behind and to the left of the

Table 4

Medical and Demographic Characteristics of the NBW-FT and VLBW-PT Groups

Characteristics	Birth Status: NBW-FT (n = 15)	Birth Status: VLBW-PT (n = 15)	df	t
Medical Characteristics				
Mean birth weight (g)	3318.80 (360.35)	1016.47 (217.74)	28	-22.74***
Mean gestational age (weeks)	39.47 (1.19)	28.20 (2.46)	28	-16.00*
Days in hospital	3.37 (3.43)	77.93 (38.90)	28	7.40***
Demographic Characteristics				
Mother				
Mean maternal age (years)	30.20 (3.99)	31.33 (5.21)	28	0.67
Mean maternal education (years)	14.27 (2.34)	13.80 (1.90)	28	-0.60
Infant				
Postnatal age at 5½-month interaction (days)	162.73 (8.11)	170.27 (16.38)	28	1.60
% male	47	47		

Note. Medical and demographic characteristics, except percentage of participating males and females, were contrasted for the NBW-Ft and VLBW-PT groups. Values enclosed in parentheses denote standard deviations.

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

mother. A mirror identical to that described in Study 1 was placed behind and to the right of the infant to capture the mother's facial expressions. A stopclock was used to calculate the period start and stop times.

Experimental Instructions and Design

The session consisted of three interaction periods lasting 2 minutes each, and separated by 20-second inter-period intervals. The first (greeting; N1) and third (reunion; N2) periods were Normal interactions wherein mothers were instructed to play with their infants as they normally would at home. In the second period, mothers were requested to remain silent and neutral in facial expression while maintaining eye contact with their infants, and to refrain from touching, or smiling at, their infants (SF period).

The design of the study is illustrated in Table 5 and reflects a 2 (Sex) x 2 (Birth Status) x 3 (Period) mixed design with two between factors of Sex (Male, Female), and Group (VLBW-PT, NBW-FT), and one within factor of Period (N1, SF, N2).

Experimental Procedure

Upon arrival at the home, two experimenters greeted the mother and her infant. The primary experimenter (E1) then reviewed the purpose and procedural details of the study and asked the mother to read and sign an informed consent form in her preferred language of English or French (see Appendix T). At the same time, the second experimenter (E2) assessed the most suitable location in the home in which to conduct the face-to-face interaction and position the equipment.

Several criteria were used to determine the most appropriate location in which to conduct the face-to-face interaction. These criteria included: (a) freedom from

Table 5

Design Table for Study 2 (N = 30)

Group	Period		
NBW-FT (n = 15) males (7) females (8)	N1	SF	N2
VLBW-PT (n = 15) males (7) females (8)	N1	SF	N2

N1 = First Normal interaction period
SF = Still-Face interaction period
N2 = Second Normal interaction period

distractions, (b) a flat surface large and stable enough for the placement of an infant seat (e.g., a kitchen table), and (c) adequate lighting. Once these requirements were met and the mother determined that her infant was ready to begin, the mother was asked to secure her infant in the infant seat that was firmly and securely placed on the flat surface. The mother was then asked to seat herself on either a chair or pillow (depending on the height of the table selected) facing her infant at eye level at a distance of approximately 70 cm.

E1 provided the mother with instructions for the first period, during which all mothers were asked to interact normally with their infants, following which E2 started the videocamera. Both experimenters left the room so as not to distract the dyad during their interaction. Following from the original SF procedure outlined by Tronick et al. (1978), E1 signaled the start of the period to the mother by a knock on the wall and simultaneously set the time clock for 2 minutes, following which time she again knocked on the wall to signal the end of the period. E1 then re-entered the room for a 20-second period during which time the instructions for the following period were provided to the mother. The same procedure was repeated for all remaining periods. As the experimenters were not able to directly monitor the mother's face to ensure that she maintained a still, neutral facial expression during the SF period, the mirror image of the mother's facial expression from each dyad's video record was viewed as a reliability check. Any mother who was facially expressive, vocalized, or made dramatic posture shifts during the SF period was excluded from the final sample. As infants were selected from among a larger sample of mothers and infants who successfully completed the procedure, no dyads were excluded from the present sample.

Consistent with Study 1, if, at any time during the session, the infant became distressed or cried for a sustained period of 20 seconds (n = 3), or if the mother wished to terminate a period (n = 0), the session was interrupted. The infant was then removed from the seat and given an opportunity to rest, feed or be changed. Once the mother considered her infant to be ready to continue the session, testing resumed and all interaction periods were repeated. Following completion of the testing session, the mother was asked standardized questions regarding her infant's medical history and general demographic information (Appendix U).

Behavioral Measures and Coding

The same dependent measures as in Study 1 were coded, namely (1) maternal touch, (2) maternal gestures, (3) infant gaze at the mother's face, (4) infant gaze at the mother's hands, (5) infant gaze away, (6) infant smiling, and (7) infant fretting, as well as the qualitative aspects of the CITS including (1) type of touch and (2) area of the infant's body being touched. However, as mothers were instructed not to touch their infants during the SF period, maternal touch, maternal gestures, the CITS (i.e., type of touch, area of touch), and infant gaze at hands were not coded during this period.

Coders were trained on videotape examples prior to scoring the present data set until such time as they achieved a high degree of reliability ($r > .90$) with experienced coders. Videotapes were subsequently coded blind to each infant-mother dyad's group membership (i.e., VLBW-PT, NBW-FT). A reliability coder who was blind to group membership and the hypotheses of the study conducted a check on 30% of the video records to assess inter-rater reliability. Intraclass reliability coefficients (Shrout & Fleiss,

1979) were conducted and were above $r = .92$ on all the mother and infant duration measures (i.e., maternal touch and gestures, infant gaze at face, hands, and gaze away, and infant smiling). Furthermore, to assess the reliability of onset and offset times (points of transition) for each measure, rather than merely overall duration, Kappa coefficients (Cohen, 1968; Hunter & Koopman, 1990) were also calculated and were above $K = .85$ for all measures. Once coding was completed and reliability assessed, the raw data were reduced to obtain the mean percent durations of each measure as a function of period, which were used for the purposes of statistical analysis. With respect to the CITS, Kappa coefficients conducted on coder agreement/disagreement regarding the type of touch and area of the body coded during each second of the interaction revealed reliability figures of $K = .87$ for type of touch, and $K = 1.00$ for area of the body.

Results

Descriptive analyses were conducted according to the same procedure outlined for Study 1. The results of these analyses revealed that transformations were not indicated on any of the variables. Subsequent split-plot ANOVAs were then conducted on each of the aforementioned dependent variables with Sex (Male, Female), and Birth Status (NBW-FT; VLBW-PT) as the between-subjects variables, and Period (N1, SF, N2) as the within-subjects variable. Where Sex was significant, results are reported. However, in cases where no significant differences involving this variable were found, analyses were re-run collapsed across this variable.

Repeated-Measures Analyses

Maternal Measures

A table comparing the mean percent durations of both the maternal and infant measures between Studies 1 and 2 is provided in Appendix V for descriptive purposes.

Maternal touch. Analyses (Table W1) revealed no significant differences in maternal touch, either as a function of birth status or interaction period.

Maternal gestures. Similarly, no significant differences in maternal gesturing were found (Table W2).

Infant Measures

Infant gaze at face. Analyses (Table X1) revealed a Period main effect, $F(2, 58) = 10.93$, $p < .001$, whereby both VLBW-PT and NBW-FT infants gazed more at their mothers' faces during both the N1 (M = 41.57%) and N2 (M = 38.50%) periods relative to the SF (M = 18.13%) period.

Infant gaze at hands. No differences in gaze at mothers' hands were found (Table X2).

Infant gaze away. Results (Table X3) revealed a Period main effect, $F(1, 29) = 5.61$, $p < .05$, and Tukey comparisons (Table X4) indicated that infants in both groups gazed away from their mothers more during the SF period ($M = 28.66\%$) than during either the N1 ($M = 16.74\%$) or N2 ($M = 18.25\%$) periods.

Infant smiling. With respect to the infant smiling measure (Table Y1), a difference between the birth status groups was identified, $F(1, 28) = 5.07$, $p < .05$, with NBW-FT infants ($M = 29.96\%$) smiling more than their VLBW-PT counterparts ($M = 19.53\%$) overall. Differences in infant smiling were also found as a function of Period, $F(2, 56) = 40.03$, $p < .001$, and Tukey HSD post-hoc (Table Y2) comparisons revealed significantly more smiling during the N1 ($M = 35.53\%$) and N2 ($M = 32.23\%$) periods relative to the SF period ($M = 6.49\%$).

Infant fretting. Similar to Study 1, the infant fretting measure was not analyzed due to the low percentages of fretting for infants in both groups. Nevertheless, the means are reported here for descriptive purposes. Similar percentages of fretting were found between the birth status groups, with VLBW-PT infants fretting for an average of 4.71% and NBW-FT infants fretting for 2.36% of the entire session.

Results Pertaining to Objective 2 - Analysis of the Quality of Maternal Touch

Analysis of the qualitative aspects of maternal touching, including type of touch employed and area of the infant's body touched, were analyzed in the same fashion as for Study 1. A repeated-measures ANOVA with Birth Status (VLBW-PT, NBW-FT) as the between-subjects factor and Type (or Area depending on the analysis in question) and Period (N1, N2) as the repeated-measures factors was conducted on each of the variables of Type of touch and Area of touch. The results of the analysis regarding Type of touch (Table Z1) revealed a significant main effect, $F(4.61, 129.13) = 29.44$, $p < .001$, indicating that mothers differed in their uses of the various forms of touch. Follow-up analyses (Table Z2) indicated that across both groups, mothers engaged in more lifting (M = 27.49%) than any other form of contact, except 'no touch' (Ms = 2.06% for static touch, 9.09% for stroking, 0.89% for patting, 6.81% for squeezing, 7.82% for tickling, 4.87% for shaking, and 3.07% for 'other' forms of touch). Mothers also engaged in less patting (M = 0.89%) and static touch (M = 2.06%) than all other types of contact (Ms = 19.22% for no touch, 2.06% for static touch, 9.09% for stroking, 6.81% for squeezing, 7.82% for shaking, 27.49% for lifting, and 3.07% for 'other' forms of touch). Results also revealed more squeezing (M = 6.81%) than 'other' forms of touch (M = 3.07%) and more stroking (M = 9.09%) than either patting (M = 0.89%) or 'other' (M = 3.07%).

An additional ANOVA conducted on Area of the infant's body being touched (Table Z3) similarly revealed a main effect for Area of touch, and follow-up analyses (Table Z4) indicated that mothers touched their infants trunks (M = 6.42%) and faces (M = 6.01%) more than their shoulders (M = 1.23%). In addition, they touched their hands (M = 33.15%), feet (M = 33.14%) or did not touch their infants' bodies (M = 19.21% for 'no area') more than their shoulders (M = 1.23%), faces (M = 6.01%), or trunks (M = 6.42%).

Results Pertaining to Objective 4 - Co-Occurrence of Nonverbal Behaviors

Wilcoxon signed ranks tests were conducted on pairs of dependent measures using the same procedure as outlined in Study 1. Table 6 illustrates the significant co-occurrences between the infant gaze measures with infant smiling for each of the three periods as a function of birth status.

Infant Nonverbal Behaviors

Smiling and gaze at face. Consistent with the findings of Study 1, infants in both birth status groups evidenced a positive association between smiling and gazing at their mothers' faces in all three interaction periods.

Smiling and gaze at hands. Analyses revealed that smiling and looking at mothers' hands were negatively associated in the N2 period, but only for infants of NBW-FT birth status.

Smiling and gaze away. No significant results were found for the co-occurrence of the infant smiling and gaze away measures.

Infant and Mother Nonverbal Behaviors

The results of the analyses examining co-occurrences between infants' signals of engagement and disengagement with mothers' touching and gesturing are located in Table 7.

Gaze at face and maternal touch. Gazing at mothers' faces was negatively associated with maternal touch for infants of NBW-FT birth status only.

Gaze at hands and maternal touch. No significant co-occurrences involving these two behaviors were found.

Table 6

Co-occurrence Analyses for the Infant Gaze Behaviors and Infant Smiling Behavior as a Function of Birth Status for Study 2: Wilcoxon Matched-Pairs Signed-Ranks Test

	Period		
	N1	SF	N2
Gaze Behaviors		Smiling	
NBW-FT			
Face	14/1**	12/1*	13/2**
Hands	2/9	-	3/10*
Away	4/5	2/13**	5/3
VLBW-PT			
Face	13/1**	7/0*	13/0**
Hands	2/10	-	2/7
Away	6/4	1/11*	6/2

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

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

Table 7

Co-occurrence Analyses for the Infant Gaze and Smiling Behaviors and Maternal Touch and Gesture as a Function of Birth Status for Study 2: Wilcoxon Matched-Pairs Signed-Ranks Test

	Period					
	N1		SF		N2	
	Maternal Behaviors					
Gaze Behaviors	Touch	Gesture	Touch	Gesture	Touch	Gesture
NBW-FT						
Face	2/9*	5/5	-	-	8/4	6/4
Hands	8/6	6/4	-	-	6/3	7/3
Away	2/10*	3/6	-	-	6/5	5/2
Smiling	3/8	7/5	-	-	5/1	3/3
VLBW-PT						
Face	8/3	4/4	-	-	6/4	5/3
Hands	4/8	6/3	-	-	6/4	6/2
Away	3/11*	4/7	-	-	7/3	4/4
Smiling	5/4	6/6	-	-	4/4	3/6

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

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

Gaze away and maternal touch. Results revealed a negative association between gazing away and maternal touch for infants in both birth status groups during the N1 period. However, no such associations were found for the N2 period.

Further analyses revealed no significant co-occurrences between any of the infant measures with maternal hand gestures. Consequently, no further results are reported within the text.

Discussion

The aim of Study 2 was to examine mothers' uses of touch and gesture during interactions with their VLBW-PT and NBW-FT infants, and infants' nonverbal behavioral signals of engagement and disengagement in response to such stimulation. Mothers of VLBW-PT and NBW-FT infants were expected to differ in both the quantity of touch and gestures used with their infants, as well as in the qualitative characteristics of touching employed. In addition, VLBW-PT infants were hypothesized to exhibit lower positive arousal (i.e., less smiling) and more negative arousal (i.e., less gaze at the mother's face and more gazing away and fretting) relative to NBW-FT infants, reflecting their greater difficulties with arousal regulation.

With respect to the duration of maternal behavior, the results of the present study revealed that the degree of touching and gesturing employed by mothers did not differ as a function of infant birth status. That is, mothers provided equal amounts of stimulation to VLBW-PT as they did to NBW-FT infants. The lack of significant findings with respect to maternal touching and gesturing was surprising given the results of past investigations that have yielded inconsistent results, but have generally reported differences in maternal stimulation. Several researchers have found mothers of pre-terms to overstimulate their infants (e.g., Als & Brazelton, 1981; Bakeman & Brown, 1980; Barnard et al., 1984; Field, 1979). More specifically, Field (1981, 1982) reported that mothers of pre-terms overstimulated their infants by increasing their activity level, thereby generating levels of infant arousal that resulted in gaze aversion, fewer smiles and vocalizations, and more sad expressions and crying. Similarly, Als and Brazelton (1981) found that parents of pre-terms talked, touched, and smiled more at their infants than did those of full-terms. Indeed, excessive stimulation combined with some mothers' difficulties adapting their stimulation to their infants' rhythms has been hypothesized by some to be at the root of these dyads' interaction difficulties. In contrast, however, other researchers have found mothers of pre-terms to be less stimulating that those of full-terms. For instance, they have been found to touch their infants less than mothers of full-terms (e.g., DiVitto & Goldberg, 1979; Stern & Hildebrant, 1986).

In their study of healthy full-term infants, Stack and Arnold (1998) also found no differences between an Experimental group of mothers who were asked to use only touch and were provided with instructions regarding the type of responses to elicit from their infants and a control group of mothers who similarly used touch but did not receive instructions. Differences in infant gaze and affect across the various periods led the authors to conclude that something about the quality of mothers' touching must have differed between the groups. Consequently, although mothers of VLBW-PT infants in this study were found to provide their infants with the same amount of tactile stimulation, it was hypothesized that perhaps the quality of their tactile stimulation might differ between the groups. To the contrary, however, the results of analyses examining the qualitative aspects of maternal touching revealed no differences in either the types of touch employed by mothers, or the areas of the infants' bodies on which the tactile stimulation was presented.

Taken together, the results of the analyses indicated that infant birth status did not appear to influence either the amount or quality of the mothers' tactile-gestural stimulation. Nevertheless, it is important to note that, of the many characteristics of maternal touch, only two qualitative indices were examined for the purposes of the present investigation. Thus, it may be that subtle differences in other aspects of maternal touch, such as the speed with which mothers touched their infants, or the intensity of their touching may have differed between the groups but that the indices employed were unable to detect such differences. Alternatively, more global interactional measures such as the pacing or tempo of the interaction may have differed (e.g., Arco & McClusky; 1981). Thus, prior to concluding with any degree of certainty that mothers of VLBW-PT and NBW-FT infants do not differ in their stimulation, a larger-scale investigations involving a greater number of indices of maternal touch would need to be undertaken. Further investigation of these variables is warranted, as these characteristics are also believed to contribute to infant engagement and disengagement (Brazelton, 1984; Stack, 2001; Stack et al., 1998).

With respect to infant responsiveness, contrary to previous literature (e.g., Field, 1982; Malatesta et al., 1986), the VLBW-PT sample in this study did not gaze less at their mothers' faces. Rather, equal amounts of gazing at mothers' faces and hands, and gazing away from the mother characterized both groups. The absence of differences between the groups in gazing at the mother's face is consistent with Leroux et al. (1999) who found no differences between pre-term and full-term infants in either the frequency or duration of gazing at the mother, regardless of the behavior of the mother. The similar findings reported herein and in Leroux et al. (1999) may well have resulted from the fact that, in contrast to other investigations, dyads in both these studies were observed in their homes.

Indeed, the only significant behavioral difference between the groups on the measures investigated was the decreased smiling exhibited by the VLBW-PT sample. Thus, consistent with expectations, VLBW-PT infants exhibited less positive arousal in response to the face-to-face interaction. The finding of dampened positive affect in VLBW-PT infants confirms the results of past investigations in which pre-term infants were found to be less positively responsive to social stimulation (e.g., Bakeman & Brown, 1980; Crnic, Ragozin et al., 1983; Field, 1981, 1982; Segal et al., 1995). Furthermore, it appears to suggest that the greater neurological immaturity of VLBW-PT infants impacts the normal development of their affective skills (Stiefel, Plunkett, & Meisels, 1987). Notably, however, the literature examining affective expression in pre-term infants is replete with inconsistent findings, with several studies documenting fewer smiles for pre-terms during social encounters (e.g., Bigsby et al., 1996; Crnic, Ragozin et al., 1983; Field, 1982) and others reporting no such differences (Greene et al., 1983; Malatesta et al., 1986).

Contrary to previous suggestions and the expectations for the study, the marginal amount of fretting exhibited by infants in both birth status groups and across all interaction periods indicated that VLBW-PT infants were not more likely to exhibit negative arousal during social interactions with their mothers. The finding that VLBW-PT infants were not more likely than NBW-FT infants to become distressed in any of the three periods is encouraging, as it indicates that they were able to successfully tolerate the mild stress engendered by the SF perturbation. Furthermore, the results are consistent with the findings of Toda and Fogel (1993) who reported that full-term infants were more likely to be sober, as evidenced by their reduced smiling and increased neutral expressions, than to cry during the still face at both 3 and 6 months. Indeed, it has been suggested that fussing and crying is unlikely to occur as long as the still-face lasts no more than 2-3 minutes (Fogel et al., 1982; Toda & Fogel, 1993). Nevertheless, the incrementally increased fretting from the first to the third periods in both groups is consistent with other SF studies (e.g., Segal et al., 1995).

Consistent with previous studies employing the SF procedure (e.g., Gusella et al., 1988), the results of this investigation revealed decreased gazing at the mother's face, increased gazing away and decreased smiling in the SF relative to the other, Normal, interaction periods by infants in both birth status groups. These findings reinforce the assertion that the SF violates infants' expectations of a typical communicative interaction (Tronick et al., 1978; Tronick 1989). Specifically, the contradiction posed by the mother's face-to-face position (signaling readiness to interact) and her simultaneous disengagement has been argued to foster negative arousal in the infant. The finding of increased gazing away specifically during the SF period supports this assertion. However, the limited fretting exhibited by infants in both groups suggests that by averting their gaze, infants may have prevented an even more exaggerated avoidance response.

The decreased smiling exhibited by infants in both groups during the SF period was consistent with previous work (e.g., Toda & Fogel, 1983; Tronick et al., 1978; Weinberg & Tronick, 1994), as was the recovery of smiling in the N2 period (Weinberg & Tronick, 1996). However, although VLBW-PT and NBW-FT infants evidenced a similar pattern of decreased smiling in the SF period and recovery in the N2 period, displays of positive emotion were muted in the VLBW-PT infants when compared to those of NBW-FT infants, again suggesting lower overall positive arousal in this group.

Despite the limited differences revealed by the analyses examining both the durations of maternal and infant behaviors and the qualitative aspects of maternal touching, it was believed that the groups nevertheless might be distinguished by differences in the organization of their nonverbal behavior. Previous research has described pre-term infants as being more behaviorally disorganized (e.g., Als & Brazelton, 1981). Furthermore, pre-term infant-mother dyads have been found to have greater difficulty coordinating their cycles of affect and attention during social interactions, thereby resulting in lower levels of synchrony during their encounters than full-terms (Lester, Hoffman, & Brazelton, 1985).

Co-occurrence analyses designed to examine the associations among different infant behaviors revealed that NBW-FT infants were actually inclined not to look at their mothers' faces when being touched during the N1 period. This result is consistent with that of Study 1 with infants of the same age, again supporting the assertion that healthy, full-term infants will naturally look less at their mothers with age. In contrast, however, VLBW-PT infants looked at their mothers' faces when touched to a degree predicted by chance. In other words, they were neither more nor less likely to look at their mothers' faces when touched. The reason for this difference is not entirely clear. However, it is consistent with previous suggestions (e.g., Landry & Chapieski, 1989) that motor delays and longer latencies in initiating responses to stimuli may contribute to pre-term infants' difficulties shifting the focus of their attention, perhaps naturally resulting in more obligatory attention to the face and less gazing away than full-terms. This finding is important because it has implications for their abilities to visually disengage during periods of excessive arousal and suggests that mothers of these infants may be called on to externally regulate their infants' arousal to a greater extent than is normally the case, a task that might contribute to their less synchronous and satisfying interactions.

Another difference in the pattern of co-occurrences between the groups occurred during the N2 period, where NBW-FT infants were actually prone not to smile while gazing at their mothers' hands. Again, however, VLBW-PT infants were neither more nor less likely to smile while doing so. This result may imply greater behavioral disorganization and/or a lengthier period of behavioral recovery from arousal in VLBW-PT infants. Overall, however, the small differences in nonverbal behavioral organization exhibited between VLBW-PT and NBW-FT infants strongly limit the conclusions that can be reached.

Infants in both birth status groups were prone not to gaze away when touched by their mothers during the N1 period, thereby reinforcing the assertion that maternal touch can aid in eliciting and maintaining infant attention. Interestingly, however, this effect was not observed in the N2 period, perhaps suggesting some degree of ambivalence or wariness on the part of the infants following the resumption of maternal activity. This hypothesis is viable, given the findings of Weinberg and Tronick (1996) who reported that the reunion period of the SF procedure continued to be characterized by negative affective displays, distancing, and autonomic stress indicators at levels comparable to the

SF period. The authors interpreted these findings as suggesting that infants' negative states are not easily assuaged by the return to maternal interaction following arousal.

Notably, infants in both groups were also inclined to smile while looking at their mothers' faces to a degree exceeding chance in all periods. Thus, although VLBW-PT infants smiled less overall, they nevertheless evidenced the same pattern of directing their smiles toward their mother's faces as did NBW-FT infants. The pattern of high degrees of looking at the face combined with fewer positive expressions exhibited by the VLBW-PT sample in the present study is consistent with the results of van Beek et al. (1994) with pre-term infants, suggesting that lower positive arousal may be characteristic of such infants.

The present study is unlike many previous studies of its nature with respect to the context in which the SF procedure was studied. Specifically, the majority of studies employing the SF procedure have been conducted in the laboratory. However, within this setting infants may be aroused not only by the exposure to a perturbed interaction with their caregivers but also by the new and unfamiliar context itself. Pre-term infants have been described as having lower thresholds for overarousal than full-term infants (e.g., Als, 1983; Field, 1981). Very low birth weight pre-term infants' neurobiological immaturity may contribute to even greater difficulties tolerating arousal compared to pre-terms. Thus, when exposed to their mothers' still and expressionless faces in an unfamiliar context in which the cues associated with that context are themselves stimulating, VLBW-PT infants' arousal regulation capacities may be more easily overloaded. As a result, laboratory studies may unfairly portray such infants as perpetually dysregulated.

In the present study, infants' reactions to the SF were studied in a familiar environment, the infants' homes. As young infants spend the majority of their time in this setting, it was postulated that this context represented a more ecologically valid context of study. It was also hypothesized that the home setting might be less arousing to VLBW infants because they would have already habituated to this setting. Thus, the arousal engendered by the mother's still face would not be enough to overwhelm the infant's regulatory capacities. Consequently, the few differences between the groups may be related to the fact that VLBW-PT infants were more successfully able to regulate themselves in the presence of this lower degree of arousal.

A home investigation conducted by Leroux et al. (1999) similarly revealed no differences in the behavioral and developmental characteristics of pre-term and full-term infants over the course of the first six months of life. Thus, contrary to popular belief, the results of these investigations suggest that, during brief interactions conducted in their homes, pre-term and VLBW-PT infants appeared to behave similarly with respect to isolated indices of mother and infant nonverbal behavior. These findings should not to be eschewed given that this is the context in which these infants spend a large proportion of their time. The results reinforce assertions that emotion regulation and dysregulation should be considered in the social context in which they occur (Campos et al., 1989; Izard, 1977). Furthermore, they highlight the need for future research that more closely examines the importance of contextual influences on infants' arousal.

In addition, the present study examined maternal and infant responsiveness at only one time point, 5½ months of age. However, by this time, the impact of VLBW birth status may have diminished, thereby explaining the limited differences found between the groups. This hypothesis is supported by the results of Leroux et al. (1999) who found differences in measures of maternal sensitivity and contingency between pre-term and full-term dyads at 2 months that subsequently disappeared when dyads were re-tested at the 4 and 6 months. Although the exact reason for the disappearance of this effect is unclear, the authors suggest that the finding may be related to mothers' decreasing anxiety regarding their infants' development and their ability to care for their infants.

Although diminished maternal distress may be a contributing factor, it is equally plausible that sufficient time and social experience permitted these infants simply to "catch up" to their full-term counterparts. Notably, the greater physiological and motoric stability achieved with infant age may contribute toward pre-term infants' cues becoming more comparable to those of full-term infants (Bigsby et al., 1996). Furthermore, the correction for prematurity in the VLBW-PT group may have reduced or eliminated the developmental lag in core perceptual, cognitive, and social abilities known to be associated with VLBW birth (Barratt, Roach, & Leavitt, 1992). Consequently, the literature would benefit from future studies that seek to examine the use and impact of maternal tactile-gestural stimulation in a wider age range of VLBW-PT and NBW-FT infants, particularly those at younger ages when differences in maternal stimulation and infant functioning may still be apparent.

The results of the present investigation, although promising, require some interpretation as several of the findings (i.e., equal gaze at the mother's face and gazing away, lower fretting) run counter to well-established beliefs. Notably, several researchers have attributed the inconsistent findings replete in the literature to small sample sizes, as well as differences in the populations of pre-term infants studied (e.g., those differing in age at testing, selection criteria, degree of perinatal biological risk). Pre-term infants have been argued to represent an extremely heterogenous group, both in terms of gestational age, as well as in existence and degree of postnatal medical complications that frequently accompany premature birth status.

In particular, the confounding nature of medical status has made it difficult to isolate the contribution of prematurity to the behavior of these infants. Studies assessing the expressive development of pre-term infants have neither rigorously nor consistently attempted to devise studies that isolate the contributions of prematurity from those of medical illness. Consequently, the present study sought to accomplish this goal through the use of stringent selection criteria that excluded infants suffering from serious medical complications that might have confounded the impact of gestational age and birth weight.

An increasingly prevalent assumption in the literature is that it is the medical complications, rather than the degree of prematurity and lower birth weight per se, that drive developmental outcomes and the observed differences between such infants when compared to NBW-FT infants (e.g., Creasey, Jarvis, Myers, Markowitz, & Kerkering, 1993; Miceli et al., 2000). For instance, Miceli et al. (2000) found that medical complications mediated the relationship between birth status (i.e., birth weight and gestational age) and developmental outcome in VLBW-PT infants, accounting for between 22-37% of the variance in infants' performance on the Bayley mental and psychomotor scales at 4 and 13 months of age. Furthermore, in all cases, the addition of medical complications to the prediction equations resulted in improved prediction over birth status alone. Based on these findings the authors concluded that prematurity and low birth weight per se do not place infants at risk; rather, it is the medical complications that such infants experience following birth that function to heighten their vulnerability. Notably, however, the influence of such biological factors was found to diminish with time, as neither birth status nor medical complications impacted the performance of 36-month-olds.

Supporting Miceli et al.'s (2000) assertion, infants who are born prematurely but who are healthy have been found to perform similarly to full-term infants on global measures of cognitive and motor development within the first year of life (Bakeman & Brown, 1980; Crnic, Ragozin et al., 1983), as well as on more discrete measures of cognitive functioning, including visual recognition memory (e.g., Rose, 1983) and cross-modal transfer abilities (Rose, Gottfried, & Bridger, 1981). In addition, Evans, Pederson, Bento, Chance, and Fox (1990; as cited in Leroux et al., 1999) reported that when corrected for prematurity, pre-term infants without medical complications did not differ from those born at term with respect to temperament ratings. Nevertheless, it is recognized that findings involving pre-term infants may not necessarily directly translate to VLBW-PT infants who experience even greater neurobiological immaturity and are at even greater risk for medical complications compared to pre-terms.

Greene et al. (1983) compared four groups of infants, healthy term, healthy pre-term, sick term and sick pre-term, and reported that postnatal illness significantly impacted both infant and maternal behavior. Specifically, sick infants were found to be less attentive during the neonatal period, and subsequently fretted and cried more at 3 months of age. Moreover, mothers of such infants responded to them with increased caregiving behavior but little affective stimulation. Of particular interest, however, these mothers continued to behave differently toward their infants even after differences between the groups had disappeared, thereby suggesting that they continued to be impacted by their infants' birth status.

Postnatal illness may also account for the contradictory findings reported in studies of mother-pre-term social interactions. It has been suggested that the decreased behavioral competence and responsiveness of premature infants leads parents to compensate for their hypo-responsiveness by stimulating them more as a means of gaining their attention and sustaining the interaction (Field, 1977, 1981, 1982; Jarvis, Myers, & Creasey, 1989). However, when sick and moderately ill VLBW infants were studied neonatally, mothers of sick VLBW infants touched them less, smiled less, and engaged them in face-to-face interactions less than mothers of healthier VLBW infants (Minde et al., 1983). Thus, perhaps the infants studied by Field represented healthier pre-terms.

Beyond the presence of medical illness, type and severity of illness have also been argued to impact infant performance on a variety of measures (Greene et al., 1983). Bronchopulmonary dysplasia (BPD) represents a particularly serious lung condition that is associated with cognitive, motor, and neurodevelopmental delays (Goldson, 1983). In contrast, respiratory distress syndrome (RDS) represents a milder form of lung involvement. Myers et al. (1992) studied three groups of infants, premature infants with BPD, those with RDS, and well prematures. Although the infants were not found to differ in birth weight, gestational age, or demographic status, these infants differed markedly in their behavior. Healthy pre-term infants outperformed those with RDS who, in turn, outperformed those with BPD. More precisely, infants with BPD scored lower on items such as looking at and following faces, voices, and inanimate objects, and were less alert, cuddly, and consolable.

Creasey et al. (1993) studied these same three groupings of infants and similarly found that, with respect to mental development scores, healthy pre-terms outperformed those with RDS who again outperformed those with BPD. Interestingly, infants with RDS did not differ from healthy pre-term infants on measures of motor development, and both these groups scored significantly higher than those infants diagnosed with BPD. These findings suggest that degree of medical illness is also an important predictor of infant developmental outcome (Creasey et al., 1993).

When interpreted in light of the aforementioned literature regarding the impact of medical illness, it is not surprising that this study reported few differences between VLBW-PT and NBW-FT infants. Essentially, it may be that the exclusion of VLBW-PT infants with medical complications resulted in a more homogeneous group composition of infants at low degree of perinatal biological risk that more closely approximated that of the NBW-FT sample. Consequently, the absence of differences in maternal tactile-gestural stimulation found in the present study may have been a function of the healthier composition of the VLBW-PT group.

Thus, it appears that medical complications additional to prematurity may be responsible for differences found in infant expressivity, a possibility that underscores the importance of not conceptualizing all VLBW-PT infants as a homogeneous group. Indeed, Creasey et al. (1993) reported large degrees of variability even within different groups of pre-term infants. Taken together, this research also highlights the importance of devising studies that properly isolate the contribution of prematurity from those of medical illness. Unfortunately, many of the original studies (and some more recent investigations) contrasted the behavior of healthy full-term infants with pre-term infants suffering from a wide variety of medical complications (Creasey et al., 1993).

Notably, the rigorous selection and matching criteria employed in the present study resulted in a small sample size that may have limited the ability to uncover subtle variations in maternal and infant nonverbal behavior. Consequently, the results of Study 2 should be interpreted with caution. Moreover, review of the literature would appear to suggest that the results of this study may not be reflective of the entire population of VLBW-PT infants. Research has identified a significant link between infant birth status and medical complications, with younger, smaller infants experiencing greater medical complications (Miceli et al., 2000). Thus, as this study was limited to healthy VLBW-PT infants, the results likely generalize only to that particular subsample of the VLBW-PT population.

Nevertheless, it is highly encouraging that, within the present study, infants born prematurely and at very low birth weight appeared to respond in similar fashion to those born at term with at normal birth weight, at least during a brief period of interaction and on the particular measures studied. Traditionally, it has been assumed that VLBW-PT birth status is inevitably accompanied by differences in maternal stimulation. However, the results of this study suggest that if mothers did differ in their stimulation, it was neither in the degree of tactile or gestural stimulation, nor in the quality (specifically type and area) of the tactile stimulation provided.

Long-established beliefs hold that premature (and more recently VLBW-PT) infants are inevitably vulnerable to a host of difficulties that act to compromise their arousal regulation and social development in general. The fact that VLBW-PT infants exhibited low overall positive arousal in response to this interaction may indeed negatively impact their social interactions with their mothers, as they would appear to enjoy the interaction less. Although this assumption may have merit, the findings of the present investigation suggest that healthy VLBW-PT infants not suffering from postnatal medical illness did not exhibit more negative arousal than NBW-FT infants. Furthermore, the results indicate that although VLBW-PT infants responded in a grossly similar fashion to their NBW-FT counterparts, some important, and as of yet unexplained variation exists in the organization of their nonverbal behavior, both within the infant and between the infant and mother.

CHAPTER 4: General Discussion

Overview

The studies reported herein were designed to examine mothers' uses of touch and gesture with their infants, as well as infants' behavioral indices of engagement and disengagement during interactions involving these forms of stimulation. Five objectives guided the development of the studies, namely to assess for the presence of: (a) contextual influences on mothers' uses of tactile and gestural stimulation during face-to-face interactions designed to influence their infants' arousal states, and infants' gaze and affective behaviors during interaction periods in which such stimulation was presented. (b) possible differences in qualitative aspects of maternal touch (c) developmental changes in mothers' uses of touch and gesture and infants' responses to these over the course of a brief two-month period from 3½ to 5½ months of age, (d) possible associations in nonverbal behaviors reflecting the organization of behavior, both within the infant and between the infant and mother, and (e) differences in mothers' uses of touch and gesture and infant gaze and affect as a function of infant birth status in VLBW-PT and NBW-FT mother-infant dyads studied in their homes.

Two experiments were conducted to fully address these issues. In Study 1, maternal tactile-gestural stimulation, and infants' gaze and affect, were assessed during four brief interaction periods. Contextual variations were introduced by: (a) providing instructions to mothers on the behavior/state to elicit from their infants, and (b) varying the method through which mothers attempted to accomplish these goals, namely through the use of only touch (uni-modal context) or all modes of communication (multi-modal context). Mothers' and infants' nonverbal behaviors were first examined in two within-modality control comparisons designed to evaluate whether mothers' tactile-gestural behavior and infants' gaze and affect actually varied as a function of the different instructions to mothers to influence their infants' behaviors/states of arousal. A subsequent comparison between the two Experimental groups was then conducted to specifically examine whether, and in what way, mothers' and infants' nonverbal behaviors differed when these identical instructions were attempted in different ways (i.e., only touch vs. all modes). Within each of these comparisons, developmental differences were assessed by examining infants at 3½ and 5½ months. In addition, co-occurrences between nonverbal behaviors were assessed, both within the infant and between the infant and mother, to assess for differences in the organization of nonverbal behaviors as a function of instruction period, modality, and age.

In Study 2, mothers' uses of touch and gesture and infants' gaze and affect were compared in VLBW-PT and NBW-FT infants during interactions involving a brief period of maternal unavailability. VLBW-PT infants were selected as the focus of study based on the results of past research which have raised concerns about possible: (a) compromises to their arousal-regulation abilities occasioned by their low birth weight and neurobiological immaturity (e.g., Als, 1983; Als Lester, Tronick, & Brazelton, 1982; Eckerman et al., 1999), (b) differences in the amount (and possibly types) of stimulation to which they are exposed (e.g., Bakeman & Brown, 1980; Barnard et al., 1984), and (c) possible differences in VLBW-PT infants' perceptions of, and reactions to, such stimulation (e.g., DeMaio-Feldman, 1994; Weiss et al., 2000).

Taken together, the results of the present studies revealed: (a) differences in the duration of maternal touch and gesture and the (b) qualities of touch that mothers employed with their infants that were influenced by the context in which the stimulation occurred (i.e., both as a function of instruction period and modality), (c) developmental changes in the duration of maternal gesture, the qualities of maternal touch, and infants' nonverbal behaviors occurring during social interactions involving these forms of stimulation between 3½ and 5½ months, (d) differences in the organization (i.e., co-occurrences) of nonverbal behaviors both within the infant and between the infant and mother as a function of instruction period, modality, and infant age, and (e) that differences in infant birth status did not appear to be associated with differences in maternal touching or gesturing or infant gaze, but were associated with differences in infants' affective expression and some subtle differences in the organization of nonverbal behavior when compared to full-term infants.

Importance of the Social Interactive Context

Numerous studies have underscored the importance of the social context in influencing maternal behavior and infant arousal and responsiveness (Field, 1981; Fogel et al., 1992; Seifer et al., 1992; Stechler & Carpenter, 1967; Sroufe, 1979b; Sroufe et al., 1974; Stack & Arnold, 1988; Stack & LePage, 1996; Stack & Muir, 1990; Symons & Moran, 1987; Walker et al., 1992). The studies reported herein extend the knowledge base by examining maternal tactile-gestural stimulation and infants' gaze and affect during arousal achieved through two complimentary methods. In Study 1, the creation of arousing interactions was achieved through the provision of instructions to mothers to modify their infants' behaviors/states. In Study 2, infants' responses were studied both prior, and subsequent to, a brief period of maternal unavailability, a condition that was itself arousing. Thus, whereas in Study 1, touch and gesture were indirectly manipulated through the use of instructions to mothers, in Study 2 they were observed during two naturalistic interactions, thereby permitting comparison of the way in which maternal tactile-gestural stimulation was naturally employed and the way its use was modified during the resumption of interaction following arousal.

Within the uni-modal, touch-only context of Study 1, the provision of instructions to mothers to alter their infants' arousal states did not influence the overall amount of touch used, but did result in observable differences in two qualitative aspects of mothers' touching (i.e., type and area of touch) and in the duration of their gesturing. Furthermore, infants perceived, and were susceptible to, such external sources of stimulation as evidenced by subtle variations in the direction of their gaze and smiling. Taken together, the results culminate to suggest that touch and gestures alone were capable of eliciting, directing, and maintaining infant gaze, eliciting positive affect, and limiting the expression of negative affect, thus lending additional support to the work of other researchers (e.g., Brown & Tronick, in preparation, as cited in Tronick, 1995; Gusella et al., 1998; Pelàez-Nogueras et al., 1996; Stack & Arnold, 1998; Stack & LePage, 1996; Stack & Muir, 1990, 1992).

When touch was examined within multi-modal contexts (Studies 1 and 2), the results revealed that despite the availability of other salient modes of communication, touch was a frequently employed means of interaction. Supporting the soothing function of touch, instructions to relax and calm their infants in Study 1 resulted in a significant decrease in 'off the body behavior' and concomitant an increase in touch, specifically the use of proximal soothing strategies (i.e., stroking). Subsequent comparison of the uni-modal and multi-modal social contexts revealed that when used in isolation, mothers' increased their use of touch and gestures potentially reflecting their attempts to compensate for the removal of other communicative modalities.

A particularly interesting finding was the contextual influence on the direction of infant gaze, whereby infants in the uni-modal and multi-modal contexts appeared to focus their attention on different aspects of their mothers' behavior. Specifically, during the touch-only interaction, infants gazed more at their mothers' hands whereas in the all modes interaction they appeared more drawn to their mothers' faces. Given that gaze is a salient medium through which to acquire information about one's surroundings (e.g., Stern, 1977; Webbink, 1986), it is not surprising that infants directed their focus of attention to the most stimulating aspect of their mothers' behavior. This finding lends support to the assertion that infants are highly attuned to their environment and possess the cognitive capacity and awareness to detect sources of information that may assist them in negotiating their surroundings (Kagan, 1967; Kagan, Kearsley, & Zelazo, 1978). Indeed, it may be that infants' attunement to their mothers' stimulation during these early months of life serves as a foundation for later, more complex skills, such as social referencing. Social referencing appears within the latter half of the first year and is a process by which infants seek and use information from others' emotional reactions to events to guide their own responses (Walden, 1991). In so doing, they actively solicit assistance from their mothers in acquiring information about the emotional tone of a situation as well as models for appropriate behavioral responses to the event (Dodge & Garber, 1991).

Taken together, the present studies underscore the considerable importance of the social interactive context for learning opportunities in early infancy. Indeed, it is likely that many of infants' first developmental behaviors occur in the context of social interactions with their caregivers (Papoušek, Papoušek, & Harris, 1987; Stern, 1974). The finding that contextual variations to the interactions resulted in changes in infant gaze and smiling is also consistent with a functionalist theory of infant emotion. According to the functionalist approach, emotions are intrinsically relational rather than intrapersonal. As a result, they cannot be understood by examining the individual or the environment in isolation; rather, these components constitute an indissociable whole (Campos, Mumme, Kermoian, & Campos, 1994). According to Campos and colleagues (Campos et al., 1989) emotions represent the individual's attempt to establish, maintain, modify, or terminate an encounter with the environment. Previous research has revealed that infant gaze and affect are highly effective means of achieving these goals (e.g., Blehar et al., 1977; DeBoer & Boxes, 1979; Gewirtz & Boyd, 1976, 1977; Kaye 1977, as cited in Kaye, 1982; Papoušek & Papoušek, 1978). As one of the major postulates of this theory is that only those events that are significant to the individual produce emotion (Campos et al., 1994), it can be argued that mother-infant interactions are of significance to young infants and thus constitute meaningful encounters. Indeed, mother-infant social interactions have been implicated as the primary context for the development of infants' social, emotional, and cognitive development (Dunham & Dunham, 1990).

Importance of the Mother-Infant Relationship

According to Hartup (1985) the mother-infant relationship serves three functions in the social, emotional, and cognitive development of the infant, namely: (1) as a resource that furnishes the child with the needed security and skills, (2) as a context in which fundamental competencies emerge, and (3) as forerunners of other relationships. The results of the present studies serve as illustrations of these processes.

Early on, mothers are believed to compensate for their infants' arousal modulation limitations by monitoring their arousal states and sensitively tailoring their stimulation to their infants' abilities so as to not overwhelm them (e.g., Gable & Isabella, 1992). Thus, consistent with Vygotsky's (1978) theory of development, it appears that the development of emotion regulation is a socially-directed phenomonon, with arousal parameters and strategies for arousal modulation being first learned in the context of joint interpersonal interactions and only later being internalized into more complex self-regulation strategies. By providing a range of tactile-gestural stimulation to their infants, mothers may have structured their infants' experiences and, in so doing, assisted in their infants' learning. It is notable that even in these arousing interactions infant fretting was low, suggesting that mothers were able to tailor their stimulation in such a way as to alter their infants' behaviors while simultaneously maintaining their infants' arousal within appropriate limits. In so doing, they appeared to function within their infants' zones of proximal development (Vygotsky, 1978), thereby promoting continued engagement with the environment.

Some researchers have suggested that maternal monitoring of infants' attention may represent an elementary form of scaffolding (e.g., Pêcheux, Findji, & Ruel, 1992). According to these researchers, although infants are capable of exploring their external environments from approximately 3 months of age, they have difficulty focusing and maintaining their attention long enough to process all of the information contained therein. Consequently, parents frequently employ strategies to recapture their infants' waning attention, thereby maintaining their visual involvement. The results of the present research suggest that maternal tactile-gestural stimulation may represent one such strategy serving to elicit and maintain infants' attention.

Taken together, the results of Study 1 combine to indicate that the mother-infant relationship is an important context in which emotion regulation strategies emerge (Crockenberg & Leerkes, 2000) and that maternal tactile-gestural stimulation plays an important role in influencing infant behavior. When attempting to alter their infants' states, mothers used touch and gestures as a means of influence. Through alterations in their touching and gesturing, mothers modulated the overall level and quality of the stimulation to which infants were exposed. Moreover, these changes in maternal nonverbal behavior were reflected in observable differences in infant gaze and affect, potentially reflecting differences in infants' states of arousal. Thus, these findings provide support for the assertion that changes in stimulation achieved through variations in maternal nonverbal behavior may facilitate arousal regulation (Gable & Isabella, 1992;

Papoušek & Papoušek, 1987; Stack, 2001). However, they further suggest that the context in which the stimulation takes place also acts to influence mothers' and infants' nonverbal behavioral expressions. In contexts in which the degree of touch remains constant, more subtle variations to the quality of the touch and the duration of gesturing may contribute to differences in infants' responding.

According to Hartup (1985), the mother-infant relationship is also important in that it acts a forerunner for other relationships. This is so because later transactions with the environment depend, to a certain extent, on prior experience (Stack & Poulin-Dubois, 1998). Specifically, the mother-infant relationship is believed to serve as a developmental model for infants' relationships with both their nonsocial and social environments. Cohn, Campbell, Matias, and Hopkins (1990) found that infants of depressed mothers not only showed limited interest in their mothers, but also in objects. In contrast, maternal responsiveness has been argued to foster a sense of control and effectance in the infant that motivates engagement with the environment. The infant's perceptions of the environment as predictable, stable, and secure depend largely on the caregiver's sensitivity to the infant's needs (Cicchetti, Ganiban, & Barnett, 1991). Indeed, the security of infants' attachments with their caregivers has been found to contribute to greater exploratory behavior and, in so doing, to promote further learning (Ainsworth, Blehar, Waters, & Wall, 1978). Thus, an understanding of the developmental course of mother-infant nonverbal behavior in a social context may assist in identifying factors that promote social and cognitive competence and well-being.

Importance of Nonverbal Behavior in At-Risk Dyads

Knowledge of the developmental patterns of infants' nonverbal behaviors at different ages and across different social contexts has the potential to assist in the early identification of infants who demonstrate maladaptive patterns of social communication. For instance, autism is a developmental disorder characterized, in part, by limited eye contact and social responsiveness. Studies of autistic infants have shown marked differences in social gazing, including gaze avoidance and deviant patterns of reciprocal gaze (Rutter & Schopler, 1987). Although autism is generally not diagnosed until four years of age (Siegel, Pliner, Eschler, & Elliot, 1988), 50% of parents of a child with autism report suspected concerns prior to 1 year of age (Ornitz, Guthrie, & Farley, 1977). In a study by Adrien et al. (1993), blind raters viewed home movies taken of both normal infants and infants later diagnosed as autistic filmed between birth and 2 years of age. The authors reported that five pathological behaviors, including poor social interactions, the absence of a social smile, lack of appropriate facial expressions, hypotonia, and poor attention, significantly differentiated the autistic and normal groups within the first year of age. Osterling and Dawson (1994) subsequently asked blind raters to observe videotapes of each of 11 normal and 11 autistic children filmed at their first birthday party. Four behaviors, namely pointing, showing an object to another, looking at the face of another, and failing to orient to name correctly classified 91% of the cases. Taken together, these studies appear to suggest that differences between normally developing children and autistic children are present and can be observed within the first year of life.

The results of Study 2 appear to indicate that VLBW-PT infants are also susceptible to deviations in affective expression. Confirming the results of past studies (e.g., Greenspan, 1981; Segal et al., 1995), VLBW-PT infants displayed less positive affect than their control counterparts. Prematurity is known to affect the course of affective development, with even relatively advantaged pre-terms being found to develop less mature forms of expressive behavior, and more muted expressions that place them at high risk for socio-interactive difficulties that persist well into the third year of life (Malatesta-Magai, 1991). As infants' affective signals are among the most compelling forms of communication that a young infant has at his/her disposal with which to engage others, the finding of muted positive affect in VLBW-PT infants may be at least one contributing factor to these dyads' reported interaction difficulties and less engaging social interactions (Field, 1977).

Nevertheless, the absence of observed differences between the VLBW-PT and NBW-FT groups on many of the measures studied highlights the importance of the social interactive context as a possible contributor to the reported behavioral differences exhibited by VLBW-PT infants. The results of Study 2 suggest that high-risk infants do not necessarily differ from NBW-FT infants in their behavioral manifestations of arousal, as the majority of past studies of pre-term and VLBW-PT infants appear to suggest. The present research conducted with 5½-month-old age-corrected VLBW-PT infants indicated that, at least during a brief face-to-face interaction conducted in their homes, VLBW-PT infants' and NBW-FT infants differed neither in the durations of touch and gesture directed toward them by their mothers nor in their directions of gaze. Thus, at 5½ months corrected age, VLBW-PT infants appeared to react similarly to interactions involving maternal tactile-gestural stimulation as NBW-FT infants

The absence of differences in VLBW-PT and NBW-FT infants' levels of distress during interactions involving maternal touch and gesture was encouraging as it suggested that VLBW-PT infants' coping mechanisms were not excessively taxed in response to a brief period of maternal unavailability, and that they were able to successfully recuperate from the mild stress engendered by the SF perturbation. The absence of differences in the Normal periods preceding and following the SF also suggest that VLBW-PT infants did not respond to maternal tactile-gestural stimulation in an aversive manner. This finding is interesting from a number of different perspectives. Notably, investigations of VLBW-PT infants prior to term age have reported that such infants showed signs of distress during interactions in which touch was added to talking, suggesting that either touch itself or touch in combination with voice, exceeded their coping mechanisms. In addition, past research has suggested that VLBW infants may suffer from tactile defensiveness and fundamental differences in their sensory processing of touch that persisted into later childhood (DeMaio-Feldman, 1994).

Although it would be tempting to conclude that VLBW-PT infants do not differ from NBW-FT infants in their ability to regulate the intensity of their arousal, such a conclusion is premature and cannot adequately be supported on the basis of the present research. As maternal vocal and facial expression were not analyzed, it may be that some unexplained variation in maternal behavior accounted for the limited differences between the groups. As an example, perhaps mothers of VLBW-PT infants were less vocally or facially expressive, thereby reducing the complexity of the stimulation to which their infants were exposed. Additional characteristics such as the tempo and pacing of the interaction may also have differentiated the groups. Thus, although infants' behavioral outcomes may have appeared highly similar, the packaging of the stimulation leading to that outcome may have been very different.

In the present investigation, maternal tactile-gestural stimulation and infant gaze and affect were observed during two Normal periods, one preceding and one following an SF perturbation. Given the identical naturalistic instructions in these two periods, it is encouraging, although not entirely surprising, to find that VLBW-PT and NBW-FT infants and their mothers responded similarly on several nonverbal behavioral measures of engagement/disengagement. What would be particularly interesting, and what remains unclear, is whether differences between these two groups would be exhibited under different experimental perturbations in which their arousal modulation abilities were more directly challenged. For instance, these two groups of mothers and infants may have responded very differently from one another if observed under the conditions of Study 1 where mothers were specifically attempting to heighten and dampen infant arousal. Alternatively, differences may have been revealed if the procedure of Study 2 had been carried out in the laboratory setting. Such possibilities need to be explored in future studies before firm conclusions regarding VLBW-PT infants' arousal modulation capacities may be established.

Prior observations of pre-term infants and their mothers have generally been conducted in the laboratory. However, given Field's (1981) hypothesis that pre-term infants have higher-than-normal attention and lower-than-normal aversion thresholds, the unfamiliarity of the laboratory context may more easily overload pre-term infants' arousal regulation capacities. In so doing, laboratory studies may unfairly portray such infants as perpetually dysregulated. It has been suggested that emotional competence is context dependent (Stack & Poulin-Dubois, 1998). Thus, as the home environment is the context in which young infants spend the majority of their time, it was considered important to evaluate their responsiveness during social interactions occurring in this context. Although the present findings are not conclusive, the results provide initial support for the assertion that contextual factors may play a role in influencing how these dyads interact and may contribute to the reported differences, or lack thereof, between these groups. Nevertheless, as the present study did not specifically investigate VLBW-PT infants' responses during interactions in the laboratory setting, the results would be strengthened by the addition of a laboratory comparison.

Qualities of Maternal Touch

The present studies represent one of a very limited number of investigations that have sought to characterize different types of touch (e.g., Cohn & Tronick, 1983; Stack et al., 1998; Weinberg, 1994, as cited in Tronick, 1995; Weiss, 1992), and to examine the functions they serve in modulating infant state. As predicted, the results of Study 1 revealed different types and areas of touching under different contexts, both as a function of instruction and modality. These results provide further support for the notion that different forms of touch may communicate different messages to infants (Stack, 2001; Tronick, 1995), and suggest that modifications of maternal touching are one possible means of influencing infants' arousal states as indexed by their nonverbal behaviors. Furthermore, they suggested that mothers may be sensitive to the impact of qualitative changes in their touching, and that they may possess an implicit awareness of the types of touch that can elicit certain behaviors from their infants (Stack et al., 1998).

However, they also suggest that not every form of touch facilitated positive arousal, supporting Tronick's (1995) assertion. Past studies have revealed that depressed and intrusive mothers spend more time poking and jabbing their infants and that these forms of behavior were directly related to their infants' gazing away and negative affect (Cohn & Tronick, 1983). The present study extends these findings by suggesting that even affectively positive forms of touch (e.g., stroking), when used redundantly or when incorporated noncontingently into an interaction in the absence of infants' cues indicating its appropriateness, can result in infant sobering and disengagement (e.g., gazing away, little smiling) possibly reflective of negative arousal. Specifically, the results of the RL period suggested that mothers' attempts to alter their infants' emotional expressions ran counter to their infants' expectations and needs. Thus, the findings provide support for Thompson and Calkins' (1996) assertion that maternal attempts at emotion regulation may actually be counterproductive when such strategies counteract the infant's goals.

Developmental Progressions in Mothers' Uses of Tactile-Gestural Behavior and Infants' Behaviors

Study 1 also represents the first attempt to characterize age-related changes in maternal touch and gesture and infants' gaze and affective expressions during interactions involving these forms of stimulation during the first year of life. Such an investigation was considered important, as it has been hypothesized that mothers modify their emotion induction strategies to suit their infants' developing capacities. Taken together, the touch results suggested that although mothers touched to the same extent with age, they differed in both the manner in which they employed their touch and the areas of the infants' bodies to which they delivered their stimulation. Such a finding is valuable, as the majority of prior investigations of touch have relied heavily upon duration of touch as the primary index of maternal stimulation. Although touch duration is undoubtedly important, the presented findings suggest that it may be misleading in not revealing more subtle variations occurring within this communicative channel.

The findings also suggest that the specific strategies mothers employ are intimately tied to the developmental capacities of the infant in question. Indeed, the results of Study 1 provide preliminary evidence in support of this assertion. Regardless of the fact that mothers were instructed on the type of behavior to elicit from their infants, the type and duration of maternal nonverbal behavior used to accomplish these instructions were permitted to vary. Developmental changes in both the qualities of touch and the duration of maternal gesturing imply that mothers specifically tailored their stimulation to the developmental age of the infant toward whom the stimulation was being directed. Thus, it appears that mother-infant interactions are based on bi-directional developmental influences. As infants mature in their capabilities, they become more proficient at delivering signals designed to communicate their behavioral states and required assistance in arousal regulation (e.g., Stern, 1974; Kaye & Fogel, 1980). In turn, mothers imbue these nonverbal behaviors with significance and adjust their strategies to their infants' changing developmental levels. Despite the finding of clear age-related developmental changes in both maternal and infant nonverbal behaviors, the reported conclusions would be strengthened by longitudinal data. Consequently, future studies should seek to expand the present research by observing the same infants across developmental time.

Organization of Nonverbal Behavior

A comparison of the various infant responses employed in the present studies suggests that they varied as a result of the context in which the interactions took place, but did not rise and fall in unison. Taken together, these results combine to suggest that infants' behavioral contributions during mother-infant social interactions are complex and cannot be adequately captured using isolated nonverbal behavioral indices of infant responding (Symons & Moran, 1987).

Indeed, the results from the co-occurrence analyses suggested that the association between nonverbal behaviors provided an additional level of information not readily available through observation of the individual measures of infant responsiveness. In particular, the finding of a positive association between infant smiling and gazing at the mother's face in both studies strongly supports the hypothesized socially-directed communicative salience inherent in the association of these behaviors (e.g., van Beek et al., 1994; Fogel & Thelen, 1987; van Wulfften Palthe & Hopkins, 1984). Notably, this association characterized the interactions of both healthy full-term (Studies 1 and 2) and VLBW-PT infants (Study 2). That VLBW-PT infants demonstrated such an association in contexts in which their overall positive affect was dampened lends convincing support to this assertion. Yet another salient finding was the association between gazing away and infant affect. Specifically, the results of the present research appear to indicate that infant gazing away may actually serve different functions, including reducing arousal in response to both negatively- (e.g., Gable & Isabella, 1992) and positively-charged (e.g., Stifter & Moyer, 1991) emotional interactions, a conclusion that was not possible to ascertain on the basis of the gazing away results alone.

With respect to high-risk infant populations, prior investigations (e.g., Als & Brazelton, 1981) have reported that pre-term infants are more disorganized in their behavior than full-term infants. The results of Study 2 revealed some differences in behavioral organization between the groups. For instance, VLBW-PT infants did not demonstrate a tendency to gaze away from their mothers when touched during the first N period as did NBW-FT infants. Again, however, the differences were small and future research will be needed to clarify the meaning of these different behavioral configurations.

Taken together, the results of Studies 1 and 2 indicate that the organization of nonverbal behavior within the infant was influenced by the age and birth status of the infant, as well as the context in which the interaction took place. Infants' gaze and affective displays formed configurations that appeared to be specifically tailored to the interaction they were experiencing, thus supporting the work of other researchers (e.g., Weinberg & Tronick, 1996). Notably, past studies have largely inferred differences in maternal stimulation based on observable differences in infants' behaviors. Consequently these studies extended past research by directly assessing for possible associations between maternal stimulation and infant gaze and affect. The results of these analyses revealed that infants' gaze and smiling were specifically associated with periods of maternal tactile and gestural stimulation suggesting interdependence between mother and infant behavior.

Theoretical Implications

Originally, theories of infant development focused almost exclusively on the individual contributions of the infant, thereby neglecting the influences arising from the relationship between the two interactive partners (Schaffer, 1989). In contrast, more contemporary views depict infant behavioral expression as occurring within the infant but emerging as a product of mutually influential mother-infant interactions (Malatesta-Magai, 1991). In addition to supporting a functionalist theory of emotion, the present findings are consistent with dynamic systems theory (Fogel & Thelen, 1987) in which both mother and infant are conceptualized as being attuned to one another and jointly contribute to the flow of the ongoing interactions which continually evolves and changes over time.

Systems theories also argue that development cannot be compartmentalized according to the unique contributions of various infant systems. Rather, development is posited to be nonlinear, involving the inseparable contributions of multiple sources of influence. The present studies aptly highlight the systems perspective by suggesting that cognitive, physiological (e.g., arousal), and motoric (e.g., head modulation) factors within the infant, as well as influences from the interactive partner and the context of the play combined to influence the patterning and progression of mother-infant interaction.

Mothers appeared to be sensitively attuned to their infants' behaviors and abilities and structured their infants' experiences by providing adequate amounts of stimulation that influenced their infants' behavior while simultaneously maintaining their attention and limiting their negative affect. Taken together, these inter-related aspects of infant and maternal behavior reflect the transactional view of infant development as consisting of forces both internal and external to the infant.

The findings of the present studies provide support for a cognitive component to mother-infant interaction. It has been argued that the experience of emotion requires the existence of certain fundamental cognitive abilities, including the ability to perceive, discriminate, recall, associate, and compare (Lewis, 1993). That infants in the present studies reacted to experimentally induced changes in their mothers' behavior across the various interaction periods implied the ability on their part to perceive and react to differences in maternal stimulation. In Study 1, the finding of distinct patterns of gaze and smiling that were associated with contextual variations to the interaction suggested that infants detected subtle variations in maternal touch and gestures. Similarly, changes in infants' behaviors during the brief period of maternal unavailability achieved via the SF perturbation in Study 2 suggests that they perceived the change in their mothers' behavior.

According to the recognition assimilation hypothesis originally proposed by Piaget (1952) and later extended by Kagan (1967), there is a connection between cognitive processing and the development and elicitation of positive affect. According to this theory, the establishment of a connection between an external event and an internal representation results in pleasure for the infant, reflected in a smile. As a result, smiling is believed to reflect successful problem-solving in what is called "effortful assimilation" (Kagan, 1967). In a similar vein, the failure of the infant to assimilate will result in uncertainty and a buildup of tension, reflected in behaviors such as withdrawal and crying (Kagan, Kearsley, & Zelazo, 1978). It follows, therefore, that the cognitive and affective components of infant behavior should be viewed as related and even interdependent.

Thus, the positive affect exhibited by infants in the present studies may have reflected their development competence. In Study 1, variations in the instructions during the interaction periods resulted in mothers using different amounts of touch and gestures, as well as different types of touch, in order to comply with the experimental instructions. These changes in maternal behavior from one period to the next may have created discrepancies for infants, and infants' abilities to perceive such discrepancies resulted in smiling.

Interpreted in this light, one possible, although tentative, suggestion for the dampened expressions of smiling exhibited by VLBW-PT infants in Study 2 may be that they experienced difficulty detecting, or assimilating, differences in their mothers' behavior. That such infants are predisposed to a variety of cognitive difficulties that may depress their behavioral competence has been well documented. Consequently, the more restricted expression of positive affect in VLBW-PT infants may possibly reflect their cognitive challenges. In turn, their muted expressions of positive affect may create further challenges for VLBW-PT infants by providing fewer opportunities for shared positive affect with their mothers, thereby possibly contributing to interactions that are less synchronous and satisfying. These results highlight the interdependence of cognition and emotion, and suggest that limitations in one developmental domain may have implications for other aspects of infant functioning.

Future Directions

Although it was considered a valuable and necessary step to isolate tactile stimulation with the aim of assessing its independent role in influencing infant behavior, recognition that much of infants' early development occurs within a multi-modal social context is also essential (Arnold et al., 1996; Stack, 2001). Consequently, future studies should seek to examine additional forms of maternal communicative expression to more precisely delineate the individual contributions of the modalities, as well as the way in which multiple modalities interact in influencing infant behavior.

To date, the literature has not addressed the question of whether the use of multiple modalities increases the salience and/or effectiveness of mothers' messages to their infants (Arnold et al., 1998; Stack, 2001). However, the results of Study 1 suggest that this may indeed be the case. Specifically, the findings highlighted the important contribution of maternal gestures in eliciting and maintaining infant attention. Infants in the Experimental group gazed more at their mothers' faces during the AF period than Controls and this was the same period in which mothers gestured the most. Nevertheless, comparison of the two Experimental groups indicated that, not surprisingly, mothers in the All Modes group were more successful in eliciting and maintaining their infants' attention on their faces than those in Tactile group. Although maternal vocal expression was not analyzed, its utility in mobilizing attention has previously been documented (e.g., Pêcheux et al., 1992). Consequently, perhaps the combination of two attention-getting strategies, namely voice and gestures, served to increase salience and effectiveness of the message thereby prompting infants to attend more than those who received touch in isolation. If confirmed, such dynamic flexibility in the communicative system would benefit the dyad in several ways. For instance, by permitting the mother to express the same message in different ways, the likelihood that the infant would correctly perceive, interpret, and respond to her overtures would be increased. Furthermore, the possibility of substituting various communicative behaviors for one another while retaining the same meaning would permit the mother to tailor her strategies to the context of the interaction (Weinberg & Tronick, 1994).

With respect to the infant, the present studies included well–established measures of infant state. Nevertheless, the measures used were only a few of the many recognized behavioral indices of infant arousal and arousal regulation. Thus, future research should seek to extend the present work by incorporating a larger variety of infant measures reflecting infant state. For instance, splaying of the fingers and arm/leg extensions have been found to be reliable indices of mounting stress. In addition, hand clasping, foot bracing, and hand-to-mouth behaviors have been considered to be indices of self-regulation (Als, 1986; Als et al., 1982; Blackburn, 1993; Gorski, Hole, Leonard, & Martin, 1983; Sell, Hill-Mangan, & Holdberg, 1992). Furthermore, although the results from the present studies indicated that touch was associated with differences in infants' behavioral expressions of arousal, the studies did not investigate other important aspects of infant state, such as physiological manifestations of arousal (e.g., infant heart rate). As there is some evidence to suggest that touch influences physiological functioning (e.g., Brazelton, 1990; Montagu, 1986), and that gaze and affective expressions correlate with fluctuations in physiological manifestations of arousal (e.g., Brazelton et al., 1974; Field, 1981; Stern, 1974; Stoller & Field, 1982; Vaughn & Sroufe, 1979) future studies might seek to incorporate both behavioral and physiological measures in an effort to more clearly delineate the contribution of maternal touch in influencing infant arousal.

The results of co-occurrence analyses investigating associations in nonverbal behavior, both within the infant and between the mother and infant, provided valuable information regarding the organization of nonverbal behavior during socially arousing interactions. Nevertheless, the results of the present studies permitted only indirect statements regarding the association between infants' gaze and affect and the types of touch used by mothers. Findings of associations between nonverbal indices of infant arousal and particular type(s) of touch would further strengthen evidence suggesting a functional communicative role for the tactile modality. Future research might also seek to analyze the data using sequential analysis, a statistical technique that has been argued to be beneficial in establishing directionality in patterns of ongoing interactions (e.g., Bakeman & Gottman, 1997).

Additional study is also needed to distinguish the responses of healthy VLBW-PT infants from those suffering from different degrees of postnatal illness. Although biological risk has been argued to be less predictive of outcome than contextual risk (i.e., parental education and occupation, SES, maternal mental health, and features of the parent-child interaction; Sameroff & Chandler, 1975), it nevertheless adds an additional element of risk into the dyadic interaction through its impact on infant behavioral organization (Bigsby et al., 1996). Consequently, future research examining mothers' uses of, and infants' responses to, tactile-gestural stimulation should seek to include both low- and high-risk groups of VLBW-PT infants, in addition to NBW-FT controls.

Applied Implications of the Present Studies

The results of the present investigations support Burgoon's (1985) assertion that nonverbal behaviors function both individually and collectively in achieving a variety of functions. Certainly, the results of Study 1 suggest that when presented uni-modally, touch and gesture alone were capable of influencing arousal as manifested in changes in gaze and affect. The results of Studies 1 and 2 also suggest that when combined multi-modally, touch continues to be used at high levels in combination with maternal facial and vocal expression. In addition, the results of these studies reinforce the assertion that although infants may be unable to use speech as a mode of expression, their nonverbal behavior provides rich sources of information regarding their states of engagement and disengagement (e.g., Field, 1977; Kaye & Fogel, 1980; Symons & Moran, 1987; Stern, 1974, 1977).

Taken together, the results from the present studies appear to suggest that even within the first year of life, both the mother's and the infant's nonverbal behaviors provide invaluable pragmatic information that function to initiate, alter, sustain, and terminate their social interactions, thus lending support to von Cranach and Vine's (1973) suggestion that the nonverbal social signals expressed by adults may well have their origin in social interactions beginning in early infancy.

The present studies were important in providing information about how mother-infant nonverbal behavioral signals are impacted by contextual variables and how they develop over time. Furthermore, they underscored the bi-directional nature of mother-infant social interactions and highlighted the flexibility of the dyad, wherein each partner adjusted and modified their behavior to meet both the contextual demands of the social interactive context and their partners' expectations.

Although the many differences between the home environment and the NICU limit the generalizability of the present findings, the results of Study 2 call into question the validity of blanket policies designed to limit contact between parents and their infants during their stay in the NICU and suggest that touch may not necessarily be noxious to such infants. This assertion was also made by Harrison et al. (1990) who reported large individual variability in pre-term infants' responses to parental touch. Taken together, the results of these investigations combine to suggest that in place of universal policies designed to prohibit tactile stimulation or provide it in an unvarying manner, it may be more beneficial to implement programs that teach parents to interpret their infants' behavioral cues and to provide their tactile stimulation in accordance with their infants' signals. However, Brazelton (1990) appropriately summarized the difficulties involved in such a proposal, as it would be necessary for parents to distinguish appropriate, enriching stimulation from inappropriate, overwhelming stimulation so as to select the appropriate level of stimulation for their particular infant. The results of the present investigations also suggest that the context in which this stimulation is presented may play a role in infants' responses, thereby introducing an additional element of complexity.

As there are currently no existing data on which to evaluate the merits of such policies, research directly examining the quality of social stimulation provided to infants, and infants' reactions to such stimulation, in the NICU is warranted. Furthermore, given Stern and Hildebrandt's (1986) finding that female adults who interacted with an unfamiliar full-term infant identified as pre-term touched the infant differently, comparisons of touch delivered by caregivers and medical personnel may be useful in identifying the range of stimulation to which these infants may be exposed.

The results pertaining to the quality of maternal touch also appear to call into question the appropriateness of blanket supplemental stimulation and intervention programs in the treatment of pre-term infants. Research examining the impact of massage on pre-term infants has generally reported beneficial effects (e.g., Harrison, 1985; Helders et al., 1989; Rose, Schmidt, Riese, & Bridger, 1980; Scafidi et al., 1986, 1990). However, the present findings suggest that even such seemingly innocuous forms of stimulation as stroking may be negatively arousing to infants when presented noncontingently and/or repetitively. Adverse reactions to stroking in small LBW infants have also been reported elsewhere (Powell, 1974; Weiss et al., 2000). Furthermore, as the effects of massage have generally been evaluated using medically-based criteria (e.g., caloric intake, weight gain; days to hospital discharge) there is currently little available information on which to judge the socio-behavioral impact of such strategies.

Conclusions and Contributions of the Present Research

In summary, there is both theoretical and empirical support for the assertion that mother-infant interaction serves as an important context for the development of infants' abilities and that maternal tactile-gestural stimulation is one means of fostering and supporting these skills. The results from Study 1 underscore the considerable breadth and diversity of touch and gesture as a communicative channel and highlight its utility in modifying infant behavior. Although touch alone appears capable of altering infants' behavior, it is also incorporated to a great extent in naturalistic interactions, and appears to complement the facial and vocal communicative channels. In addition, however, the results of the present studies suggest that even in the presence of other salient modes of communication touch serves an important communicative function, and that the function it serves may be distinct from those of the facial and vocal communicative channels. Infants appear highly attuned and sensitive to their mothers' tactile-gestural behavior and appear to respond to subtle variations occurring within this communicative channel. Nevertheless, the results of Study 2 indicate that even natural perturbations to the dyad do not necessarily result in differences in maternal tactile-gestural stimulation. However, they do appear to contribute to differences in infant smiling and some subtle differences in their nonverbal behavioral configurations.

The proposed studies contributed significantly and uniquely to our understanding of the ways in which tactile-gestural stimulation influences infant behavior by permitting both contextual and developmental examinations of multiple infant and maternal nonverbal behaviors as they occur during dyadic interactions, information that was lacking in the literature. In addition, they provided much-needed information regarding the organization of nonverbal behavior as it exists during mother-infant face-to-face interactions, by examining co-occurrences both among different infant nonverbal behaviors, as well as between mothers' and their infants' nonverbal behaviors. In so doing, they provided information from which to specifically assess whether periods of maternal touching and gesturing were associated with infant engagement and disengagement. Lastly, they permitted a comparison of mothers' uses of tactile-gestural stimulation with NBW-FT and VLBW-PT infants, and infants' reactions to such stimulation.

References

Adamson, L. B., & Bakeman, R. (1985). Affect and attention: Infants observed with mothers and peers. Child Development, 56, 582-593.

Adrien, J. L., Lenoire, P., Martineau, J., Perrot, A., Hameury, L., Larmande, C., & Sauvage, D. (1993). Blind ratings of early symptoms of autism based upon family home movies. Journal of the American Academy of Child and Adolescent Psychiatry, 32, 617-626.

Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. (1978). Patterns of attachment: A psychological study of the strange situation. Hillsdale, NJ: Lawrence Erlbaum Associates.

Als, H. (1983). Infant individuality: Assessing patterns of very early development. In J. D. Call, E. Galenson, & R. L. Tyson (Eds.), Frontiers of infant psychiatry (pp. 363-378). New York: Basic Books.

Als, H., & Brazelton, T. B. (1981). A new model of assessing the behavioral organization in preterm and full-term infants: Two case studies. Journal of the American Academy of Child Psychiatry, 20, 239-263.

Als, H., Lester, B. M., Tronick, E. Z., & Brazelton, T. B. (1982). Manual for the Assessment of Preterm Infants' Behavior (APIB). In H. Fitzgerald, B. Lester, & M. Yogman (Eds.), Theory and research in behavioral pediatrics. New York: Plenum Press.

Anderson, J. (1986). Sensory intervention with the preterm infant in the neonatal intensive care unit. American Journal of Occupational Therapy, 40, 19-26.

Arco, C. M. B. (1983). Infant reactions to natural and manipulated temporal patterns of paternal communication. Infant Behavior and Development, 6, 391-399.

Arco, C. M. B., & McClusky, K. A. (1981). "A change of pace": An investigation of the salience of maternal temporal style in mother-infant play. Child Development, 52, 941-949.

Argyle, M. (1988). Bodily communication. New York: Methuen.

Arnold, S. L. (1995). Manipulations of verbal instructions provided to mothers: Effects on 5.5-month-old infants' responses during touch-only face-to-face interactions. Unpublished master's thesis, Concordia University, Montreal, Quebec, Canada.

Arnold, S. L., Brouillette, J., & Stack, D. M. (1996, August). Changes in maternal and infant behavior as a function of instructional manipulations during unimodal and multimodal interactions. Poster session presented at the biennial meeting of the International Society for the Study of Behavioral Development, Quebec City, Canada.

Arnold, S. L., & Deschênes, N. (2000). Co-occurrence program for merging two streams of ongoing interaction [Computer programming language]. Montreal, Quebec, Canada: Authors.

Bakeman, R. & Brown, J. V. (1977). Behavioral dialogues: An approach to the assessment of mother-infant interaction. Child Development, 48, 195-203.

Bakeman, R. & Brown, J. V. (1980). Early interaction: Consequences for social and mental development at three years. Child Development, 51, 437-447.

Bakeman, R., & Gottman, J. M. (1997). Observing interaction: An introduction to sequential analysis (2nd ed.). New York: Cambridge University Press.

Banks, M., & Salapatek, P. (1983). Infant visual perception. In P. H. Mussen (Series Ed.), & M. M. Haith & J. J. Campos (Vol. Eds.), of P. H. Mussen (Ed.) Handbook of child psychology: Vol. 2. Infancy and developmental psychobiology (4th ed., pp. 435-572). New York: Wiley.

Barnard, K., Bee, H., & Hammond, M. (1984). Developmental changes in maternal interactions with term and preterm infants. Infant Behavior and Development, 7, 101-113.

Barratt, M. S., Roach, M. A., & Leavitt, L. A. (1992). Early channels of mother-infant communication: Preterm and term infants. Journal of Child Psychology and Psychiatry, 33, 1193-1204.

Barrera, M. E., Rosenbaum, P. L., & Cunningham, C. E. (1987). Corrected and uncorrected Bayley scores: Longitudinal developmental patterns in low and high birth weight preterm infants. Infant Behavior and Development, 10, 337-346.

Bates, E. (1979). The emergence of symbols: Cognition and communication in infancy. New York: Academic Press.

Bauchner, H., Brown, E., & Peskin, J. (1988). Premature graduates of the newborn intensive care unit: A guide to follow-up. Pediatric Clinics of North America, 35, 1207-1225.

Beckwith, L., & Cohen, S. E., (1989). Maternal responsiveness with preterm infants and later competency. Child Development, 43, 75-87.

Beebe, B. (2000). Constructing mother-infant distress: The microsynchrony of maternal impingement and infant avoidance in the face-to-face encounter. Psychoanalytic Inquiry, 20, 421-440.

Behrman, R. (1985). Preventing low birth weight: A pediatric perspective. Journal of Pediatrics, 107, 842-854.

Belsky, J. (1981). Early human experience: A family perspective. Developmental Psychology, 17, 630-639.

Bernbaum, J., & Hoffman-Williamson, M. (1985). Following the NICU graduate. Contemporary Pediatrics, 3, 22-37.

Bigsby, R., Coster, W., Lester, B. M., & Peucker, M. R. (1996). Motor behavioral cues of term and preterm infants at 3 months. Infant Behavior and Development, 19, 295-307.

Birdwhistell, R. L. (1963). The kinesic level in the investigation of the emotions. In R. H. Knapp (Ed.), Expression of emotion in man (pp. 123-139). New York: International Universities Press.

Birdwhistell, R. L. (1970). Kinesics and context: Essays on body motion communication. Philadelphia, PA: University of Pennsylvania Press.

Birns, B., Blank, M., & Bridger, W. H. (1966). The effectiveness of various soothing techniques on human neonates. Psychosomatic Medicine, 28, 316-322.

Blackburn, S. (1993). The use of orally directed behaviors by VLBW infants. Neonatal Network, 12, 61.

Blehar, M. C., Lieberman, A. F., & Ainsworth, M. D. S. (1977). Early face-to-face interaction and its relation to later infant-mother attachment. Child Development, 48, 182-194.

Bornstein, M. H. (2000). Infant into conversant: Language and nonlanguage processes in developing early communication. In N. Budwig, I. Užgiris, & J. V. Wertsch (Eds.), Communication: An arena of development (pp. 109-129). Stamford, CN: Ablex.

Bornstein, M. H., & Lamb, M. E. (1992). Development in infancy (3rd ed.). New York: McGraw-Hill.

Brazelton, T. B. (1982). Joint regulation of neonate-parent behavior. In E. Z. Tronick (Ed.), Social interchange in infancy: Affect, cognition, and communication. Baltimore, MD: University Park Press.

Brazelton, T. B. (1984). Introduction. In C. C. Brown (Ed.), The many facets of touch. Skillman, NJ: Johnson & Johnson.

Brazelton, T. B. (1990). Introduction. In N. Gunzenhauser (Ed.), Advances in touch (pp. xiii-xvii). Skillman, NJ: Johnson and Johnson.

Brazelton, T. B., Koslowski, B., & Main, M. (1974). The origins of reciprocity: The early mother-infant interaction. In M. Lewis, & L. A. Rosenblum (Vol. Eds.), The effect of the infant on its caregiver: Vol. 1. The origin of behavior (pp. 49-76). New York: Wiley.

Breslau, N., Klein, N., & Allen, L. (1988). Very low birthweight: Behavioral sequelae at nine years of age. Journal of the American Academy of Child and Adolescent Psychiatry, 27, 605-612.

Bronfenbrenner, U. (1999). Environments in developmental perspective: Theoretical and operational models. In S. L. Friedman & T. D. Wachs (Eds.), Measuring environment across the life span: Emerging methods and concepts (pp. 3-28). Washington, DC: American Psychological Association.

Bruner, J. S. (1971). The relevance of education. New York: W. W. Norton.

Bruner, J. S. (1983). Child's talk: Learning to use language. New York: Norton.

Bruner, J. (1984). Vygotsky's zone of proximal development: The hidden agenda. In B. Rogoff & J. D. Wertsch (Eds.), Children's learning in the zone of proximal development (pp. 93-97). San Francisco, CA: Jossey Bass.

Bullowa, M. (1979). Before speech: The beginnings of interpersonal communication. New York: Cambridge University Press.

Burgoon, J. K. (1985). Nonverbal signals. In M. L. Knapp & G. R. Miller (Eds.), Handbook of interpersonal communication (pp. 344-390). Beverly Hills, CA: Sage.

Butterworth, G. (1991). The ontogeny and phylogeny of joint visual attention. In A Whiten (Ed.), Natural theories of mind: Evolution, development and simulation of everyday mind reading (pp. 223-232). Cambridge, MA: Basil Blackwell.

Butterworth, G., & Cochran, E. (1980). Toward a mechanism of joint visual attention in human infancy. International Journal of Behavioral Development, 3, 253-272.

Butterworth, G., & Grover, L. (1988). The origins of referential communication in human infancy. In L. Weiskrantz (Ed.), Thought without language (pp. 5-24). New York: Clarendon Press.

Butterworth, G., & Grover, L. (1990). Joint visual attention, manual pointing, and preverbal communication in human infancy. In M. Jeannerod (Ed.), Attention and performance 13: Motor representation and control (pp. 605-624). Hillsdale, NJ: Lawrence Erlbaum Associates.

Butterworth, G., & Jarrett, N. (1991). What minds have in common space: Spatial mechanisms serving joint visual attention in infancy. British Journal of Developmental Psychology, 9, 55-72.

Byrne, J. M., & Horowitz, F. D. (1981). Rocking as a soothing intervention: The influence of direction and type of movement. Infant Behavior and Development, 4, 207-218.

Campos, J. J., Campos, R. G., & Barrett, K. C. (1989). Emergent themes in the study of emotional development and emotional regulation. Developmental Psychology, 25, 394-402.

Campos, J. J., Mumme, D. L., Kermoian, R., & Campos, R. G. (1994). A functionalist perspective on the nature of emotion. Monographs of the Society for Research in Child Development, 59 (2-3, Serial No. 240).

Cappella, J. N. (1981). Mutual influence in expressive behavior: Adult-adult and infant-adult dyadic interactions. Psychological Bulletin, 89, 101-132.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. Monographs of the Society for Research in Child Development, 63, (Serial No. 255).

Cicchetti, D., Ganiban, J., & Barnett, D. (1991). Contributions from the study of high-risk populations to understanding the development of emotion regulation. In J. Garber & K. Didoge (Eds.), The development of emotion regulation and dysregulation (pp. 15-48). New York: Cambridge University Press.

Cohen, J. (1968). Weighted Kappa: Nominal scale agreement with provision for scaled disagreement or partial credit. Psychological Bulletin, 70, 213-220.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd. ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cohen, S. E., & Beckwith, L. (1976). Maternal language in infancy. Developmental Psychology, 12, 371-372.

Cohn, J. F., Campbell, S. B., Matias, R., & Hopkins, J. (1990). Face-to-face interactions of postpartum depressed and nondepressed mother-infant pairs at 2 months. Developmental Psychology, 26, 15-23.

Cohn, J. F., & Tronick, E. Z. (1983). Three-month-old infants' reaction to simulated maternal depression. Child Development, 54, 185-193.

Cohn, J. F., & Tronick, E. Z. (1987). Mother-infant face-to-face interaction: The sequence of dyadic states at 3, 6, and 9 months. Developmental Psychology, 23, 68-77.

Cohn, J. F., & Tronick, E. (1989). Specificity of infants' response to mothers' affective behavior. Journal of the American Academy of Child and Adolescent Psychiatry, 28, 242-248.

Colburne, K. A. (2000). The emergence of triadic play in mother-infant interactions: Play context and nonverbal communicative behaviors. Unpublished doctoral dissertation, Concordia University, Montreal, Quebec, Canada.

Cole, P. M., Michel, M. K., & Teti, L. O. (1994). The development of emotion regulation and dysregulation: A clinical perspective. In N. A. Fox (Ed.), The development of emotion regulation: Biological and behavioral considerations. Monographs of the Society for Research in Child Development, 59, (2-3, Serial No. 240).

Corkum, V., & Moore, C. (1995). Development of joint visual attention in infants. In C. Moore & P. J. Dunham (Eds.), Joint attention: Its origins and role in development (pp. 61-83). Hillsdale, NJ: Lawrence Erlbaum Associates.

Corkum, V., & Moore, C. (1998). The origins of joint visual attention in infants. Developmental Psychology, 34, 28-38.

Creasey, G. L., Jarvis, P. A., Myers, B., Markowitz, P. I., & Kerkering, K. W. (1993). Mental and motor development for three groups of premature infants. Infant Behavior and Development, 16, 365-372.

Crnic, K., Greenberg, M., Ragozin, A., Robinson, N., & Basham, R. (1983). Effects of stress and social support on mothers and premature and full-term infants. Child Development, 54, 209-217.

Crnic, K., Greenberg, M., Robinson, N., & Ragozin, A. (1984). Maternal stress and social support: Effects on the mother-infant relationship from birth to eighteen months. American Journal of Orthopsychiatry, 54, 224-235.

Crnic, K. A., Ragozin, A. S., Greenberg, M. T., Robinson, N. M., & Basham, R. B. (1983). Social interaction and developmental competence of preterm and full-term infants during the first year of life. Child Development, 54, 1199-1210.

Crockenberg, S., & Leerkes, E. (2000). Infant social and emotional development in family context. In C. H. Zeanah Jr. (Ed.), Handbook of infant mental health (2nd ed., pp. 60-90). New York: Guilford Press.

DeBoer, M. M., & Boxes, A. M. (1979). Signal functions of infant facial expressions and gaze direction during mother-infant face-to-face play. Child Development, 50, 1215-1218.

DeMaio-Feldman, D. (1994). Somatosensory processing abilities of very low-birth weight infants at school age. American Journal of Occupational Therapy, 48, 639-645.

D'Entremont, B., & Muir, D. (1997). Five-month-olds' attention and affective responses to still-faced emotional expressions. Infant Behavior and Development, 20, 563-568.

D'Entremont, B., Hains, S. M. J., & Muir, D. W. (1997). A demonstration of gaze following in 3-6-month-olds. Infant Behavior and Development, 20, 569-572.

Desrochers, S., Morisette, P., & Ricard, M. (1995). Two perspectives on pointing in infancy. In C. Moore & P. J. Dunham (Eds.), Joint attention: Its origins and role in development (pp. 85-101). Hillsdale, NJ: Lawrence Erlbaum Associates.

Dickson, K. L., Walker, H., & Fogel, A. (1997). The relationship between smile type and play type during parent-infant play. Developmental Psychology, 33, 925-933.

Diskin, S. D., & Heinicke, C. M. (1986). Maternal style of emotional expression. Infant Behavior and Development, 9, 167-187

Dittman, A. T. (1987). The role of body movement in communication. In A. W. Siegman & S. Feldstein (Eds.), Nonverbal behavior and communication (pp. 37-64). Hillsdale, NJ: Lawrence Erlbaum Associates.

DiVitto, B., & Goldberg, S. (1979). The effects of newborn medical status on early parent-infant interaction. In T. M. Field, A. M. Sostek, S. Goldberg, & H. H. Sherman (Eds.), Infants born at risk: Behavior and development (pp. 311-332). New York: SP Medical and Scientific Books.

Dixon, W. J., Brown, M. B., Engelman, L., & Jennings, R. I. (1990). BMDP statistical software manual (Vols. 1-2). Berkeley, CA: University of California Press.

Dodge, K. A., & Garber, J. (1991). Domains of emotion regulation. In J. Garber & K. Dodge (Eds.), The development of emotion regulation and dysregulation. New York: Cambridge University Press.

Dunham, P., & Dunham, F. (1990). Effects of mother-infant social interactions on infants' subsequent contingency task performance. Child Development, 61, 785-793.

Eckerman, C. O., Hsu, H-C., Molitor, A., Leung, E. H. L., & Goldstein, R. F. (1999). Infant arousal in an en-face exchange with a new partner: Effects of prematurity and perinatal biological risk. Developmental Psychology, 35, 282-293.

Eckerman, C. O., & Oehler, J. M. (1992). Very-low-birthweight newborns and parents as early social partners. In S. L. Friedman & M. D. Sigman (Eds.), The psychological developmentof low-birthweight children (pp. 91-123). Norwood, NJ: Ablex.

Eckerman, C. O., Oehler, J. M., Hannan, T. E., & Molitor, A. (1995). The development prior to term age of very prematurely born newborns' responsiveness in en face exchanges. Infant Behavior and Development 18, 283-297.

Eckerman, C. O., Oehler, J. M., Medvin, M. B., & Hannan, T. E. (1994). Premature newborns as social partners before term age. Infant Behavior and Development, 17, 55-70.

Ellsworth, C. P., Muir, D. W., & Hains, S. (1993). Social competence and person-object differentiation: An analysis of the still-face effect. Developmental Psychology, 29, 63-73.

Emde, R. N., Gaensbauer, T. J., & Harmon, R. J. (1976). Emotional expression in infancy: A biobehavioral study. Psychological Issues, 10, Monograph 37.

Fernald, A. (1993). Approval and disapproval: Infant responsiveness to vocal affect in familiar and unfamiliar languages. Child Development, 64, 657-674.

Field, T. M. (1977). Effects of early separation, interactive deficits, and experimental manipulations on infant-mother face-to-face interaction. Child Development, 48, 763-771.

Field, T. M. (1979). Visual and cardiac responses to animate and inanimate faces by young term and preterm infants. Child Development, 50, 188-194.

Field, T. M. (1981). Gaze behavior of normal and high-risk infants during early interactions. Journal of the American Academy of Child Psychiatry, 20, 308-317.

Field, T. M. (1982). Interaction coaching for high-risk infants and their parents. Prevention in Human Services, 1, 5-24.

Field, T. M. (1984). Early interactions between infants and their postpartum depressed mothers. Infant Behavior and Development, 7, 517-522.

Field, T., Greenberg, R., Woodson, R., Cohen, D., & Garcia, R. (1984). A descriptive study of facial expressions during Brazelton neonatal behavior assessments. Infant Mental Health Journal, 5, 61-71.

Field, T., Healy, B., Goldstein, S., & Guthertz, M. (1990). Behavior state matching in mother-infant interactions of nondepressed versus depressed mother-infant dyads. Developmental Psychology, 26, 7-14.

Field, T. M., Schanberg, S. M., Scafidi, F., Bauer, C. R., Vega-Lahr, N., Garcia, R., Nystrom, J., & Kuhn, C. M. (1986). Effects of tactile/kinesthetic stimulation on preterm neonates. Pediatrics, 77, 654-658.

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

Fitzgerald, M., Millard, D., & MacIntosh, N. (1988). Hyperalgesia in premature infants. Lancet, II, 292.

Fogel, A. (1982). Affect dynamics in early infancy: Affective tolerance. In T. Field & A. Fogel (Eds.), Emotion and early interaction (pp. 25-56). Hillsdale, NJ: Lawrence Erlbaum Associates.

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

Fogel, A. (1997). Infancy: Infant, family, and society (3rd ed.). New York: West Publishing Company.

Fogel, A., Dedo, J., & McEwen, I. (1992). Effect of postural position and reaching on gaze during mother-infant face-to-face interaction. Infant Behavior and Development, 15, 231-244.

Fogel, A., Diamond, G. R., Hoover Langhorst, B., & Demos, V. (1982). Affective and cognitive aspects of the 2-month-old's participation in face-to-face interaction with the mother. In E. Z. Tronick (Ed.), Social interchange in infancy: Affect, cognition, and communication (pp. 37-57). Baltimore, MD: University Park Press.

Fogel, A., & Hannan, T. E. (1985). Manual actions of nine- to fifteen-week-old human infants during face-to-face interaction with their mothers. Child Development, 56, 1271-1279.

Fogel, A., Nwokah, E., & Karns, J. (1993). Parent-infant games as dynamic social systems. In K. MacDonald (Ed.), Parent-child play: Descriptions and implications (pp. 43-70). New York: State University of New York Press.

Fogel, A., & Thelen, E. (1987). Development of early expressive and communicative action: Reinterpreting the evidence from a dynamic systems perspective. Developmental Psychology, 23, 747-761.

Folven, R. J., Bonvillian, J. D., & Orlansky, M. D. (1984/1985). Communicative gestures and early sign language acquisition. First Language, 5, 129-143.

Gable, S., & Isabella, R. A. (1992). Maternal contributions to infant regulation of arousal. Infant Behavior and Development, 15, 95-107.

Gardner, J. M., & Karmel, B. Z. (1983). Attention and arousal in preterm and full-term neonates. In T. Field & A. Sostek (Eds.), Infants born at risk: Physiological perceptual, and cognitive processes (pp. 69-98). New York: Grune & Stratton.

Gennaro, S., York, R., & Brooten, D. (1990). Anxiety and depression in mothers of low birthweight and very low birthweight infants: Birth through 5 months. Issues in Comprehensive Pediatric Nursing, 13, 97-109.

Gewirtz, J. L., & Boyd, E. F. (1976). Mother-infant interaction and its study. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 11). New York: Academic Press.

Gewirtz, J. L., & Boyd, E. F. (1977). Experiments on mother-infant interaction underlying mutual attachment acquisition: The infant conditions the mother. In T. Alloway, L. Krames, & P. Piner (Eds.), Attachment behavior: Advances in the study of communication and affect (Vol. 3). New York: Plenum Press.

Goldberg, S. (1979). Premature birth: Consequences for the parent-infant relationship. American Scientist, 67, 214-220.

Goldberg, S., Brachfeld, S., & DiVitto, B. (1980). Feeding, fussing, and play: Parent-infant interaction in the first year as a function of prematurity and perinatal medical problems. In T. M. Field, S. Goldberg, D. Stern, & A. M. Sostek (Eds.), High-risk infants and children: Adult and peer interactions. New York: Academic.

Goldschmidt, W. (1997). Nonverbal communication and culture. In U. Segerstråle & P. Molnár (Eds.), Nonverbal communication: Where nature meets culture (pp. 229-243). Mahwah, NJ: Lawrence Erlbaum Associates.

Gorga, D., Stern, F. M., & Ross, G. (1985). Trends in neuromotor behavior of preterm and fullterm infants in the first year of life: A preliminary report. Developmental Medicine and Child Neurology, 27, 756-766.

Gorski, P. A. (1984). Infants at risk. In M. J. Hanson (Ed.), Atypical infant development. Baltimore, MD: University Park Press.

Gorski, P. A., Hole, W. T., Leonard, C. H., & Martin, J. A. (1983). Direct computer scoring of premature infants and nursery care. Distress following two interventions. Pediatrics, 72, 198-202.

Gottfried, A. W., Lande, P. W., Brown, S. S., King, J., Coen, C., & Hodgman, J. E. (1981). Physical and social environments of newborn infants in special care units. Science, 214, 673-675.

Greene, J. G., Fox, N. A., & Lewis, M. (1983). The relationship between neonatal characteristics and three-month mother-infant interaction in high-risk infants. Child Development, 54, 1286-1296.

Greenspan, S. (1981). Psychopathology and adaptation in infancy and early childhood. Clinical infant reports: Series of the National Center for Clinical Infant Programs. New York: International Universities Press.

Gusella, J. L., Muir, D. W., & Tronick, E. Z. (1988). The effect of manipulating maternal behavior during an interaction on 3- and 6-month olds' affect and attention. Child Development, 59, 1111-1124.

Gustafson, G. E., Green, J. A., & West, M. J. (1979). The infant's changing role in mother-infant games: The growth of social skills. Infant Behavior and Development, 2, 301-308.

Haaf, R. A., & Bell, R. Q. (1967). A facial dimension in visual discrimination by human infants. Child Development, 38, 893-899.

Hack, M., Faranoff, A., & Merkatz, I. (1979). The low birth weight infant: Evolution of a changing outlook. New England Journal of Medicine, 301, 1162-1165.

Harper, R., Weins, A., & Matarazzo, J. (1978). Nonverbal communication: The state of the art. New York: Wiley.

Harrison, L. (1985). Effects of early supplemental stimulation programs for premature infants: Review of the literature. Maternal Child Nursing Journal, 14, 69-90.

Harrison, L. L., Leeper, J. D., & Yoon, M. (1990). Effects of early parent touch on preterm infants' heart rates and arterial oxygen saturation levels. Journal of Advanced Nursing, 15, 877-885.

Hartup, W. W. (1985). Relationships and their significance in cognitive development. In R. A. Hinde, A. N. Perret-Clermont, & J. Stevenson-Hinde (Eds.), Social relationships and cognitive development (pp. 68-81). Oxford, England: Clarendon Press.

Heaton, J. M. (1968). The eye: Phenomenology and psychology of function and disorder. London: Tavistock.

Helders, P. J. M., Cats, B. P., & Debast, S. (1989). Effect of a tactile stimulation/range finding programme on the development of VLBW-neonates during the first year of life. Child Care, Health and Development, 15, 369-380.

Hertzig, M. E. (1981). Neurological "soft signs" in low-birth weight children. Journal of Developmental Medicine and Child Neurology, 23, 778-791.

Hewes, G. W. (1957). The anthropology of gesture. Scientific American, 196, 123-132.

Hopkins, B. (1983). The development of early non-verbal communication: An evaluation of its meaning. Journal of the American Academy of Child Psychology Psychiatry and Allied Disciplines, 24, 131-144.

Hoy, E. A., Bill, J. M., & Sykes, D. H. (1988). Very low birthweight: A long-term developmental impairment? International Journal of Behavioral Development, 11, 37-67.

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

Hsu, H. C., Fogel, A., & Cooper, R. B. (2000). Infant vocal development during the first 6 months: Speech quality and melodic complexity. Infant and Child Development, 9, 1-16.

Hunter, M. A., & Koopman, R. (1990). Interobserver agreement and reliability of infant visual fixation data. Infant Behavior and Development, 13, 109-116.

Iverson, J. M., Tencer, H. L., Lany, J., & Goldin-Meadow, S. (2000). The relation between gesture and speech in congenitally blind and sighted language-learners. Journal of Nonverbal Behavior, 24, 105-130.

Izard, C. E. (1977). Human emotions. New York: Plenum Press.

Jarvis, P. A., Myers, B. J., & Creasey, G. L. (1989). The effects of infants' illness on mothers' interactions with prematures at 4 and 8 months. Infant Behavior and Development, 12, 25-35.

Kagan, J. (1967). On the need for relativism. American Psychologist, 22, 131-142.

Kagan, J. (1971). Change and continuity in infancy. New York: Wiley.

Kagan, J. (1994). On the nature of emotion. In N. A. Fox (Ed.), The development of emotion regulation: Biological and behavioral considerations. Monographs of the Society for Research in Child Development, 59 (2-3), 7-24.

Kagan, J., Kearsley, R. B., & Zelazo, P. R. (1978). Infancy: Its place in human development. Cambridge, MA: Harvard University Press.

Kaye, K. (1982). The mental and social life of babies: How parents create persons. Chicago, IL: The University of Chicago Press.

Kaye, K., & Fogel, A. (1980). The temporal structure of face-to-face communication between mothers and infants. Developmental Psychology, 16, 454-464.

Kendon, A. (1987). On gesture: Its complementary relationship with speech. In A. Siegman & S. Feldstein (Eds.), Nonverbal behavior and communication (pp. 65-97). Hillsdale, NJ: Lawrence Erlbaum Associates.

Keppel, G. (1982). Design and analysis: A researcher's handbook (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Knapp, M. L. (1978). Nonverbal communication in human interaction (2nd ed.). New York: Holt, Rinehart & Winston.

Knobloch, H., Malone, A., Ellison, P. H., Stevens, F., Zdeb, M. (1982). Considerations in evaluating changes in outcome for infants weighing less than 1501g. Pediatrics, 69, 285-295.

Koester, L. S. (1995). Face-to-face interactions between hearing mothers and their deaf or hearing infants. Infant Behavior and Development, 18, 145-153.

Koester, L. S., Papoušek, H., & Papoušek, M. (1989). Patterns of rhythmic stimulation by mothers with three-month-olds: A cross-modal comparison. International Journal of Behavioral Development, 12, 143-154.

Kogan, N., & Carter, A. S. (1996). Mother-infant reengagement following the still-face: The role of maternal emotional availability in infant regulation. Infant Behavior and Development, 19, 359-370.

Kopp, C. B. (1987). Developmental risk: Historical reflections. In J. D. Osofsky (Ed.), Handbook of infant development (2nd ed.), Wiley series on personality processes (pp. 881-912). New York: Wiley and Sons.

Kopp, C. B. (1989). Regulation of distress and negative emotions: A developmental review. Developmental Psychology, 25, 343-354.

Korner, A. F., & Thoman, E. B. (1972). The relative efficacy of contact and vestibular-proprioceptive stimulation in soothing neonates. Child Development, 43, 443-453.

Kundu, M. R. (1976). Visual literacy: Teaching non-verbal communication through television. Educational Technology, 16, 31-33.

Lamb, M. E., & Malkin, C. M. (1986). The development of social expectations in distress-relief sequences: A longitudinal study. International Journal of Behavioral Development, 9, 235-249.

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

Landry, S. H., & Chapieski, M. L. (1989). Joint attention and infant toy exploration: Effects of Down syndrome and prematurity. Child Development, 60, 103-118.

Legerstee, M., Corter, C., & Kineapple, K. (1990). Hand, arm, and facial actions of young infants to a social and nonsocial stimulus. Child Development, 61, 774-784.

Legerstee, M., Pomerleau, A., Malcuit, G., & Fieder, H. (1987). The development of infants' responses to people and a doll. Implications for research in communication. Infant Behavior and Development, 10, 81-95.

Leiba, E. (2000). Maternal nonverbal behaviors and infant gaze during triadic play with toys at 5 and 12 months. Unpublished master's thesis, Concordia University, Montreal, Quebec, Canada.

Leroux, S., Malcuit, G., & Permerleau, A. (1999). Etude comparative de nourrissons prematures et nes a terme et des modes de stimulations qu'ils experimentent au cours des six premiers mois. Revue Canadienne des Sciences du Comportement, 31, 40-53.

Lester, B. M., Hoffman, J., & Brazelton, T. B. (1985). The rhythmic structure of mother-infant interaction in term and preterm infants. Child Development, 56, 15-27.

Lewis, M. (1993). The emergence of human emotions. In M. Lewis & J. M. Haviland (Eds.), Handbook of emotions (pp. 223-235). New York: Guilford.

Long, J. G., Philip, A. G. S., & Lucey, J. F. (1980). Excessive handling as a cause of hypoxemia. Pediatrics, 65, 203-207.

Lucey, J. F. (1981). Clinical uses of transcutaneous oxygen monitoring. In L. A. Borness (Ed.), Advances in Pediatrics: Vol. 28 (pp. 27-55).

Maccoby, E., & Martin, J. (1983). Socialization in the context of the family: Parent-child interaction. In E. M. Hetherington (Ed.), Handbook of child psychology: Socialization, personality, and social development (pp. 1-101). New York: Wiley.

Macnamara, J. (1977). From sign to language. In J. Macnamara (Ed.), Language learning and thought. New York: Academic Press.

Malatesta, C. Z., Grigoryev, P., Lamb, C., Albin, M., & Culver, C. (1986). Emotion socialization and expressive development in preterm and full-term infants. Child Development, 57, 316-330.

Malatesta-Magai, C. (1991). Development of emotional expression during infancy: General course and patterns of individual differences. In J. Garber & K. Dodge (Eds.), The development of emotion regulation and dysregulation (pp. 49-68). New York: Cambridge University Press.

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

Masters, J. C. (1991). Strategies and mechanisms for the personal and social control of emotion. In J. Garber & K. Dodge (Eds.), The development of emotion regulation and dysregulation (pp. 182-207). New York: Cambridge University Press.

Matlin, M. W. (1995). Psychology (2nd ed.). Fort Worth, TX: Buchholz.

Mayes, L. C., & Carter, A. S. (1990). Emerging social regulatory capacities as seen in the still-face situation. Child Development, 61, 754-763.

McGhee, L. J., & Eckerman, C. O. (1983). The preterm infant as a social partner: Responsive but unreadable. Infant Behavior and Development, 6, 461-470.

Messer, D. J., & Vietze, P. M. (1984). Timing and transitions in mother-infant gaze. Infant Behavior and Development, 7, 167-181.

Messinger, D. S. (1994). The development of infant smiling: A dynamic systems approach. Unpublished doctoral dissertation, University of Utah, Utah.

Messinger, D. S., Fogel, A., & Dickson, K. L. (1999). What's in a smile? Developmental Psychology, 35, 701-708.

Miceli, P. J., Goeke-Morey, M. C., Whitman, T. L., Kolberg, K. S., Miller-Loncar, C., & White, R. D. (2000). Brief report: Birth status, medical complications, and social environment: Individual differences in development of preterm, very low birth weight infants. Journal of Pediatric Psychology, 25, 353-358.

Millar, W. J., Strachan, J., & Wadhera, S. (1991). Trends in low birth weight Canada 1971 to 1989. Health Reports, 3, 311-325.

Millar, W. J., Strachan, J., & Wadhera, S. (1993, Spring). Trends in low birth weight. Canadian Social Trends, 26-29.

Minde, K. (1993). Prematurity and serious medical illness in infancy: Implications for development and intervention. In C. H. Zeanah Jr. (Ed.), Handbook of infant mental health (pp. 87-105). New York: Guilford.

Minde, K. (2000). Prematurity and serious medical conditions in infancy: Implications for development, behavior, and intervention. In C. H. Zeanah Jr. (Ed.), Handbook of infant mental health (2nd ed., pp. 176-194). New York: Guilford Press.

Minde, K., Perrotta, M., & Hellmann, J. (1988). The impact of delayed development in premature infants on mother-infant interaction: A prospective investigation. Journal of Pediatrics, 112, 136-142.

Minde, K., Whitelaw, H., Brown, J., & Fitzhardinge, P. (1983). Effect of neonatal complications in premature infants on early parent-infant interactions. Developmental Medicine and Child Neurology, 25, 763-777.

Mitchell, R. (1979). Objectives and outcome of perinatal care. Lancet, II, 931-933.

Molteno, C., Magasiner, V., Sayed, R., & Karplus, M. (1990). Postural development in very low birth weight and normal birth weight infants. Early Human Development, 24, 93-105.

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

Moore, C., & Corkum, V. (1998). Infant gaze following based on eye direction. British Journal of Developmental Psychology, 16, 495-503.

Morisette, P., Ricard, P., & Gouin-Decarie, T. (1995). Les relations entre l'attention conjointe au cours de la periode preverbale et le developpement de la reference verbale. International Journal of Psychology, 30, 481-498.

Moss, E. (1992). The socio-affective context of joint cognitive activity. In L. T. Winegar & J. Valsiner (Eds.), Children's development within social context: Vol.2: Research and methodology (pp. 117-154). Hillsdale, NJ: Lawrence Erlbaum Associates.

Muir, D. W., & Hains, S. M. J. (1993). Infant sensitivity to perturbations in adult facial, vocal, tactile, and contingent stimulation during face-to-face interactions. In B. Boysson-Bardies, S. de Schonen, P. Jusczyk, P. McNeilage, & J. Morton (Eds.), Developmental neurocognition: Speech and face processing in the first year of life (pp. 171-185). London: Kluwer Academic Publishers.

Murphy, C., & Messer, D. (1977). Mothers, infants and pointing: A study of gesture. In H. R. Schaffer (Ed.), Studies in mother-infant interaction. London: Academic Press.

Myers, B. J., Jarvis, P. A., Creasey, G. L., Kerkering, K. W., Markowitz, P. I., & Best, A. L. (1992). Prematurity and respiratory illness: Brazelton scale (NBAS) performance of preterm infants with bronchopulmonary dysplasia (BPD), respiratory distress syndrome (RDS), or no respiratory illness. Infant Behavior and Development, 15, 27-41.

Nance, S. (1982). Premature babies. New York: Priam.

Newman, L. F. (1981). Social and sensory environment of low birth weight infants in a special care nursery: An anthropological investigation. Journal of Nervous and Mental Disease, 169, 448-455.

Oehler, J. M., Eckerman, C. O., & Wilson, W. H. (1988). Social stimulation and the regulation of premature infants' state prior to term age. Infant Behavior and Development, 11, 335-351.

Ornitz, E. M., Guthrie, D., & Farley, A. H. (1977). The early development of autistic children. Journal of Autism and Child Schizoprenia, 7, 207-229.

Osofsky, J. (1992). Affective development and early relationships: Clinical implications. In J. W. Barron, M. N. Eagle, & D. L. Wolitzky (Eds.). Interface of psychoanalysis and psychology (pp. 233-244). Washington, DC: American Psychological Association.

Osterling, J., & Dawson, G. (1994). Early recognition of children with autism: A study of first birthday home videotapes. Journal of Autism and Developmental Disorders, 24, 247-257.

Papoušek, M. (1992). Early ontogeny of vocal communication in parent-infant interactions. In H. Papoušek, U. Juergens, & Papoušek, M. (Eds.), Nonverbal vocal communication: Comparative and developmental approaches. Studies in emotion and social interaction (pp. 230-261). New York: Cambridge University Press.

Papoušek, H., & Papoušek, M. (1978). The infant's fundamental adaptive response system in social interaction. In E. B. Thoman (Ed.), Origins of the infant's social responsiveness (pp. 175-208). Hillsdale, NJ: Lawrence Erlbaum Associates.

Papoušek, H., & Papoušek, M. (1987). Intuitive parenting: A dialectic counterpart to the infant's integrative competence. In J. D. Osofsky (Ed.), Handbook of infant development (2nd ed., pp. 669-720). New York: Wiley.

Papoušek, H., Papoušek, M., & Harris, B. J. (1987). The emergence of play in parent-infant interactions. In D. Goerlitz & J. F. Wohlwill (Eds.), Curiosity, imagination, and play: On the development of spontaneous cognitive motivational processes. Child psychology (pp. 214-246). Hillsdale, NJ: Lawrence Erlbaum Associates.

Papoušek, H., Papoušek, M., & Kesterman, G. (2000). Preverbal communication: Emergence of representative symbols. In N. Budwig, I. Užgiris, & J. Wertsch (Eds.), Communication: An arena of development (pp.81-107). Stamford, CT: Ablex.

Pêcheux, M., Findji, F., & Ruel., J. (1992). Maternal scaffolding of attention between 5 and 8 months. European Journal of Psychology and Education, 7, 209-218.

Pei, M. (1965). The story of language. Philadelphia, PA: J. B. Lippincott.

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

Petitto, L. A. (2001). On the biological foundations of human language. In K. Emmorey & H. Lane (Eds.), The signs of language revisited: An anthology to honor Ursula Bellugi and Edward Klima (pp. 449-473). Manwah, NJ: Lawrence Erlbaum Associates.

Petitto, L. A. & Marentette, P. F. (1991). Babbling in the manual code: Evidence for the ontogeny of language. Science, 25, 1493-1496.

Pharoah, P. O. D., & Alberman, E. D. (1990). Annual statistical review. Archives of Disease in Childhood, 65, 147-151.

Phillips, R. B., & Moses, H. A. (1996). Skin hunger effects on preterm neonates. The Transdisciplinary Journal, 6, 39-49.

Piaget, J. (1952). The origins of intelligence in children. New York: International University Press.

Powell, L. F. (1974). The effect of extra stimulation and maternal involvement on the development of low-birth-weight infants and on maternal behavior. Child Development, 45, 106-113.

Power, T. G. (1985). Mother- and father-infant play: A developmental analysis. Child Development, 56, 1514-1524.

Rickards, A. L., Kelly, E. A., Doyle, L. W., & Callanan, C. (2001). Cognitive, academic progress, behavior and self-concept at 14 years of very low birth weight children. Journal of Developmental and Behavioral Pediatrics, 22, 11-18.

Robson, K. S. (1967). The role of eye-to-eye contact in maternal-infant attachment. Journal of Child Psychology and Psychaitry, 8, 13-25.

Rogoff, B., Mistry, J., Radziszewska, B., & Germond, J. (1992). Infants' instrumental social interaction with adults. In S. Feinman (Ed.), Social referencing and the social construction of reality in infancy (pp. 323-348). New York: Plenum Press.

Rome-Flanders, T., Cronk, C., & Gourde, C. (1995). Maternal scaffolding in mother-infant games and its relationship to language development: A longitudinal study. First Language, 15, 339-355.

Rose, S. A. (1983). Differential rates of visual information processing in full-term and preterm infants. Child Development, 54, 1189-1198.

Rose, S. A., Gottfried, A. W., & Bridger, W. H. (1981). Cross-modal transfer in 6-month-old infants. Developmental Psychology, 17, 661-669.

Rose, S. A., Schmidt, K., Riese, M. L., & Bridger, W. H. (1980). Effects of prematurity and early intervention on responsivity to tactual stimuli: A comparison of preterm and full-term infants. Child Development, 51, 416-425.

Rothbart, M. K., Posner, M. I., & Boylan, A. (1990). Regulatory mechanisms in infant development. In J. T. Enns (Ed.), The development of attention: Research and theory. Advances in Psychology (pp. 47-66). Amsterdam: North Holland.

Rovee-Collier, C., & Hayne, H. (1987). Reactivation of infant memory: Implications for child development. Advances in Child Development and Behavior, 10, 185-238.

Rutter, M., & Schopler, E. (1987). Autism and pervasive developmental disorders: Concepts and diagnostic issues. Journal of Autism and Developmental Disorders, 17, 159-186.

Sameroff, A. J., & Chandler, M. J. (1975). Reproductive risk and the continuum of caretaking causality. In F. D. Horowitz (Ed.), Review of child development research (Vol. 4, pp. 187-244). Chicago: University of Chicago Press.

Sammons, W. A. H., & Lewis, J. M. (1985). Premature babies: A different beginning. St. Louis: Mosby.

Sander, L. W. (1962). Issues in early mother-child interaction. Journal of the American Academy of Child Psychiatry, 1, 141-166.

Scafidi, F. A., Field, T. M., Schanberg, S. M., Bauer, C. R., Tucci, K., Roberts, J., Morrow, C., & Kuhn, C. M. (1990). Massage stimulates growth in preterm infants: A replication. Infant Behavior and Development, 13, 167-188.

Scafidi, F. A., Field, T. M., Schanberg, S. M., Bauer, C. R., Vega-Lahr, N., Garcia, R., Poirier, J., Nystrom, G., & Kuhn, C. M. (1986). Effects of tactile-kinesthetic stimulation on the clinical course and sleep/wake behavior of preterm neonates. Infant Behavior and Development, 9, 91-105.

Scaife, M., & Bruner, J. S. (1975). The capacity for joint visual attention in the infant. Nature, 253, 265-266.

Schaffer, H. R. (1984). The child's entry into the social world. Behavioral Development: A Series of Monographs (Serial 236).

Schaffer, R. (1989). Early social development. In A. Slater & G. Bremner (Eds.), Infant development (pp. 189-210). Hillsdale, NJ: Lawrence Erlbaum Associates.

Schanberg, S. M., & Field, T. M. (1987). Sensory deprivation stress and supplemental stimulation in the rat pup and preterm human neonate. Child Development, 58, 1431-1447.

Schnur, E., & Shatz, M. (1984). The role of maternal gesturing in conversations with one-year-olds. Journal of Child Language, 11, 29-41.

Schraeder, B. D., Heverly, M. A., & Rappaport, J. (1990). Temperament, behavior problems, and learning skills in very low birthweight preschoolers. Research in Nursing and Health, 13, 27-34.

Segal, L. B., Oster, H., Cohen, M., Caspi, B., Myers, M., & Brown, D. (1995). Smiling and fussing in seven-month-old preterm and full-term black infants in the still-face situation. Child Development, 66, 1829-1843.

Seifer, R., Sameroff, A. J., Anagnostopolou, R., & Elias, P. K., (1992). Mother-infant interaction during the first year: Effects of situation, maternal mental illness, and demographic factors. Infant Behavior and Development, 15, 405-426.

Sell, E. J., Hill-Mangan, S., & Holberg, C. J. (1992). Natural course of behavioral organization in premature infants. Infant Behavior and Development, 15, 461-478.

Shatz, M. (1982). On mechanisms of language acquisition: Can features of the communicative environment account for development? In E. Wanner & L. Gleitman (Eds.), Language acquisition: The state of the art. Cambridge: Cambridge University Press.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. Psychological Bulletin, 86, 420-428.

Siegel, B., Pliner, C., Eschler, J., & Elliott, G. R. (1988). How children with autism are diagnosed: Difficulties in identification of children with multiple developmental delays. Journal of Developmental and Behavioral Pediatrics, 9, 199-204.

Spencer, P. E. (1993). Communication behaviors of infants with hearing loss and their mothers. Journal of Speech and Hearing Research, 36, 311-321.

Sroufe, L. A. (1979a). Socioemotional development. In J. D. Osofsky (Ed.), Handbook of infant development (pp. 462-516). New York: Wiley.

Sroufe, L. A. (1979b). The coherence of individual development: Early care, attachment, and subsequent developmental issues. American Psychologist, 34, 834-841.

Sroufe, L. A., & Waters, E. (1976). The ontogenesis of smiling and laughter: A perspective on the organization of development in infancy. Psychology Review, 83, 173-189.

Sroufe, L. A., Waters, E., & Matas, L. (1974). Contextual determinants of of infant affective response. In M. Lewis & L. A. Rosenblum (Eds.), The origins of Behavior: Vol. 2. The origins of fear (pp. 49-72). New York: Wiley

Stack, D. M. (2001). The salience of touch and physical contact during infancy: Unraveling some of the mysteries of the somaesthetic sense. In G. Bremner & A. Fogel (Eds.), Blackwell handbook of infant development, Part II, Social, emotional and communicative development (pp. 351-378). Oxford, England: Blackwell.

Stack, D. M., & Arnold, S. L. (1998). Infants' responses to changes in maternal touch and gesture. Infant Behavior and Development, 21, 45-468.

Stack, D. M., & LePage, D. E. (1996). Infants' sensitivity to manipulations of maternal touch during face-to-face interactions. Social Development, 5, 41-55.

Stack, D. M., LePage, D. E., Hains, S. M. J., & Muir, D. W. (1998). The Caregiver-Infant Touch Scale. Unpublished manuscript, Concordia University.

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

Stack, D. M., & Muir, D. W. (1992). Adult tactile stimulation during face-to-face interactions modulates 5-month-olds' affect and attention. Child Development, 63, 1509-1525.

Stack, D. M., & Poulin-Dubois, D. (1998). Socioemotional and cognitive competence in infancy: Paradigms, assessment strategies, and implications for intervention. In D. Pushkar, W. M. Bukowski, A. E. Schwartzman, D. M. Stack, & D. R. White (Eds.), Improving competence across the lifespan: Building interventions based on theory and research (pp. 37-57). New York: Plenum Press.

Stechler, G., & Carpenter, G. (1967). A viewpoint on early affective development. In J. Hellmuth (Ed.), The exceptional infant. Vol 1. (pp. 163-189).

Stiefel, G. S., Plunkett, J. W., & Meisels, S. J. (1987). Affective expression among preterm infants of varying levels of biological risk. Infant Behavior and Development, 10, 151-164.

Stern, D. N. (1971). A micro-analysis of mother-infant interaction: Behavior regulating social contact between a mother and her 3½-month-old twins. Journal of the American Academy of Child Psychiatry, 10, 501-517.

Stern, D. N. (1974). Mother and infant at play: The dyadic interaction involving facial, vocal, and gaze behaviors. In M. Lewis & L. A. Rosenblum (Eds.), The effect of the infant on its caregiver (pp. 187-214). New York: Wiley.

Stern, D. N. (1977). The first relationship. Cambridge, MA: Harvard University Press.

Stern, D. N. (1985). The interpersonal world of the infant: A view from psychoanalysis and developmental psychology. New York: Basic Books.

Stern, M., & Hildebrandt, K. A. (1986). Prematurity stereotyping: Effects on mother-infant interaction. Child Development, 57, 308-315.

Stifter, C. A., & Moyer, D. (1991). The regulation of positive affect: Gaze aversion activity during mother-infant interactions. Infant Behavior and Development, 14, 111-123.

Symons, D. K., & Moran, G. (1987). The behavioral dynamics of mutual responsiveness in early face-to-face mother-infant interactions. Child Development, 58, 1488-1495.

Symons, D. K., & Moran, G., (1994). Responsiveness and dependency are different aspects of social contingencies: An example from mother and infant smiles. Infant Behavior and Development, 17, 209-214.

Tabachnick, B. G., & Fidell, L. S. (1996). Using multivariate statistics (3rd ed.). New York: Harper and Row.

Tardy, T. J., & Volpe, J. J. (1982). Intraventricular hemorrhage in the premature infant. Pediatric Clinics of North America, 29, 1077-1104.

Thompson, R. A. (1994). Emotional regulation: A theme in search of a definition. In N. A. Fox (Ed.), The development of emotion regulation: Behavioral and biological considerations. Monographs of the Society for Research in Child Development, 59 (2-3, Serial No. 240).

Thompson, R. A., & Calkins, S. D. (1996). The double-edged sword: Emotional regulation for children at risk. Development and Psychopathology, 8, 163-182.

Thompson, R. J. Jr., Oehler, J. M., Catlett, A. T., & Johndrow, D. A. (1993). Maternal psychological adjustment to the birth of an infant weighing 1,500 grams or less. Infant Behavior and Development, 16, 471-485.

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

Trevarthen, C. (1974). Conversations with a two-month-old. New Scientist, 76, 230-236.

Tronick, E. Z. (1989). Emotions and emotional communication in infants. American Psychologist, 44, 112-119.

Tronick, E. Z. (1995). Touch in mother-infant interaction. In T. Field (Ed.), Touch in early development (pp. 53-65). Mahwah, NJ: Lawrence Erlbaum Associates.

Tronick, E. Z., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). The infant's response to entrapment between contradictory messages in face-to-face interaction. Journal of the American Academy of Child Psychiatry, 17, 1-13.

Tronick, E. Z., & Cohn, J. F. (1989). Infant-mother face-to-face interaction: Age and gender differences in coordination and the occurrence of miscoordination. Child Development, 60, 85-92.

Tronick, E. Z., & Weinberg, M. K. (1990, April). Stability of coping and emotions in 6-month-olds. Paper presented at the International Conference on Infant Studies, Montreal.

Turner, J. H. (1997). The evolution of emotions: The nonverbal basis of human social organization. In U. Segerstråle & P. Molnár (Eds.), Nonverbal communication: Where nature meets culture (pp. 211-223). Mahwah, NJ: Lawrence Erlbaum Associates.

U.S. Bureau of the Census (1996). Statistical Abstract of the United States (116th ed.). Washington, D.C.

van Beek, Y., Hopkins, B., & Hoeksma, J. B. (1994). The development of communication in preterm infant-mother dyads. Behaviour, 129, 35-61.

van der Veer, R., & van Ijzendoorn, M. H. (1985). Vygotsky's theory of the higher psychological processes: Some criticisms. Human Development, 28, 1-9.

van der Veer, R., & van Ijzendoorn, M. H. (1988). Early childhood attachment and later problem solving: A Vygotskian perspective. In J. Valsiner (Ed.), Child development within culturally structured environments: Parental cognition and adult-child interaction (pp. 215-246). Norwood, NJ: Ablex.

van Hoff-Van Duin, J., Evenhuis-van Leunen, A., Mohn, G., Baerts, W., & Fetter, W. P. F. (1989). Effects of very low birth weight (VLBW) on visual development during the first year after term. Early Human Development, 20, 255-266.

van Wulfften Palthe, T., & Hopkins, B. (1984). Development of the infant's social competence during early face-to-face interaction: A longitudinal study. In H. F. R. Prechtl (Ed.), Continuity in neural functions from prenatal to postnatal life (pp. 198-219). Oxford: Blackwell.

Vaughn, B., & Sroufe, L. A. (1979). The temporal relationship between infant heart rate acceleration and crying in an aversive situation. Child Development, 50, 565-567.

von Cranach, M., & Vine, I. (1973). Introduction. In M. von Cranach & I. Vine (Eds.), Social communication and movement. London: Academic Press.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Wahler, R. G. (1967). Infant social attachments: A reinforcement theory interpretation and investigation. Child Development, 38, 1079-1088.

Walden, T. A. (1991). Social referencing. In J. Garber & K. Dodge (Eds.), The development of emotion regulation and dysregulation (pp. 69-88). New York: Cambridge University Press.

Walker, H., Messinger, D., Fogel, A., & Karns, J. (1992). Social and communicative development in infancy. In V. B. Van Hasselt & M Hersen (Eds.), Handbook of social development: A developmental psychology perspective. Perspectives in developmental psychology (pp. 157-181). New York: Plenum Press.

Watt, J. (1990). Interaction, intervention, and development in small-for-gestational-age infants. Infant Behavior and Development, 13, 273-286.

Webbink, P. (1986). The power of the eyes. New York: Springer.

Weinberg, M., & Tronick, E. Z. (1994). Beyond the face: An empirical study of infant affective configurations of facial, vocal, gestural, and regulatory behaviors. Child Development, 65, 1503-1515.

Weinberg, M. K., & Tronick, E. Z. (1996). Infant affective reactions to the resumption of maternal interaction after the still-face. Child Development, 67, 905-914.

Weiss, S. J. (1992). Measurement of the sensory qualities in tactile interaction. Nursing Research, 41, 82-86.

Weiss, S. J., Wilson, P., Hertenstein, M. J., & Campos, R. (2000). The tactile context of a mother's caregiving: Implications for attachment of low birth weight infants. Infant Behavior and Development, 23, 91-111.

White, B. L., Castle, P., & Held, R. (1964). Observations on the development of visually-directed reaching. Child Development, 35, 349-364.

Winer, B. J. (1971). Statistical principles in experimental design (2nd ed.). New York: McGraw Hill.

Wolff, P. H. (1967). The role of biological rhythms in early psychological development. Bulletin of the Menninger Clinic, 31, 197-218.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. Journal of Child Psychology and Psychiatry, 17, 89-100.

World Health Organization (1990). Recommended definitions, standards, and reporting requirements for ICD-10 related fetal, perinatal, neonatal and infant mortality. World Health Statistics Quarterly, 43, 220-227.

Zelkowitz, P., Papageorgiou, A., & Allard., M. (1994). Relationship of rehospitalization to cognitive and behavioral outcomes in very low birth weight and normal birth weight children. Journal of Developmental and Behavioral Pediatrics, 15, 179-185.

Zelkowitz, P., Papageorgiou, A., Zelazo, P., & Weiss, M. J. S. (1995). Behavioral adjustment in very low and normal birth weight children. Journal of Clinical Child Psychology, 24, 21-30.

Appendix A

Power Analyses for Study 1

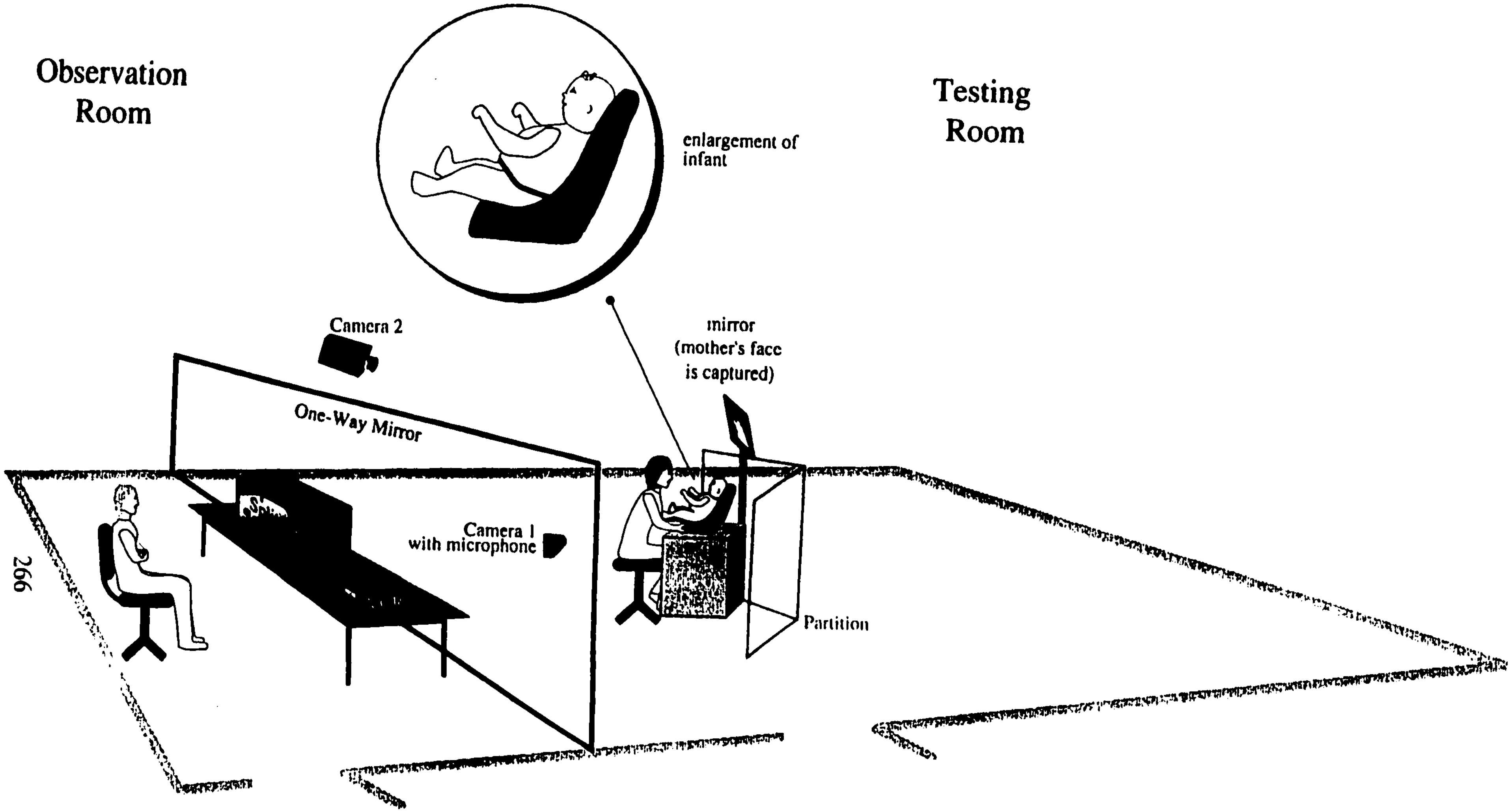
Total N = 115 Number of Cells = 32 Mean N Per Cell = 3 Alpha = .05

Factor	Number Levels	N Per Level	N' Per Level	Degrees of Freedom	Effect Size	Power
Age	2	48	33.0	1	.40	.898
Group	4	24	17.0	3	.40	.772
Period	4	24	17.0	3	.40	.772
Age x Group			17.0	3	.40	.772
Age x Period			17.0	3	.40	.772
Group x Period			7.4	9	.40	.583
Age x Group x Period			7.4	9	.40	.583

Appendix B

Schematic Diagram of Apparatus and Layout

of Testing Room for Study 1


Observation
Room
Testing
Room
enlargement of
infant
Camera 2
mirror
(mother's face
is captured)
One-Way Mirror
Camera 1
with microphone
Partition

Appendix C

Detailed Instructions to Mothers for Study 1

Tactile Experimental Group

Normal (N):
For this period. I would like you to play with your baby as you normally would at home.

Excited and Happy (EX):
For this period, I would like you to be silent and have a still face but, using only touch, get your baby excited and happy.

Relaxed and Calm (RL):
For this period, I would like you to be silent and have a still face but, using only touch, get your baby relaxed and calm.

Attention to Face (AF):
For this period, I would like you to be silent and have a still face but, using only touch, attract and hold your baby's attention on your face, with as much eye-to-eye contact as possible.

Tactile Control Group

Normal (N):
For this period, I would like you to play with your baby as you normally would at home.

Still-Face with Touch (SF+T):
For this period, I would like you to be silent and have a still face, but you may touch your baby.

Still-Face with Touch (SF+T):
For this period, I would like you to be silent and have a still face, but you may touch your baby.

Still-Face with Touch (SF+T):
For this period, I would like you to be silent and have a still face, but you may touch your baby.

All Modes Experimental Group

Normal (N):
For this period, I would like you to play with your baby as you normally would at home.

Excited and Happy (EX):
For this period, I would like you to use all modes of interaction to get your baby excited and happy.

Relaxed and Calm (RL):
For this period, I would like you to use all modes of interaction to get your baby relaxed and calm.

Attention to Face (AF):
For this period, I would like you to use all modes of interaction to attract and hold your baby's attention on your face, with as much eye-to-eye contact as possible.

All Modes Control Group

Normal (N):
For this period, I would like you to play with your baby as you normally would at home.

Normal (N):
For this period, I would like you to play with your baby as you normally would at home.

Normal (N):
For this period, I would like you to play with your baby as you normally would at home.

Normal (N):
For this period, I would like you to play with your baby as you normally would at home.

Appendix D

English and French Consent Forms for Study 1

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

Consent Form
Mother-Infant Interactions

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

I understand that my baby and I will participate in a study lasting approximately 60 minutes. During the study, my baby will be seated in an infant seat directly facing me. The procedure will consist of several interaction periods, each lasting two to three minutes in length, during which time I will be asked to interact in different ways with my baby. During some periods I will be asked to interact with my baby as I normally do, while in others I may be asked to pose a neutral facial expression and remain silent for brief periods while using touch to interact with my baby. There will be brief breaks separating the interaction periods.

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

I understand that my participation in this study is totally voluntary. I know that I may withdraw at any time and for any reason. I also understand that I may request that the videotape recording of my baby be erased. In the event that the results of the study are published, my name and the name of my baby will be kept confidential.

In the event that I have any unanswered concerns or complaints about this study, I may express these to Dr. Dale Stack (848-7565) or Sharon Arnold (848-7547) of the Psychology Department at Concordia University. In addition, the patient representative of the Jewish General Hospital is Lianne Brown (340-8222). She can be contacted should I have any questions regarding my rights as a research volunteer.

Thank you for your cooperation.

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

Parent's signature on behalf of infant: ____________________ Date: ________________

Parent's signature: ______________________________ Date: ________________

Witness: ___________________________________ Date: ________________

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(November 5, 1997)

7141 Sherbrooke Street West
Montreal, Quebec H4B 1R6

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

Formulaire de Consentement
Interaction Mère-Enfant

Cette étude a pour but d'évaluer les réactions des enfants lors d'une interaction sociale, et d'étudier les différents types d'interaction utilisés par les parents et tuteurs ainsi que leur rôle dans les échanges sociaux.

Je comprends que mon enfant participera à une séance d'observation de 60 minutes, et sera assis(e) dans un siège d'enfant me faisant face. La séance d'observation sera composée de plusieurs périodes de deux à trois minutes chacune dans lesquelles on me demandera d'interagir de différentes façons avec mon enfant. Durant certaines périodes, il me sera demandé d'interagir avec mon enfant comme je le fais habituellement à la maison, alors que dans d'autres périodes, je devrai demeurer silencieuse et conserver une expression faciale assez neutre, et n'utiliser que le toucher pour interagir avec mon enfant. Chaque période d'observation sera séparée par une courte pause et les manipulations expérimentales ne sont aucunement dangereuses pour mon enfant.

La séance entière sera filmée sur vidéo afin de permettre la cotation des réactions de mon enfant ultérieurement. Je comprends aussi que toutes les informations que nous fournissons, qu'elles soient écrites ou filmées, sont strictement confidentielles et qu'elles ne serviront qu'à des fins de recherche.

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

Dans l'éventualité où j'aurais des questions ou une plainte à formuler concernant cette étude, je pourrai m'adresser aux directeurs du projet: Dr. Dale Stack (848-7565) ou Sharon Arnold (848-7547) du département de psychologie de l'Université Concordia, ainsi que Lianne Brown (340-8222), représentante des patients à l'Hôpital Général Juif. Je peux contacter Mme Brown si j'ai des questions concernant mes droits en tant que participant volontaire à la recherche.

Merci de votre coopération.

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

Signature du parent pour l'enfant: ___________________________ Date: ___________________

Signature du parent: ______________________________________ Date: ___________________

Témoin: ____ Date: ___________________

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(5 novembre, 1997)

7141 Sherbrooke Street West
Montreal, Quebec H4B 1R6

Appendix E

Demographic Questionnaire

Demographic Information

Order:

Study #:
Infant #:
Test Date:

Infant's Name:____________ DOB:____________ EDOB:___________ Age:_____

Mother's Name:_________________ Age:__________

Languages Spoken:_____________________________

Father's Name:__________________ Age:__________

Languages Spoken:______________________________

Phone #:_______________
Address:____

Sex:__________ Birth Weight:__________ Length of Labour:_________

Preg. Complications and Delivery Status:______________________________

Medical History:____

Breast Fed:______ Bottle Fed:______

Siblings: Age Sex

______ ______
______ ______
______ ______

Father's Occupation:____________ Education:______________
Mother's Occupation:____________ Education:______________

Mother's Recent Work History (full/part-time/home):_________
Father's Work History (full/part-time/home):_________
Hours spent with infant all day:
Mother: all day ¾ ½ ¼ <¼
Father: all day ¾ ½ ¼ <¼

Caretaking History (# of caretakers, day/homecare, hours):______________

Previous tactile games:_______________
Amount relative to auditory and visual games:_____________

Appendix F

Qualitative Dimensions of Maternal Touch -

Caregiver-Infant Touch Scale (CITS)

Type of Touch:

0. No Touch
1. Static Touch (Rest, Hold, Hug)
2. Stroke/Caress/Rub/Massage
3. Pat/Tap
4. Squeeze/Pinch/Grasp
5. Tickle/Finger Walk/Prod/Poke/Push
6. Shake/Wiggle
7. Pull/Lift/Flexion/Extension/Clap
8. Other (e.g., Kiss, Wipe, Adjust Posture)

Area of Touch:

0. No Area
1. Feet/Legs
2. Trunk
3. Hands/Arms
4. Shoulders/Neck
5. Face

Appendix G

ANOVA Summary Tables, Post-Hoc Comparisons, and Means Tables for the

Maternal Touch and Maternal Gestures Measures:

Tactile Group Comparison, Study 1

Table G1

Analysis of Variance for Maternal Touch. Tactile Group Comparison for Study 1: Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	0.05
Group (G)	1	0.30
A x G	1	4.84*
S within-group error	54	(11.90)
	Within Subjects	
Period (P)	3	8.03**
P x A	3	0.35
P x G	3	2.37
P x A x G	3	1.78
P x S within-group error	162	3.00

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Table G2

Tukey Multiple Comparisons on the Period Main Effect for the Maternal Touch Measure.

Tactile Group Comparison – Study 1

Comparison	Mean Absolute Difference	Critical Difference	Probability Level
N vs. EX	1.10	0.83 (1.01)**	< .01
N vs. RL	1.55	0.83 (1.01)**	< .01
N vs. AF	0.57	0.83 (1.01)	N.S.
EX vs. RL	0.45	0.83 (1.01)	N.S.
EX vs. AF	0.53	0.83 (1.01)	N.S.
RL vs. AF	0.98	0.83 (1.01)*	< .05

Note. Values enclosed in parentheses denote .01 critical difference levels.

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

Table G3

Transformed Means for the Percent Duration of Maternal Touch by Period, Tactile Group Comparison for Study 1: Square Root Transformation

Period	M	SE
N	4.40	0.34
EX	3.30	0.30
RL	2.85	0.24
AF	3.83	0.33

Table G4

Transformed Means for the Percent Duration of Maternal Touch by Age and Group,

Tactile Group Comparison for Study 1: Square Root Transformation

Age	Group	
	Tactile Experimental	Tactile Control
3½-month-olds	2.95 (0.38)	2.97 (0.89)
5½-month-olds	4.07 (0.55)	3.29 (0.63)

Note. Values enclosed in parentheses represent standard errors.

Table G5

Analysis of Variance for Maternal Gestures, Tactile Group Comparison for Study 1: Log Transformation

Source	df	F
Between Subjects		
Age (A)	1	12.69**
Group (G)	1	2.24
A x G	1	3.16
S within-group error	54	(0.45)
Within Subjects		
Period (P)	3	7.55**
P x A	3	1.06
P x G	3	6.04*
P x A x G	3	2.56
P x S within-group error	162	(0.23)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Table G6

Transformed Means for the Percent Duration of Maternal Gestures by Age, Tactile Group Comparison for Study 1: Log Transformation

Age	M	SE
3½-month-olds	0.25	0.04
5½-month-olds	0.57	0.06

Table G7

Transformed Means for the Percent Duration of Maternal Gestures by Period and Group.

Tactile Group Comparison for Study 1: Square Root Transformation

	Group	
Period	Tactile Experimental	Tactile Control
N	2.34 (0.04)	2.41 (0.06)
EX	3.25 (0.05)	2.63 (0.05)
RL	1.31 (0.03)	1.09 (0.02)
AF	3.99 (0.08)	2.02 (0.07)

Note. Values enclosed in parentheses represent standard errors.

Appendix H

ANOVA Summary Tables and Post-Hoc Comparisons for the Infant Gaze at Face, Gaze at Hands, and Gaze Away Measures: Tactile Group Comparison, Study 1

Table H1

Analysis of Variance for Infant Gaze at Face, Tactile Group Comparison for Study 1

Source	*df*	*F*
	Between Subjects	
Group (G)	1	1.01
S within-group error	56	(750.39)
	Within Subjects	
Period (P)	3	42.48**
P x G	3	2.82*
P x *S* within-group error	168	(298.54)

Note. Values enclosed in parentheses represent mean square errors. *S* = subjects.

* $p < .016$. ** $p < .001$.

Table H2

Analysis of Variance for Infant Gaze at Hands, Tactile Group Comparison for Study 1

Source	df	F
Within Subjects		
Period (P)	3	16.04**
P x S within-group error	171	(340.93)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .016$. ** $p < .001$.

Table H3

Tukey Multiple Comparisons on the Period Main Effect for the Infant Gaze at Hands Measure, Tactile Group Comparison – Study 1

Comparison	Mean Absolute Difference	Critical Difference	Probability Level
N vs. EX	23.73	8.86 (10.74)**	< .01
N vs. RL	13.13	8.86 (10.74)**	< .01
N vs. AF	11.58	8.86 (10.74)**	< .01
EX vs. RL	10.60	8.86 (10.74)*	< .05
EX vs. AF	12.15	8.86 (10.74)**	< .01
RL vs. AF	1.55	8.86 (10.74)	N.S.

Note. Values enclosed in parentheses denote .01 critical difference levels.

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

Table H4

Analysis of Variance for Infant Gaze Away, Tactile Group Comparison for Study 1

Source	df	F
	Between Subjects	
Age (A)	1	7.45
Group (G)	1	3.84
A x G	1	5.22
S within-group error	54	(955.23)
	Within Subjects	
Period (P)	3	66.45**
P x A	3	2.88
P x G	3	12.76**
P x A x G	3	10.31**
P x S within-group error	162	(312.99)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Appendix I

ANOVA Summary Table, Post-Hoc Comparisons, and Means Table for the Infant Smiling Measure: Tactile Group Comparison, Study 1

Table 11

Analysis of Variance for Infant Smiling. Tactile Group Comparison for Study 1: Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	2.49
Group (G)	1	3.84
A x G	1	4.66
S within-group error	54	(6.43)
	Within Subjects	
Period (P)	3	95.42**
P x A	3	10.48**
P x G	3	8.12**
P x A x G	3	0.20
P x S within-group error	162	(1.87)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Table 12

Transformed Means for the Percent Duration of Infant Smiling by Period and Age, Tactile Group Comparison for Study 1: Square Root Transformation

Period	Age	
	3½-month-olds	5½-month-olds
N	7.18 (0.26)	6.83 (0.31)
EX	3.28 (0.38)	5.63 (0.44)
RL	2.60 (0.29)	2.99 (0.29)
AF	3.54 (0.34)	3.72 (0.39)

Note. Values enclosed in parentheses represent standard errors.

Table 13

Transformed Means for the Percent Duration of Infant Smiling by Period and Group,

Tactile Group Comparison for Study 1: Square Root Transformation

Period	Group	
	Tactile Experimental	Tactile Control
N	7.34 (0.24)	6.54 (0.33)
EX	5.18 (0.43)	3.32 (0.41)
RL	2.56 (0.22)	3.13 (0.38)
AF	3.80 (0.37)	3.38 (0.33)

Note. Values enclosed in parentheses represent standard errors.

Appendix J

ANOVA Summary Tables, Post-Hoc Comparisons, and Means Tables for the

Maternal Touch and Maternal Gestures Measures:

All Modes Group Comparison, Study 1

Table J1

Analysis of Variance for Maternal Touch, All Modes Group Comparison for Study 1: Square Root Transformation

Source	df	F
	Between Subjects	
Group (G)	1	1.00
S within-group error	55	(17.52)
	Within Subjects	
Period (P)	3	3.56*
P x G	3	9.88**
P x S within-group error	165	(3.94)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Table J2

Transformed Means for the Percent Duration of Maternal Touch by Period and Group. All Modes Group Comparison for Study 1: Square Root Transformation

	Group	
Period	All Modes Experimental	All Modes Control
N	5.12 (0.48)	5.70 (0.61)
EX	5.03 (0.46)	5.30 (0.53)
RL	3.17 (0.35)	5.90 (0.49)
AF	6.39 (0.56)	5.05 (0.58)

Note. Values enclosed in parentheses represent standard errors.

Table J3

Analysis of Variance for Maternal Gestures, All Modes Group Comparison for Study 1: Log Transformation

Source	df	F
	Between Subjects	
Age (A)	1	7.47*
Group (G)	1	3.45
A x G	1	0.73
S within-group error	53	(0.60)
	Within Subjects	
Period (P)	3	0.97
P x A	3	0.45
P x G	3	5.15**
P x A x G	3	2.13
P x S within-group error	159	(0.25)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Table J4

Transformed Means for the Percent Duration of Maternal Gestures by Age, All Modes Group Comparison for Study 1: Log Transformation

Age	M	SE
3½-month-olds	0.42	0.05
5½-month-olds	0.70	0.06

Table J5

Transformed Means for the Percent Duration of Maternal Gestures by Period and Group.

All Modes Group Comparison for Study 1: Log Transformation

Period	Group	
	All Modes Experimental	All Modes Control
N	0.53 (0.11)	0.59 (0.13)
EX	0.62 (0.11)	0.66 (0.13)
RL	0.17 (0.06)	0.18 (0.12)
AF	0.54 (0.12)	0.61 (0.12)

Note. Values enclosed in parentheses represent standard errors.

Appendix K

ANOVA Summary Tables and Post-Hoc Comparisons for the

Infant Gaze at Face, Gaze at Hands, and Gaze Away

Measures: All Modes Group Comparison, Study 1

Table K1

Analysis of Variance for Infant Gaze at Face, All Modes Group Comparison for Study 1

Source	df	F
	Between Subjects	
Age (A)	1	2.37
Group (G)	1	4.99
A x G	1	0.10
S within-group error	53	(1475.60)
	Within Subjects	
Period (P)	3	6.50**
P x A	3	4.86**
P x G	3	2.51*
P x A x G	3	0.76
P x S within-group error	159	(379.80)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .016$. ** $p < .001$.

Table K2

Analysis of Variance for Infant Gaze at Hands, All Modes Group Comparison for Study 1

Source	df	F
	Between Subjects	
Age (A)	1	4.04
Group (G)	1	6.62*
A x G	1	1.66
S within-group error	53	(678.63)
	Within Subjects	
Period (P)	3	3.41*
P x A	3	3.38*
P x G	3	1.85
P x A x G	3	0.15
P x S within-group error	159	(233.54)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .016$. ** $p < .001$.

Table K3

Analysis of Variance for Infant Gaze Away, All Modes Group Comparison for Study 1

Source	df	F
	Between Subjects	
Age (A)	1	2.37
Group (G)	1	3.61
A x G	1	0.67
S within-group error	53	(1256.10)
	Within Subjects	
Period (P)	3	5.44
P x A	3	3.17
P x G	3	4.99
P x A x G	3	9.47*
P x S within-group error	159	(321.54)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .016$. ** $p < .001$.

Appendix L

ANOVA Summary Table, Post-Hoc Comparisons, and Means Table for the

Infant Smiling Measure: All Modes Group Comparison, Study 1

Table L1

Analysis of Variance for Infant Smiling, All Modes Group Comparison for Study 1

Source	df	F
	Between Subjects	
Age (A)	1	0.12
Sex (S)	1	2.45
Group (G)	1	1.37
A x S	1	2.46
A x G	1	0.13
S x G	1	1.95
A x S x G	1	0.01
S within-group error	49	(6.22)
	Within Subjects	
Period (P)	3	28.64**
P x A	3	6.32**
P x S	3	1.44
P x G	3	4.73**
P x A x S	3	1.58
P x A x G	3	1.02
P x S x G	3	0.64
P x A x S x G	3	4.35*
P x S within-group error	147	(2.47)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Table L2

Transformed Means for the Percent Duration of Infant Smiling by Period and Age, All Modes Group Comparison for Study 1: Square Root Transformation

Period	Age	
	3½-month-olds	5½-month-olds
N	7.16 (0.25)	6.67 (0.27)
EX	6.33 (0.34)	6.55 (0.43)
RL	4.64 (0.37)	3.86 (0.38)
AF	4.69 (0.39)	6.17 (0.42)

Note. Values enclosed in parentheses represent standard errors.

Table L3

Transformed Means for the Percent Duration of Infant Smiling by Period and Group, All Modes Group Comparison for Study 1: Square Root Transformation

Period	Group	
	All Modes Experimental	All Modes Control
N	7.16 (0.24)	6.62 (0.28)
EX	7.03 (0.35)	5.61 (0.35)
RL	3.96 (0.37)	4.70 (0.39)
AF	5.50 (0.37)	5.24 (0.50)

Note. Values enclosed in parentheses represent standard errors.

Appendix M

ANOVA Summary Tables, Post-Hoc Comparisons, and Means Tables for the

Maternal Touch and Maternal Gestures Measures:

Experimental Group Comparison, Study 1

Table M1

Analysis of Variance for Maternal Touch, Experimental Group Comparison for Study 1: Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	0.45
Group (G)	1	11.17**
A x G	1	4.04
S within-group error	63	(11.60)
	Within Subjects	
Period (P)	3	20.36**
P x A	3	1.73
P x G	3	2.49*
P x A x G	3	0.35
P x S within-group error	189	(3.62)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Table M2

Tukey Multiple Comparisons on the Period Main Effect for the Maternal Touch Measure, Experimental Group Comparison – Study 1

Comparison	Mean Absolute Difference	Critical Difference	Probability Level
N vs. EX	0.56	0.84 (1.02)	N.S.
N vs. RL	1.84	0.84 (1.02)**	< .01
N vs. AF	0.60	0.84 (1.02)	N.S.
EX vs. RL	1.28	0.84 (1.02)**	< .01
EX vs. AF	1.16	0.84 (1.02)**	< .01
RL vs. AF	2.44	0.84 (1.02)**	< .01

Note. Values enclosed in parentheses denote .01 critical difference levels.

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

Table M3

Transformed Means for the Percent Duration of Maternal Touch by Group, Experimental Group Comparison for Study 1: Square Root Transformation

Group	M	SE
Tactile Experimental	3.47	0.19
All Modes Experimental	4.92	0.25

Table M4

Transformed Means for the Percent Duration of Maternal Touch by Period, Experimental Group Comparison for Study 1: Square Root Transformation

Period	M	SE
N	4.64	0.32
EX	4.08	0.30
RL	2.80	0.21
AF	5.24	0.37

Table M5

Analysis of Variance for Maternal Gestures, Experimental Group Comparison for Study 1: Log Transformation

Source	df	F
	Between Subjects	
Age (A)	1	10.02**
Group (G)	1	0.46
Order (O)	2	0.01
A x G	1	1.54
A x O	2	7.55**
G x O	2	4.04*
A x G x O	2	1.32
S within-group error	55	(0.39)
	Within Subjects	
Period (P)	3	11.59**
P x A	3	3.78*
P x G	3	8.12**
P x O	6	1.49
P x A x G	3	0.16
P x A x O	6	1.13
P x G x O	6	1.16
P x A x G x O	6	0.42
P x S within-group error	165	(0.25)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .001$.

Table M6

Transformed Means for the Percent Duration of Maternal Gestures by Age and Order.

Experimental Group Comparison for Study 1: Log Transformation

Age	Order		
	One	Two	Three
3½-month-olds	0.51 (0.18)	0.21 (0.12)	0.19 (0.11)
5½-month-olds	0.37 (0.17)	0.63 (0.18)	0.67 (0.15)

Note. Values enclosed in parentheses represent standard errors.

Table M7

Transformed Means for the Percent Duration of Maternal Gestures by Group and Order.

Experimental Group Comparison for Study 1: Log Transformation

Group	Order		
	One	Two	Three
Tactile Experimental	0.54 (0.18)	0.31 (0.15)	0.28 (0.13)
All Modes Experimental	0.35 (0.18)	0.45 (0.18)	0.58 (0.16)

Note. Values enclosed in parentheses represent standard errors.

Table M8

Transformed Means for the Percent Duration of Maternal Gestures by Period and Age.

Experimental Group Comparison for Study 1: Log Transformation

Period	Age	
	3½-month-olds	5½-month-olds
N	0.29 (0.08)	0.76 (0.12)
EX	0.31 (0.08)	0.72 (0.13)
RL	0.15 (0.06)	0.06 (0.04)
AF	0.45 (0.11)	0.72 (0.12)

Note. Values enclosed in parentheses represent standard errors.

Table M9

Transformed Means for the Percent Duration of Maternal Gestures by Period and Group,

Experimental Group Comparison for Study 1: Log Transformation

Period	Group	
	Tactile Experimental	All Modes Experimental
N	0.51 (0.08)	0.53 (0.11)
EX	0.72 (0.10)	0.62 (0.11)
RL	0.11 (0.05)	0.17 (0.06)
AF	0.60 (0.11)	0.54 (0.12)

Note. Values enclosed in parentheses represent standard errors.

Appendix N

ANOVA Summary Tables and Post-Hoc Comparisons for the Infant Gaze at Face, Gaze at Hands, and Gaze Away Measures: Experimental Group Comparison, Study 1

Table N1

Analysis of Variance for Infant Gaze at Face, Experimental Group Comparison for Study 1

Source	df	F
Between Subjects		
Age (A)	1	0.42
Sex (S)	1	1.48
Group (G)	1	32.18**
A x S	1	5.30
A x G	1	2.45
S x G	1	0.64
A x S x G	1	0.49
S within-group error	59	(1216.62)
Within Subjects		
Period (P)	3	20.17**
P x A	3	2.17
P x S	3	0.77
P x G	3	9.79**
P x A x S	3	1.22
P x A x G	3	1.48
P x S x G	3	0.99
P x A x S x G	3	0.56
P x S within-group error	177	(401.42)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .016$. ** $p < .001$.

Table N2

Analysis of Variance for Infant Gaze at Hands, Experimental Group Comparison for Study 1

Source	df	F
	Between Subjects	
Age (A)	1	0.04
Sex (S)	1	0.45
Group (G)	1	25.31**
Order (O)	2	0.37
A x S	1	0.67
A x G	1	0.59
A x O	2	0.03
S x G	1	0.21
S x O	2	4.51
G x O	2	0.18
A x S x G	1	0.43
A x S x O	2	0.48
A x G x O	2	0.27
S x G x O	2	1.73
A x S x G x O	2	0.05
S within-group error	43	(768.27)
	Within Subjects	
Period (P)	3	5.05**
P x A	3	1.66
P x S	3	1.39
P x G	3	11.97**
P x O	6	1.60
P x A x S	3	1.18
P x A x G	3	3.20
P x A x O	6	0.76
P x S x G	3	1.96
P x S x O	6	0.52
P x G x O	6	0.95
P x A x S x G	3	0.75
P x A x S x O	6	0.86
P x A x G x O	6	0.72
P x S x G x O	6	2.07
P x A x S x G x O	6	1.47
P x S within-group error	129	(286.60)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .016$. ** $p < .001$.

Table N3

Analysis of Variance for Infant Gaze Away, Experimental Group Comparison for Study1: Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	1.15
Group (G)	1	3.41
A x G	1	2.77
S within-group error	63	(7.58)
	Within Subjects	
Period (P)	3	4.04
P x A	3	2.83
P x G	3	3.75
P x A x G	3	1.66
P x S within-group error	189	(3.44)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .016$. ** $p < .01$.

Appendix O

ANOVA Summary Table, Post-Hoc Comparisons, and Means Table for the Infant Smiling Measure: Experimental Group Comparison, Study 1

Table O1

Analysis of Variance for Infant Smiling. Experimental Group Comparison for Study1:

Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	5.70*
Group (G)	1	14.14**
A x G	1	2.82
S within-group error	63	(6.44)
	Within Subjects	
Period (P)	3	87.42**
P x A	3	5.68**
P x G	3	6.23**
P x A x G	3	2.78
P x S within-group error	189	(2.32)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

* $p < .025$. ** $p < .01$.

Table O2

Transformed Means for the Percent Duration of Infant Smiling by Period and Age.

Experimental Group Comparison for Study 1: Square Root Transformation

Period	Age	
	3½-month-olds	5½-month-olds
N	7.22 (0.24)	7.29 (0.23)
EX	5.21 (0.40)	7.21 (0.38)
RL	3.22 (0.33)	3.26 (0.31)
AF	4.22 (0.34)	5.12 (0.46)

Note. Values enclosed in parentheses represent standard errors.

Table O3

Transformed Means for the Percent Duration of Infant Smiling by Period and Group.

Experimental Group Comparison for Study 1: Square Root Transformation

Period	Group	
	Tactile Experimental	All Modes Experimental
N	7.34 (0.24)	7.16 (0.24)
EX	5.18 (0.42)	7.03 (0.35)
RL	2.55 (0.22)	3.96 (0.37)
AF	3.80 (0.37)	5.50 (0.37)

Note. Values enclosed in parentheses represent standard errors.

Appendix P

ANOVA Summary Tables and Means Tables for Type and Area of Maternal Touch: Tactile Group Comparison for Study 1

Table P1

Analysis of Variance for Type of Touch, Tactile Group Comparison for Study 1: Square Root Transformation

Source	df	F
Between Subjects		
Age (A)	1	0.24
Group (G)	1	0.40
A x G	1	7.05*
Error	54	(0.02)
Within Subjects		
Type (T)	3.97	65.66**
T x A	3.97	2.35*
T x G	3.97	3.53*
T x A x G	3.97	1.51
Error (T)	214.58	(0.12)
Period (P)	2.93	2.94
P x A	2.93	0.31
P x G	2.93	2.73
P x A x G	2.93	1.33
Error (P)	158.43	(0.01)
T x P	9.09	8.69**
T x P x A	9.09	0.91
T x P x G	9.09	4.42**
T x P x A x G	9.09	0.89
Error (T x P)	491.19	(0.02)

Note. Values enclosed in parentheses represent mean square errors.

* $p < .025$. ** $p < .001$.

Table P2

Transformed Means for the Duration of Maternal Touch by Age and Group, Tactile Group Comparison for Study 1: Square Root Transformation

Age	Group	
	Tactile Experimental	Tactile Control
3½-month-olds	0.24 (0.01)	0.23 (0.01)
5½-month-olds	0.21 (0.02)	0.24 (0.01)

Note. Values enclosed in parentheses represent standard errors.

Table P3

Transformed Means for the Duration of Maternal Touch by Type and Age, Tactile Group Comparison for Study 1: Square Root Transformation

Type of Touch	Age	
	3½-month-olds	5½-month-olds
No Touch	0.35 (0.02)	0.40 (0.03)
Static (Rest, Hold, Hug)	0.38 (0.02)	0.33 (0.01)
Stroke/Caress/Rub/Massage	0.37 (0.02)	0.31(0.01)
Pat/Tap	0.04 (0.02)	0.03 (0.01)
Squeeze/Pinch/Grasp	0.22 (0.01)	0.19 (0.01)
Tickle/Finger Walk/Poke/Prod/Push	0.21 (0.01)	0.25 (0.01)
Shake/Wiggle	0.15 (0.03)	0.09 (0.02)
Pull/Lift/Flexion/Extension/Clap	0.34 (0.04)	0.44 (0.04)
Other (e.g., Kiss, Wipe, Adjust Posture)	0.09 (0.02)	0.05 (0.02)

Note. Values enclosed in parentheses represent standard errors.

Table P4

Transformed Means for the Duration of Touch by Type, Period, and Group, Tactile Group Comparison for Study1: Square Root Transformation

	Period							
	N		EX		RL		AF	
	Group							
Type of Touch	Tactile Experimental	Tactile Control	Tactile Experimental	Tactile Control	Tactile Experimental	Tactile Control	Tactile Experimental	Tactile Control
No Touch	0.40 (0.05)	0.49 (0.06)	0.35 (0.04)	0.38 (0.06)	0.23 (0.03)	0.39 (0.05)	0.39 (0.04)	0.37 (0.06)
Static (Rest, Hold, Hug)	0.42 (0.04)	0.40 (0.04)	0.31 (0.03)	0.37 (0.04)	0.30 (0.04)	0.38 (0.05)	0.31 (0.03)	0.37 (0.05)
Stroke/Caress/Rub/ Massage	0.10 (0.02)	0.14 (0.03)	0.50 (0.05)	0.33 (0.04)	0.67 (0.06)	0.29 (0.04)	0.27 (0.03)	0.28 (0.02)
Pat/Tap	0.02 (0.01)	0.04 (0.02)	0.02 (0.01)	0.04 (0.02)	0.04 (0.01)	0.07 (0.02)	0.03 (0.01)	0.04 (0.02)
Squeeze/Pinch/Grasp	0.22 (0.04)	0.19 (0.04)	0.20 (0.02)	0.19 (0.03)	0.17 (0.02)	0.23 (0.04)	0.18 (0.03)	0.22 (0.04)
Tickle/Finger Walk/Poke/Prod/Push	0.24 (0.03)	0.26 (0.04)	0.27 (0.02)	0.26 (0.04)	0.09 (0.01)	0.17 (0.03)	0.37 (0.03)	0.17 (0.05)
Shake/Wiggle	0.15 (0.01)	0.14 (0.03)	0.13 (0.02)	0.14 (0.03)	0.04 (0.01)	0.11 (0.02)	0.15 (0.02)	0.11 (0.03)
Pull/Lift/Flexion/ Extension/Clap	0.47 (0.02)	0.41 (0.04)	0.29 (0.03)	0.41 (0.06)	0.27 (0.02)	0.45 (0.05)	0.39 (0.04)	0.45 (0.07)
Other (e.g., Kiss, Wipe, Adjust Posture)	0.14 (0.01)	0.10 (0.02)	0.05 (0.01)	0.06 (0.01)	0.10 (0.01)	0.03 (0.01)	0.08 (0.01)	0.04 (0.01)

Note. Values enclosed in parentheses represent standard errors.

Table P5

Analysis of Variance for Area of Touch, Tactile Group Comparison for Study 1: Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	0.19
Group (G)	1	1.80
A x G	1	3.06
Error	54	(0.03)
	Within Subjects	
Area (R)	3.58	65.39**
R x A	3.58	3.65*
R x G	3.58	4.24*
R x A x G	3.58	1.81
Error (R)	193.56	(0.14)
Period (P)	2.90	2.08
P x A	2.90	0.95
P x G	2.90	0.27
P x A x G	2.90	0.94
Error (P)	156.99	(0.01)
R x P	9.29	4.34**
R x P x A	9.29	0.83
R x P x G	9.29	3.20**
R x P x A x G	9.29	0.64
Error (R x P)	501.43	(0.06)

Note. Values enclosed in parentheses represent mean square errors.

* $p < .025$. ** $p < .001$.

Table P6

Transformed Means for the Duration of Maternal Touch by Area and Age, Tactile Group Comparison for Study 1: Square Root Transformation

Area of Touch	Age	
	3½-month-olds	5½-month-olds
No Area	0.35 (0.05)	0.40 (0.05)
Feet/Legs	0.44 (0.05)	0.54 (0.05)
Trunk	0.21 (0.04)	0.22 (0.04)
Hands/Arms	0.52 (0.05)	0.40 (0.05)
Shoulders/Neck	0.04 (0.01)	0.08 (0.02)
Face	0.27 (0.03)	0.18 (0.04)

Note. Values enclosed in parentheses represent standard errors.

Table P7

Transformed Means for the Duration of Touch by Area, Period, and Group, Tactile Group Comparison for Study1: Square Root Transformation

	Period							
	N		EX		RL		AF	
	Group							
Area of Touch	Tactile Experimental	Tactile Control	Tactile Experimental	Tactile Control	Tactile Experimental	Tactile Control	Tactile Experimental	Tactile Control
No Area	0.40 (0.05)	0.49 (0.06)	0.35 (0.04)	0.38 (0.06)	0.24 (0.03)	0.39 (0.05)	0.39 (0.04)	0.37 (0.06)
Feet/Legs	0.45 (0.04)	0.54 (0.05)	0.52 (0.03)	0.55 (0.06)	0.38 (0.05)	0.57 (0.06)	0.44 (0.04)	0.53 (0.06)
Trunk	0.20 (0.03)	0.22 (0.04)	0.23 (0.04)	0.23 (0.04)	0.17 (0.03)	0.16 (0.04)	0.31 (0.04)	0.19 (0.04)
Hands/Arms	0.56 (0.05)	0.35 (0.06)	0.45 (0.03)	0.42 (0.04)	0.49 (0.05)	0.43 (0.05)	0.47 (0.04)	0.46 (0.05)
Shoulders/Neck	0.07 (0.01)	0.11 (0.02)	0.09 (0.02)	0.12 (0.02)	0.11 (0.02)	0.09 (0.02)	0.11 (0.02)	0.12 (0.02)
Face	0.14 (0.02)	0.12 (0.02)	0.23 (0.04)	0.16 (0.03)	0.26 (0.04)	0.17 (0.04)	0.19 (0.03)	0.16 (0.03)

Note. Values enclosed in parentheses represent standard errors.

Appendix Q

ANOVA Summary Tables and Means Tables for Type and

Area of Maternal Touch: All Modes Group

Comparison for Study 1

Table Q1

Analysis of Variance for Type of Touch, All Modes Group Comparison for Study 1: Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	0.18
Group (G)	1	1.43
A x G	1	0.75
Error	53	(0.02)
	Within Subjects	
Type (T)	2.50	80.62**
T x A	2.50	0.96
T x G	2.50	2.59
T x A x G	2.50	1.31
Error (T)	132.43	(0.22)
Period (P)	2.78	0.46
P x A	2.78	0.22
P x G	2.78	0.53
P x A x G	2.78	0.27
Error (P)	147.55	(0.01)
T x P	9.46	3.07*
T x P x A	9.46	0.77
T x P x G	9.46	3.83**
T x P x A x G	9.46	0.99
Error (T x P)	501.27	(0.02)

Note. Values enclosed in parentheses represent mean square errors.

* $p < .025$. ** $p < .001$.

Table Q2

Transformed Means for the Duration of Touch by Type, Period, and Group, All Modes Group Comparison for Study1: Square Root Transformation

	Period							
	N		EX		RL		AF	
	Group							
Type of Touch	All Modes Experimental	All Modes Control	All Modes Experimental	All Modes Control	All Modes Experimental	All Modes Control	All Modes Experimental	All Modes Control
No Touch	0.55 (0.05)	0.54 (0.06)	0.48 (0.05)	0.54 (0.06)	0.38 (0.05)	0.59 (0.06)	0.62 (0.05)	0.50 (0.06)
Static (Rest, Hold, Hug)	0.40 (0.04)	0.38 (0.04)	0.48 (0.05)	0.40 (0.04)	0.48 (0.05)	0.39 (0.04)	0.36 (0.04)	0.41 (0.04)
Stroke/Caress/Rub/ Massage	0.15 (0.02)	0.11 (0.03)	0.20 (0.04)	0.12 (0.02)	0.43 (0.05)	0.15 (0.03)	0.11 (0.02)	0.15 (0.03)
Pat/Tap	0.04 (0.02)	0.04 (0.01)	0.02 (0.01)	0.05 (0.02)	0.02 (0.01)	0.04 (0.02)	0.01 (0.01)	0.05 (0.02)
Squeeze/Pinch/Grasp	0.20 (0.02)	0.19 (0.02)	0.19 (0.02)	0.18 (0.03)	0.23 (0.01)	0.17 (0.02)	0.15 (0.02)	0.12 (0.02)
Tickle/Finger Walk/Poke/Prod/Push	0.14 (0.03)	0.18 (0.03)	0.14 (0.02)	0.18 (0.03)	0.11 (0.03)	0.19 (0.03)	0.18 (0.03)	0.18 (0.04)
Shake/Wiggle	0.12 (0.02)	0.21 (0.03)	0.12 (0.02)	0.18 (0.02)	0.04 (0.02)	0.17 (0.03)	0.16 (0.03)	0.16 (0.03)
Pull/Lift/Flexion/Extension/Clap	0.37 (0.04)	0.35 (0.05)	0.30 (0.04)	0.42 (0.05)	0.25 (0.02)	0.38 (0.04)	0.29 (0.04)	0.43 (0.04)
Other (e.g., Kiss, Wipe, Adjust Posture)	0.13 (0.02)	0.10 (0.03)	0.11 (0.02)	0.08 (0.02)	0.09 (0.02)	0.09 (0.02)	0.12 (0.02)	0.09 (0.02)

Note. Values enclosed in parentheses represent standard errors.

Table Q3

Analysis of Variance for Area of Touch, All Modes Group Comparison for Study 1: Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	1.29
Group (G)	1	0.07
A x G	1	0.62
Error	53	(0.02)
	Within Subjects	
Area (R)	2.52	73.66**
R x A	2.52	2.72*
R x G	2.52	0.68
R x A x G	2.52	1.61
Error (R)	133.55	(0.23)
Period (P)	2.47	0.72
P x A	2.47	0.05
P x G	2.47	0.27
P x A x G	2.47	0.36
Error (P)	130.92	(0.01)
R x P	8.13	0.91
R x P x A	8.13	1.02
R x P x G	8.13	2.29*
R x P x A x G	8.13	1.62
Error (R x P)	431.05	(0.07)

Note. Values enclosed in parentheses represent mean square errors.

* $p < .025$. ** $p < .001$.

Table Q4

Transformed Means for the Duration of Maternal Touch by Area and Age, All Modes Group Comparison for Study 1: Square Root Transformation

Area of Touch	Age	
	3½-month-olds	5½-month-olds
No Area	0.50 (0.06)	0.54 (0.05)
Feet/Legs	0.36 (0.05)	0.46 (0.05)
Trunk	0.15 (0.03)	0.18 (0.03)
Hands/Arms	0.50 (0.05)	0.41 (0.05)
Shoulders/Neck	0.02 (0.01)	0.05 (0.02)
Face	0.19 (0.03)	0.14 (0.03)

Note. Values enclosed in parentheses represent standard errors.

Table Q5

Transformed Means for the Duration of Touch by Area, Period, and Group, All Modes Group Comparison for Study1: Square

Root Transformation

	Period							
	N		EX		RL		AF	
	Group							
Area of Touch	All Modes Experimental	All Modes Control	All Modes Experimental	All Modes Control	All Modes Experimental	All Modes Control	All Modes Experimental	All Modes Control
No Area	0.56 (0.05)	0.54 (0.06)	0.48 (0.05)	0.54 (0.06)	0.38 (0.05)	0.59 (0.06)	0.62 (0.05)	0.50 (0.06)
Feet/Legs	0.40 (0.05)	0.42 (0.06)	0.40 (0.05)	0.47 (0.05)	0.42 (0.05)	0.43 (0.05)	0.32 (0.04)	0.43 (0.06)
Trunk	0.16 (0.02)	0.14 (0.03)	0.18 (0.03)	0.15 (0.04)	0.19 (0.03)	0.13 (0.03)	0.15 (0.02)	0.17 (0.04)
Hands/Arms	0.48 (0.05)	0.45 (0.06)	0.49 (0.05)	0.41 (0.06)	0.49 (0.05)	0.44 (0.05)	0.46 (0.05)	0.42 (0.06)
Shoulders/Neck	0.01 (0.01)	0.04 (0.02)	0.04 (0.01)	0.03 (0.01)	0.04 (0.02)	0.05 (0.02)	0.05 (0.01)	0.03 (0.01)
Face	0.12 (0.02)	0.17 (0.03)	0.17 (0.03)	0.13 (0.03)	0.27 (0.04)	0.14 (0.03)	0.13 (0.02)	0.15 (0.03)

Note. Values enclosed in parentheses represent standard errors.

Appendix R

ANOVA Summary Tables and Means Tables for Type and Area of Maternal Touch: Experimental Group Comparison for Study 1

Table R1

Analysis of Variance for Type of Touch, Experimental Group Comparison for Study 1: Square Root Transformation

Source	df	F
Between Subjects		
Age (A)	1	0.89
Group (G)	1	1.18
A x G	1	6.14*
Error	63	(0.02)
Within Subjects		
Type (T)	3.20	92.03**
T x A	3.20	1.84
T x G	3.20	11.52**
T x A x G	3.20	1.85
Error (T)	201.51	(0.13)
Period (P)	2.91	2.87
P x A	2.91	0.33
P x G	2.91	1.89
P x A x G	2.91	0.62
Error (P)	183.34	(0.02)
T x P	8.80	15.29**
T x P x A	8.80	0.75
T x P x G	8.80	2.81**
T x P x A x G	8.80	0.47
Error (T x P)	554.66	(0.08)

Note. Values enclosed in parentheses represent mean square errors.

* $p < .025$. ** $p < .001$.

Table R2

Transformed Means for the Duration of Maternal Touch by Age and Group, Experimental Group Comparison for Study 1: Square Root Transformation

Age	Group	
	Tactile Experimental	All Modes Experimental
3½-month-olds	0.24 (0.01)	0.23 (0.03)
5½-month-olds	0.21 (0.02)	0.22 (0.02)

Note. Values enclosed in parentheses represent standard errors.

Table R3

Transformed Means for the Duration of Touch by Type, Period, and Group, Experimental Group Comparison for Study1: Square Root Transformation

	Period							
	N		EX		RL		AF	
	Group							
Type of Touch	Tact Exp	AM Exp	Tact Exp	AM Exp	Tact Exp	AM Exp	Tact Exp	AM Exp
No Touch	0.40 (0.05)	0.55 (0.05)	0.35 (0.04)	0.48 (0.05)	0.23 (0.03)	0.38 (0.05)	0.39 (0.04)	0.62 (0.05)
Static (Rest, Hold, Hug)	0.42 (0.04)	0.40 (0.04)	0.31 (0.03)	0.48 (0.05)	0.30 (0.04)	0.48 (0.05)	0.31 (0.03)	0.36 (0.04)
Stroke/Caress/Rub/ Massage	0.10 (0.02)	0.15 (0.02)	0.50 (0.05)	0.20 (0.04)	0.67 (0.06)	0.43 (0.05)	0.27 (0.03)	0.11 (0.02)
Pat/Tap	0.02 (0.01)	0.04 (0.02)	0.02 (0.01)	0.02 (0.01)	0.04 (0.01)	0.02 (0.01)	0.03 (0.01)	0.01 (0.01)
Squeeze/Pinch/Grasp	0.22 (0.04)	0.20 (0.02)	0.20 (0.02)	0.19 (0.02)	0.17 (0.02)	0.23 (0.01)	0.18 (0.03)	0.15 (0.02)
Tickle/Finger Walk/Poke/Prod/Push	0.24 (0.03)	0.14 (0.03)	0.27 (0.02)	0.14 (0.02)	0.09 (0.01)	0.11 (0.03)	0.37 (0.03)	0.18 (0.03)
Shake/Wiggle	0.15 (0.01)	0.12 (0.02)	0.13 (0.02)	0.12 (0.02)	0.04 (0.01)	0.04 (0.02)	0.15 (0.02)	0.16 (0.03)
Pull/Lift/Flexion/ Extension/Clap	0.47 (0.02)	0.37 (0.04)	0.29 (0.03)	0.30 (0.04)	0.27 (0.02)	0.25 (0.02)	0.39 (0.04)	0.29 (0.04)
Other (e.g., Kiss, Wipe, Adjust Posture)	0.14 (0.01)	0.13 (0.02)	0.05 (0.01)	0.11 (0.02)	0.10 (0.01)	0.09 (0.02)	0.08 (0.01)	0.12 (0.02)

Note. Values enclosed in parentheses represent standard errors. Tact Exp = Tactile Experimental; AM Exp = All Modes Experimental

Table R4

Analysis of Variance for Area of Touch, Experimental Group Comparison for Study 1: Square Root Transformation

Source	df	F
	Between Subjects	
Age (A)	1	0.15
Group (G)	1	6.14*
A x G	1	4.36
Error	63	(0.02)
	Within Subjects	
Area (R)	3.14	81.34**
R x A	3.14	1.69
R x G	3.14	6.06**
R x A x G	3.14	1.35
Error (R)	197.69	(0.15)
Period (P)	2.76	1.29
P x A	2.76	1.33
P x G	2.76	0.91
P x A x G	2.76	0.43
Error (P)	174.00	(0.01)
R x P	9.01	7.37**
R x P x A	9.01	1.02
R x P x G	9.01	2.03*
R x P x A x G	9.01	0.89
Error (R x P)	567.39	(0.07)

Note. Values enclosed in parentheses represent mean square errors.

* $p < .025$. ** $p < .001$.

Table R5

Transformed Means for the Duration of Touch by Area, Period, and Group, Experimental Group Comparison for Study1: Square Root Transformation

	Period							
	N		EX		RL		AF	
	Group							
Area of Touch	Tact Exp	AM Exp	Tact Exp	AM Exp	Tact Exp	AM Exp	Tact Exp	AM Exp
No Area	0.40 (0.05)	0.56 (0.05)	0.35 (0.04)	0.48 (0.05)	0.24 (0.03)	0.38 (0.05)	0.39 (0.04)	0.62 (0.05)
Feet/Legs	0.45 (0.04)	0.40 (0.05)	0.52 (0.03)	0.40 (0.05)	0.38 (0.05)	0.42 (0.05)	0.44 (0.04)	0.32 (0.04)
Trunk	0.20 (0.03)	0.16 (0.02)	0.23 (0.04)	0.18 (0.03)	0.17 (0.03)	0.19 (0.03)	0.31 (0.04)	0.15 (0.02)
Hands/Arms	0.56 (0.05)	0.48 (0.05)	0.45 (0.03)	0.49 (0.05)	0.49 (0.05)	0.49 (0.05)	0.47 (0.04)	0.46 (0.05)
Shoulders/Neck	0.07 (0.01)	0.01 (0.01)	0.09 (0.02)	0.04 (0.01)	0.11 (0.02)	0.04 (0.02)	0.11 (0.02)	0.05 (0.01)
Face	0.14 (0.02)	0.12 (0.02)	0.23 (0.04)	0.17 (0.03)	0.26 (0.04)	0.27 (0.04)	0.19 (0.03)	0.13 (0.02)

Note. Values enclosed in parentheses represent standard errors. Tact Exp = Tactile Experimental; AM Exp = All Modes Experimental

Appendix S

Additional Demographic Characteristics of the NBW-FT and

VLBW-PT Groups for Study 2

Demographic Characteristics	Birth Status NBW-FT (n = 15)	VLBW-PT (n = 15)
Ethnicity		
% White	86	40
% Black	7	27
% Hispanic	7	27
% Middle Eastern	0	0
% Asian/Pacific Islander	0	7
Parental Occupation		
Executive, Managerial	27	20
Professional Specialty	7	0
Technical & Related Support	20	27
Sales	13	7
Administration, Support, & Clerical	20	20
Precision, Production, Craft, & Repair	7	7
Handlers, Equipment Cleaners, Helpers & Laborers	0	7
Service Workers	7	13

Note. Occupational status categories taken from U.S. Bureau of the Census (1996).

Appendix T

English and French Consent Forms for Study 2

HÔPITAL GÉNÉRAL JUIF
SIR MORTIMER B. DAVIS
JEWISH GENERAL HOSPITAL

Concordia UNIVERSITY

Department of Neonatology
Département de Néonatalogie

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

Consent Form
Mother-Infant Interactions

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

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

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

I understand that my participation in this study is totally voluntary. I know that I may withdraw at any time and for any reason. I also understand that I may request that the videotape recording of my baby be erased. In the event that the results of the study are published, my name and the name of my baby will be kept confidential. I am also aware that I may be asked to participate again when my baby is 12 and 18 months of age.

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

Thank you for your cooperation.

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

Parent's signature on behalf of infant: ____________________ Date: ________________

Parent's signature: ________________________________ Date: ________________

Witness: ____________________________________ Date: ________________

HÔPITAL GÉNÉRAL JUIF
SIR MORTIMER B. DAVIS
JEWISH GENERAL HOSPITAL

Department of Neonatology
Département de Néonatologie

Concordia
UNIVERSITY

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

Formulaire de Consentement
Interaction Mère-Enfant

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

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

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

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

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

Merci de votre coopération.

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

Signature du parent pour l'enfant: ______________________ Date: ____________

Signature du parent: ______________________________ Date: ____________

Témoin: ____________________________________ Date: ____________

Appendix U

Medical and Demographic Information Questionnaire for Study 2

Identification: ______________

LIFE PROFILE: Obstetrical history

SECTION A: Summary of Pregnancy (target child)

1 - Were you followed by a doctor during your pregnancy?

No _____ Yes _____ --> number of times: __________

2 - Did you have either of the following tests?

Amniocentesis: No _____ Yes _____ --> results: __________________________

Echography : No _____ Yes _____ --> results: __________________________

3 - At what point did you discover you were pregnant? at ______weeks of pregnancy.

4 - Did you smoke while you were pregnant?

No _____ Yes _____ --> On average, how many cigarettes a day? ________

5 - Did you drink at all while you were pregnant?

No _____ Yes _____ --> On average, how many drinks ...

per month _________/ per week _________/ per day __________/

6 - Were you exposed to any toxic material?

No _____ Yes _____ --> What? ______________________ ___________________

For how long during your pregnancy? ____________ weeks.

7 - Did you take any medication while you were pregnant? If yes, please indicate

_____ No or

_________	Diuretics	_________	Antihypertensives
_________	Phenobarbital	_________	Sedatives/tranquillizer
_________	Anticonvulsives	_________	Gestational hormones
_________	Antibiotics	_________	Narcotics
_________	Hallucinogens	_________	Antihistamines
_________	Other: (specify) ___________________________________		

SECTION B: Prenatal Problems

1 - Did you suffer from any illness during your pregnancy?
No _____ Yes _____ --> What? ____

____

2 - Blood loss during pregnancy? No _____ Yes _____ --> Which trimester __________

3 - **Diabetes?**
No ______

Yes ______ --> (pregnancy related _____; insulin dependent _____ ; Other: ______________)

4 - **Any chronic problems before pregnancy?**
No ______

Yes ______ --> (hypertension _____; hypotension; _____; Other ______________________)

5 - **Endogenous toxemia (Blood poisoning)?**

No ______ Yes ______ --> Which trimester ______________

6 - **Fever during gestation: > 100°F (37.8°C)**

No ______ Yes ______ --> Which trimester ______________

SECTION C: Summary of Labor and Delivery

1 - **At which hospital was the child born?** ______________________________________

2 - **Mother's age** _________**; Father's age** _________ **when child was born?**

3 - **Number of weeks of gestation (length of pregnancy):** ___________ weeks.

4 - **Particularly stressful or difficult events at the time of delivery?**

No ______ Yes ______ --> Specify: ______________________________________

____

5 - **When did your water break?**

________ Prematurely (> 8 hours before onset of labor)
________ Spontaneously before onset of labor
________ Spontaneously after onset of labor
________ Induced artificially

6 - **Onset of labor was...** Spontaneous ________ Induced --> (how? _______________)

7 - **Was there any oxytocin, pytocin, etc. administered?**

No ______ Yes ______ --> Specify: ______________________________________

8 - **Did you have an epidural?**

No ______ Yes ______ --> How long before delivering the baby? ____________________

9 - Any other medication during labor/delivery?

No ______ Yes _______ --> Specify type, timing, reason ______________________________
____

10 - Any complications during labor?

_____ No or

_________ Long labor: > 24 hrs
_________ Pre-eclampsia
_________ Toxemia
_________ Oligohydramnios
_________ Other: (specify) ______________________________
_________ Induced labor: < 37 weeks
_________ Placental dysfunction
_________ Infection
_________ polyhydramnios

11 - How long was the labor? ________________________ hours.

12 - Type of delivery?

________ Head first (vertex)
________ Breech

________ Posterior (on the back)
________ Vaginal (spontaneous)

<u>Forceps</u> : ________ Low ______ Mid _____ High

<u>Vacuum extraction</u>: _________

<u>C-Section</u> : ________ Elective _______ Emergency

If it was a caesarian Primary ______ or Repeat _______

Reason: ____

<u>SECTION D: Characteristics of the newborn</u> <u>(with baby book if it is available)</u>

1 - Height at birth: __________

2 - Birthweight: __________

	GRAMS	LBS
0 =	< 1000	< 2.2
1 =	1001 - 1500	2.2 - 3.3
2 =	1501 - 2000	3.3 - 4.4
3 =	2001 - 2500	4.4 - 5.5
4 =	2501 - 3000	5.5 - 6.6
5 =	3001 - 3500	6.6 - 7.7
6 =	3501 - 4000	7.7 - 8.8
7 =	> 4000	> 8.8

3 - Head circumference: __________ cm
4 - RH factor: _________ (+ or -)
5 - Apgar: __________ 1 min; __________ 5 min.
6 - Feeding: Breast? _______ No _______ Yes --> Period ________________________
Bottle? _______ No _______ Yes --> Period ________________________

SECTION E: various neonatal complications

1 - How long did the child stay in the hospital after his/her birth? ______________ days.

2 - Did the child return home with his/her mother? ______ No _______ Yes

3 - Any congenital anomalies (minor, major or chromosomal)?

No _____ Yes _____ --> Specify: ____

4 - Did the child have any health problems while at the hospital? ______ No _______ Yes
If yes,

a. **Skin problems:** No _____ Yes _____ (specify)
_____ Jaundice _____ Cyanosis _____ Petechiae _____ Ecchymosis
_____ pallor _____ Desquamation _____ Oedema _____ Other: _______
Severity: ________________________________ **Duration**: _______ days

b. **Respiratory problems**: No _____ Yes _____
Type: ____________________________________ **Duration**: _______ days

c. **Steroid treatment:** No _____ Yes _____
Type: ____________________________________ **Duration**: _______ days

d. **Other medication:** No _____ Yes _____
Type: ____________________________________ **Duration**: _______ days

e. **Cardiac problems:** No _____ Yes _____
Type: ____________________________________ **Duration**: _______ days

f. **Epileptic seizures:** No _____ Yes _____
Type: ____________________________________ **Duration**: _______ days

g. **Intracranial bleeding**: No _____ Yes _____ --> Degree 1[rst] 2[nd] 3[rd] 4[th] unspecified
h. **Hematological problems:** No _____ Yes _____ --> Specify: _____________________
i. **Blood transfusions:** No _____ Yes _____ --> Specify: _____________________

j. **Infections:** No _____ Yes _____ --> Specify: _____________________
k. **Hospitalized in the Neonatal Intensive Care Unit:** No _____ Yes _____ --> Length, reason:_____

l. **Hydrocephaly:** No _____ Yes _____ --> Specify: _____________________
m. **Spina bifida:** No _____ Yes _____ --> Specify: _____________________
n. **Surgery:** No _____ Yes _____ --> Specify: _____________________
o. **Circumcision:** No _____ Yes _____ --> When : _____________________
Describe any problems: ____________________

p. **Colic:** No _____ Yes _____
Start _________ End (frequency) ___________

q. **Receipt of Vaccinations** Yes _____ ↓
Reaction and their treatment: ____________________
No ______ --> Which vaccines have not been received and why?
____

SECTION F: How many children... (including this child)

______ have you carried to term (> 38 weeks)? Who? ______________________________

______ were premature? Who and by how much? ______________________________

______ were born with congenital anomalies (minor or major)? Who? ____________________

______ whose birthweight < 5.5 lbs (2500 g.? Who? ______________________________

______ whose birthweight > 9 lbs (4100 g.? Who? ______________________________

How many
______ abortions? ______ miscarriages? ______ stillborns?

SECTION G: Developmental milestones

1 - At what age did your child achieve the following developmental milestones

a. ___________ Raise his/her head

b. ___________ First smile

c. ___________ Roll on his/her side

d. ___________ Roll over completely (back or abdomen)

e. ___________ Sit without help

f. ___________ Crawl

g. ___________ Vocalize

h. ___________ Take/grasp objects

i. Baby sitting/ Day Care:

___________ Family member

___________ Daycare

___________ Baby sitter/family care

j. ________ Eye contact

k. ________ Cuddly/affectionate

2 - Current height of child: __________________

3 - Current weight of child: __________________

SECTION H: Developmental tasks (Write down period and relevant comments)

1 - Easy to feed ____

2 - Regular bowel movements __________________________________

3 - Cries intensively and frequently ______________________________

4 - Goes to sleep easily ____________________________________

5 - Sleeps through the night __________________________________

SECTION H: Developmental tasks (Write down period and relevant comments)

*This section deals with tension and stressful events that may have occurred at your home since the birth of your child. It must be carried out as a clinical interview in which the interviewer records all relevant information about stress that may have affected the life of the parents, the whole family or the development of the relationship between the parents and the target child. **WHEN THE STRESS SCORE IS BETWEEN 3 and 5** (scale below), the interviewer will ask additional questions and note down relevant answers **(except for question 1 where all questions have to be asked)**. Indicate when these events occurred (which trimester while pregnant, first year of life, subsequent years).*

Stress Scale

1 = Not stressful at all
2 = A little stressful
3 = Quite stressful
4 = Very stressful
5 = Extremely stressful

1 - a) **Did you feel depressed or extremely tired, with no energy at all after ________'s birth (or the birth of any other children following the target child)?**
No _______ Yes _______
- Did you feel like that day after day? No _______ Yes _______; Period: ___________

b) **Did you feel you had lost interest for things you liked before?**
No _______ Yes _______
- Did you feel like that day after day? No _______ Yes _______; Period: ___________

c) **What opinion did you have of yourself? Did you feel worthless?**
No _______ Yes _______
- Did you feel like that day after day? No _______ Yes _______; Period: ___________

d) **Did you have difficulty concentrating or thinking?**
No _______ Yes _______
- Did you feel like that day after day? No _______ Yes _______; Period: ___________

e) **Did you have any irrational ideas or fears like hurting your child or hurting yourself or even killing yourself?**
No _______ Yes _______; Describe: ____

____

2 - a) **Did the primary person who provides the financial support for the family lose his/her job?**
No _______ Yes _______ --> Stress code _______

Who: _______________ Duration: __________________ Age/Trimester of child ___________

b) **Did s/he obtain a promotion or commence a new job?**
No _______ Yes _______ --> Stress code _______

Who: _______________What: ____________________ Age/Trimester of child ___________

3 - **Decrease in salary (20% or more) or important financial loss?**

No _______ Yes _______ --> Stress code _______

Specify problem (seriously in debt?) ____

____ Age/Trimester of child __________

4 - **Hospitalization of a family member**

No _______ Yes _______ --> Stress code _______

Who? What reason? ____

____ Age/Trimester of child __________

5 - **Parent(s) with serious illness or involved in an accident (injured)?**

No _______ Yes _______ --> Stress code _______

Who? What? ____

How long? ______________________________ Age/Trimester of child __________

6 - **Household moves or changes in school?**

No _______ Yes _______ --> Stress code _______

Details on how it happened (Who, when, where) ______________________________

____Age/Trimester of child ________

7 - **Death in the family or death of a close friend of the family?**

No _______ Yes _______ --> Stress code _______ Age/Trimester of child ______________

Specify relationship and cause of death ________________________________

8 - **Changes in family structure, immediate or extended** (divorce, separation, breaking up, reconciliation, new partner, pregnancy, birth, adoption, somebody moving in/out, etc.

No _______ Yes _______ --> Stress code _______ Age/Trimester of child ______________

Specify nature and intensity of change ______________________________

____

9 - **Problems with superiors at work or with the law?**

No _______ Yes _______ --> Stress code _______ Age/Trimester of child _______________

Specify nature and duration ____

____

10 - **Alcohol or drug problems?**

No _______ Yes _______ --> Stress code _______ Age/Trimester of child _______________

Who: _______________ Duration: ___________________ Type: _________________________

11 - **Any other stressful events?**

No _______ Yes _______ --> Stress code _______ Age/Trimester of child _______________

Specify: ____

____

MEDICAL QUESTIONNAIRE: child (general)

1 - **Does your child have any symptoms of illnes or infection today?**
e.g. flu, sore throat, etc.)

No ________ yes ________ --> Commencement? ____________ Severity ________________

Specify ____

2 - **Did your child have any symptoms of illnes or infection in the last month?**
e.g. Flu, sore throat, etc.)

No ________ yes ________ --> Commencement? ____________ Severity ________________

Specify ____

3 - **Is your child taking any medication now?**

No ________ yes ________ --> Since when? ______________________

Which medication? ________ ____

For what reason? ____

4 - **In the last two months, has your child taken any prescription medication?**

No ________ yes ________ --> Since when? ______________________

Which medication? ____

For what? ______________ ____

The following questions pertain to long term health problems.

5. Does/Did your child have any of the following problems?

a) Anemia Period: ________________

b) Skin problems or skin allergies Period: ________________

c) Other allergies Period: ________________

Specify: ____

d) Asthma Period: ________________

Specify + treatment: ____

e) Urinary problems or kidney problems Period: ____________________

Specify: ____

f) Digestion problems Period: ____________________

Specify: ____

g) Otitis (ear infections) Period: ____________________

Frequency, severity, treatments: ____

____

Surgery? ____

Formal/informal hearing (audiology) assessment? ______________________________________

MEDICAL QUESTIONNAIRE: child (accidents and injuries)

We are also interested in obtaining information on accidents or injuries that your child may have suffered, as well as visits to the doctor or to the hospital (routine or emergency) since birth (doctor, medical clinic, emergency; e.g. fracture, severe cut or burn, sprained ankle, etc.). Essentially, some informations about your child's general state of health.

1. **Since his/her birth, was your child the victim of accidents that resulted in injuries?**

   No ________ yes ________ --> Specify (type of injury, age of child, circumstances).

   ____

   ____

   ____

2. **How many times have you consulted...** your family doctor's office? ____________

   a medical clinic? ____________

   the hospital's ER? ____________

Appendix V

Comparison of the Mean Percent Durations of the Maternal and Infant Measures Between Studies 1 and 2

Means for the Maternal and Infant Behaviors for all Groups of Participants During the Normal Period (Studies 1 and 2)

	Behavior					
	Maternal		Infant			
Group	Touch	Gestures	Gaze at Face	Gaze at Hands	Gaze Away	Smiling
Tactile Experimental	77.71 (4.48)	10.82 (1.45)	51.75 (5.16)	25.81 (4.08)	8.74 (1.10)	54.70 (3.28)
Tactile Control	71.01 (6.04)	9.41 (1.15)	45.98 (4.61)	22.50 (2.59)	11.41 (2.01)	44.33 (4.27)
All Modes Experimental	67.35 (5.31)	8.76 (1.09)	55.72 (5.11)	19.41 (2.99)	8.21 (2.45)	52.08 (3.38)
All Modes Control	59.92 (7.18)	9.43 (1.75)	49.43 (3.89)	26.61 (3.98)	8.81 (2.46)	44.60 (3.65)
NBW-FT	85.37 (4.45)	9.23 (1.23)	39.53 (6.69)	16.20 (2.87)	16.88 (2.07)	39.81 (5.23)
VLBW-PT	78.23 (5.81)	8.77 (1.15)	43.61 (6.67)	16.59 (3.28)	16.59 (3.11)	31.25 (4.07)

Note. Values enclosed in parentheses represent standard errors.

Appendix W

ANOVA Summary Table for the Maternal Touch and Maternal Gestures

Measures for Study 2

Table W1

Analysis of Variance for Maternal Touch - Study 2

Source	df	F
Between Subjects		
Sex (S)	1	0.07
Birth Status (B)	1	0.47
S x B	1	0.38
S within-group error	26	(501.13)
Within Subjects		
Period (P)	1	0.70
P x S	1	0.11
P x B	1	0.69
P x S x B	1	0.24
P x S within-group error	26	(407.55)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

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

Table W2

Analysis of Variance for Maternal Gestures - Study 2

Source	df	F
	Between Subjects	
Sex (S)	1	0.42
Birth Status (B)	1	0.40
S x B	1	0.51
S within-group error	26	(489.02)
	Within Subjects	
Period (P)	1	0.63
P x S	1	0.25
P x B	1	0.56
P x S x B	1	0.68
P x S within-group error	26	(410.77)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

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

Appendix X

ANOVA Summary Tables and Post-Hoc Comparisons for the Infant Gaze at Face, Gaze at Hands, and Gaze Away Measures for Study 2

Table X1

Analysis of Variance for Infant Gaze at Face - Study 2

Source	df	F
	Within Subjects	
Period (P)	2	10.93**
P x S within-group error	58	(445.28)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

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

Table X2

Analysis of Variance for Infant Gaze at Hands - Study 2

Source	df	F
Within Subjects		
Period (P)	1	4.58*
P x S within-group error	29	(93.07)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

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

Table X3

Analysis of Variance for Infant Gaze Away - Study 2

Source	df	F
	Within Subjects	
Period (P)	1	5.61*
P x S within-group error	29	(87.13)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

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

Table X4

Tukey Multiple Comparisons on the Period Main Effect for the Infant Gaze Away Measure for Study 2

Comparison	Mean Absolute Difference	Critical Difference	Probability Level
N1 vs. SF	11.92	6.97 (9.38)**	< .01
N1 vs. N2	1.51	6.97 (9.38)	N.S.
SF vs. N2	10.41	6.97 (9.38)**	< .01

Note. Values enclosed in parentheses denote .01 critical difference levels.

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

Appendix Y

ANOVA Summary Table and Post-Hoc Comparisons for the Infant Smiling Measure for Study 2

Table Y1

Analysis of Variance for Infant Smiling - Study 2

Source	df	F
	Between Subjects	
Birth Status (B)	1	114.16**
S within-group error	20	(482.86)
	Within Subjects	
Period (P)	2	40.30
P x B	2	1.69
P x S within-group error	56	(189.39)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

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

Table Y2

Tukey Multiple Comparisons on the Period Main Effect for the Infant Smiling Measure for Study 2

Comparison	Mean Absolute Difference	Critical Difference	Probability Level
N1 vs. SF	29.04	6.97 (9.38)**	< .01
N1 vs. N2	3.30	6.97 (9.38)	N.S.
SF vs. N2	25.74	6.97 (9.38)**	< .01

Note. Values enclosed in parentheses denote .01 critical difference levels.

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

Appendix Z

ANOVA Summary Tables, Post-Hoc Comparisons and Means Tables for the Type and Area of Maternal Touch for Study 2

Table Z1

Analysis of Variance for Type of Touch for Study 2: Square Root Transformation

Source	df	F
	Between Subjects	
Birth Status (B)	1	0.12
Error	28	(0.01)
	Within Subjects	
Type (T)	4.61	29.45**
T x B	4.61	0.80
Error (T)	129.13	(0.01)
Period (P)	1	0.11
P x B	1	0.13
Error (P)	28	(0.01)
T x P	2.54	0.68
T x P x B	2.54	0.23
Error (T x P)	71.00	(0.05)

Note. Values enclosed in parentheses represent mean square errors.

* $p < .025$. ** $p < .001$.

Table Z2

Follow-up Comparisons on the Period Main Effect for the Type of Touch Measure – Study 2

Comparison		Mean Absolute Difference	Probability Level
1	2	17.16	< .05
	3	10.13	> .05
	4	18.33	< .05
	5	12.41	> .05
	6	11.40	> .05
	7	14.35	< .05
	8	8.27	> .05
	9	16.15	< 05
2	1	17.16	< .05
	3	7.03	< .05
	4	1.17	< .05
	5	4.75	< .05
	6	5.76	< .05
	7	2.81	< .05
	8	25.43	< .05
	9	1.01	< .05
3	1	10.13	> .05
	2	7.03	< .05
	4	8.20	< .05
	5	2.28	> .05
	6	1.27	> .05
	7	4.22	> .05
	8	18.40	< .05
	9	6.02	< .05
4	1	18.33	< .05
	2	1.17	< .05
	3	8.20	< .05
	5	5.92	< .05
	6	6.93	< .05
	7	3.98	< .05
	8	26.60	< .05
	9	2.18	< .05
5	1	12.41	> .05
	2	4.75	< .05
	3	2.28	> .05

Table Z2 cont'd

5	4	5.92	< .05
	6	1.01	> .05
	7	1.94	> .05
	8	20.68	< .05
	9	3.74	< .05
6	1	11.40	> .05
	2	5.76	< .05
	3	1.27	> .05
	4	6.93	< .05
	5	1.01	> .05
	7	2.95	> .05
	8	19.67	< .05
	9	4.75	> .05
7	1	14.35	< .05
	2	2.81	< .05
	3	4.22	< .05
	4	3.98	<.05
	5	1.94	> .05
	6	2.95	< .05
	8	22.62	< .05
	9	1.80	> .05
8	1	8.27	> .05
	2	25.43	< .05
	3	18.40	< .05
	4	26.60	< .05
	5	20.68	< .05
	6	19.67	< .05
	7	22.62	< .05
	9	24.42	< .05
9	1	16.15	< .05
	2	1.01	< .05
	3	6.02	< .05
	4	2.18	< .05
	5	3.74	< .05
	6	4.75	< .05
	7	1.80	> .05
	8	24.42	< .05

Note. 1 = no touch; 2 = static touch; 3 = stroke; 4 = pat; 5 = squeeze; 6 = tickle; 7 = shake; 8 = lift; 9 = 'other'

Table Z3

Analysis of Variance for Area of Touch for Study 2: Square Root Transformation

Source	df	F
	Between Subjects	
Birth Status (B)	1	0.03
Error	28	(0.01)
	Within Subjects	
Area (A)	3.17	32.48**
A x B	3.17	1.56
Error (A)	88.76	(0.09)
Period (P)	1	2.45
P x B	1	0.16
Error (P)	28	(0.01)
A x P	2.42	1.56
A x P x B	2.42	0.45
Error (A x P)	67.76	(0.06)

Note. Values enclosed in parentheses represent mean square errors.

* $p < .025$. ** $p < .001$.

Table Z4

Follow-up Comparisons on the Period Main Effect for the Area of Touch Measure – Study 2

Comparison		Mean Absolute Difference	Probability Level
1	2	13.93	> .05
	3	12.79	< .05
	4	13.94	> .05
	5	17.98	< .05
	6	13.20	< .05
2	1	13.93	> .05
	3	26.72	< .05
	4	0.01	> .05
	5	31.91	< .05
	6	27.13	< .05
3	1	12.79	< .05
	2	26.72	< .05
	4	26.73	< .05
	5	5.19	< .05
	6	0.41	> .05
4	1	13.94	> .05
	2	0.01	> .05
	3	26.73	< .05
	5	31.92	< .05
	6	27.14	< .05
5	1	17.98	< .05
	2	31.91	< .05
	3	5.19	> .05
	4	31.92	> .05
	6	4.78	> .05
6	1	13.20	< .05
	2	27.13	< .05
	3	0.41	> .05
	4	27.14	< .05
	5	4.78	< .05

Note. 1 = no area; 2 = feet; 3 = trunk; 4 = hands; 5 = shoulders; 6 = face