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The tactile context of a mother's caregiving: Implications for attachment of low birth weight infants[☆]

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Abstract

This study examined the degree to which specific properties of maternal touch may be associated with a low birth weight infant's security of attachment at one year of age, considering the potential modifying effects of maternal sensitivity and history of touch as well as infant gender and biological vulnerability. One hundred and thirty one socioculturally diverse infants and their mothers were evaluated for medical complications during the neonatal period. Videotapes were made of the infant-mother dyads during an infant feeding at three months of age. Each videotape was analyzed for a mother's properties of touch and her sensitivity as well as for infant responsiveness. When the infant was six months old, each mother completed a questionnaire to determine felt security regarding her own history of touch as a child. Researchers completed the Attachment Q-Set for each infant at one year of age.

Analysis of covariance indicated that sheer frequency of touch had no relationship to infant attachment but use of nurturing touch by mothers was associated with security of attachment. However, the degree of infant vulnerability (i.e., perinatal complications, birthweight, and responsiveness) moderated the effects of nurturing touch. Nurturing touch was associated with more secure attachment for robust infants but with less secure attachment for highly vulnerable babies. Neither maternal sensitivity nor gender appeared to moderate the relationship of touch to attachment or to have any direct relationship to attachment outcomes. Infant vulnerability decreased the likelihood of a

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secure attachment while a mother's felt security regarding her own tactile experience as a child increased her infant's chances of having a secure attachment. © 2000 Elsevier Science Inc. All rights reserved.

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1. Introduction

Attachment theorists have long regarded the quality of parent-infant physical contact as a central feature of the responsive and available caregiving environment that is necessary in fostering an infant's sense of security (Ainsworth et al., 1978; Bowlby, 1973). In fact, Main (1990) argues that physical contact with an attachment figure is "the ultimate signal" to the infant that s/he is safe and secure, noting that Bowlby (1969) placed physical contact as a central requirement of proximity and felt security. The thesis that 'contact comfort' creates an experience of refuge or safety for a child was originally proposed by Harlow (1962; Harlow & Zimmermann, 1959) whose research with rhesus monkeys provided evidence of the importance of bodily contact between infant and mother as the basis of reassurance and felt security for an infant. Subsequent human research also indicates that close bodily contact with the mother may be superior to other modalities in helping an infant cope with distress or discomfort (Grossman et al., 1985; Hunziker & Barr, 1986). Although much of the focus on physical contact has been on its role in situations of stress or uncertainty, Ainsworth and colleagues' (1978) seminal work demonstrated that it was the quality of touch in day-to-day interactions, not simply separations, which influenced the infant's attachment expectations.

While the link between physical contact and attachment may be salient for all infants, it has special importance for low birth weight (LBW) babies. Because of their fragile or underdeveloped nervous systems, LBW infants have diminished ability to regulate their responses to their tactile environments during the first few months of life. Numerous studies have demonstrated potentially detrimental effects of touch on high risk infants' neurobehavioral status and emotional distress (e.g., Als, 1986; Gunnar et al., 1987; Harrison et al., 1990). Because of these findings, many hospitals have adopted 'minimal handling' policies that require nurses and parents to touch babies infrequently, and primarily for essential medical procedures or cleaning rituals. As a result, some parents learn to withhold their touch to protect their baby and thus develop ingrained patterns of infrequent interaction which continue over time. Other parents who are less sensitized to their babies' vulnerabilities may overstimulate their infants without recognizing their regulatory difficulties. LBW infants may also be especially vulnerable to touch because of their history of invasive and painful medical procedures which can distort their somatosensory perception and increase the potential for touch to be aversive (DeMaio-Feldman, 1994).

In addition, there is evidence that certain types of neurobehavioral limitations (many of which are experienced by LBW infants) may affect the attachment relationship adversely (Belsky & Rovine, 1987; Crockenberg, 1981; Miyake, Chen & Campos, 1985; Vaughn & Bost, 1999; Van den Boon, 1994). These limitations (e.g., difficulty orienting, weaker muscle tone, irritability, tremors, lack of responsiveness) are associated with diminished CNS

integrity at birth, resulting from underdeveloped or medically compromised nervous systems. In contrast to full term, robust infants who have every sensory system functioning on their behalf at birth or soon after, many LBW babies are at risk because of such neurobehavioral problems. They are less capable of dampening their own distress, depending substantially on a caregiver during their first few months to regulate their neurobehavioral response to both internal and external stimuli (Als, 1986). As a result, they are especially susceptible to the effects of parental behavior. In addition, the infant's ability to engage the mother via eye contact, vocalization or facial expression predicts greater security of attachment (Grossman, Grossman & Schwan, 1986), placing minimally responsive LBW babies at even greater risk for attachment problems (van Beek, Hopkins & Hoeksma, 1994).

2. The impact of touch on attachment

Attachment theory emphasizes the role of touch in the context of maternal sensitivity and responsiveness to distress. The literature highlights two major characteristics of touch: its overall availability to the infant and the degree to which it is affectionate and tender versus rejecting or abusive.

2.1. Availability or frequency of touch

The amount of touch provided to the child is often defined as an index of maternal availability. Ainsworth and colleagues (1978) originally noted that mothers of secure infants used touch more extensively than mothers of insecure-anxious infants. Significant correlations between the attachment of infants and a number of maternal qualities of touch have also been described in a review and synthesis article written by several scientists with related programs of research (Waters, Kondo-Ikemura, Posada and Richters, 1990). These authors detail the relationships of monkey infant attachment to a mother's a) close holding of her infant for extended periods, b) carrying of the infant when moving from place to place, and c) tolerance of the infant's touching of her body during play. They also present data indicating that human infants classified as secure enjoy more playful physical contact with their mothers than babies classified as insecure.

In one of the few experimental studies manipulating the amount of physical contact between mothers and their infants, Anisfeld and colleagues (1990) compared attachment outcomes for infants who were carried ventrally in soft baby carriers with those transported in infant seats. They concluded that increased maternal contact from early carrying enhanced the likelihood of secure attachments for the infants.

In contrast, other studies indicate that mothers of insecure-avoidant infants may have some aversion to touch, appearing to dislike close physical contact with their infants (Egeland & Farber, 1984; Main, 1981; Main & Stadtman, 1981). Some scholars speculate that this discomfort with touch is transmitted from mother to infant because the babies of mothers who have insecure attachments begin to show some aversion to and/or lack of enjoyment of physical contact as they develop (Main, 1990; Pederson & Moran, 1995; Posada et al., 1995).

While results cited above imply that more extensive touch enhances attachment outcomes,

other findings suggest that too much touch can have a negative impact on attachment. Ainsworth et al. (1978) noted that mothers of insecure-resistant infants used touch that was interfering and at times inappropriate to the infant's needs. Other investigators have found that insecure-avoidant attachments are related to intrusive, excessively stimulating caregiving approaches (Lewis & Fiering, 1989; Smith & Pederson, 1988; Vondra et al., 1995). On the other hand, 'moderate stimulation' has been associated with greater security of attachment (Belsky, Rovine & Taylor, 1984; Feldstein et al., 1995). This distinction is clearly salient for low birth weight infants who are susceptible to overstimulation from touch as a result of their fragile nervous systems. The effects of frequent touch on infant security of attachment may well be moderated by the infant's degree of biological vulnerability.

It has been argued that sensitive parenting may be particularly important in assuring secure attachments when infants present more challenging neurobehavioral or temperamental profiles such as those often seen with LBW infants (Frodi & Thompson, 1985; Pederson & Moran, 1995). A mother's sensitivity to infant cues and responsiveness to distress have been integral concepts within attachment theory, viewed as antecedents to later attachment security (Bowlby; 1973; 1982). Based upon this literature, it seems likely that a mother's sensitivity would interact with her frequency of touch to determine its effects. When a mother is more generally sensitive toward the infant, touch would more likely be used with attention to the child's unique cues and state of readiness. Less sensitive mothers may use touch without consideration of these factors, leading to more negative effects on the infant's felt security.

2.2. *Nurturing versus harsh touch*

In addition to their more extensive use of touch, Ainsworth and colleagues (1978) found that mothers of securely attached infants also used more affectionate and tender touch with their babies than did mothers of insecure infants. Specifically, they caressed, hugged and kissed their infants more frequently and were careful and gentle in their handling. Other studies have supported these initial findings, indicating that warm, affectionate touch is more prominent among mothers of secure infants (Bates et al., 1985; Leyendecker et al., 1997; Network, 1997; O'Connor et al., 1992) but lacking in mothers of insecure-resistant infants (Schneider-Rosen & Cicchetti, 1984).

In contrast to nurturing touch, research has identified rejecting, angry, abrupt touch as a more typical pattern of mothers of both insecure-avoidant infants and infants with disorganized attachments (Ainsworth et al., 1978; Carlson et al., 1989; Crittenden, 1988; Van der Kolk & Fisler, 1994). The impact of such harsh touch has been described most extensively for children who are physically abused. They, as well as children exposed to substantial physical punishment, show a high incidence of insecure attachments (Main & Hesse, 1990; Main & Solomon, 1986; van IJzendoorn et al., 1992). These studies lead to the hypothesis that less use of harsh touch and greater use of nurturing touch should be associated with secure attachment. However, there is some danger in assuming that tender, affectionate touch is inherently beneficial. Gentle, loving touch could be intrusive if used at an undesirable moment. Such a possibility suggests that a mother's sensitivity may also moderate the effects of nurturing or even harsh touch on the infant's attachment to the mother.

Gender represents another variable that could influence the relationship between maternal touch and a child's attachment. Research suggests that there are differential effects of nurturing touch on boys versus girls, with these effects being much stronger for boys (Weiss, 1990; 1999). Such findings may stem from differences that have been noted (in both human and animal studies) in the ways in which males and females perceive and process the touch they receive (Diamond, 1990; Hofer, 1981; Weiss, 1993). These touch-specific gender differences are given further significance by the fact that LBW boys are consistently more at risk for worse socioemotional outcomes than LBW girls (Brooks-Gunn & Benasich, 1997; Pharaoh et al., 1994).

2.3. *Maternal history of touch*

Research supports the notion that a mother's history of attachment-related experiences as a child will influence the nature of the attachment she cultivates with her own child. Evidence of this intergenerational transmission of attachment behavior abounds (Benoit & Parker, 1994; George & Solomon, 1996; Steele, Steele & Fonagy, 1996; van IJzendoorn, 1995; Ward & Carlson, 1995). Within the theoretical tradition of Bowlby and Ainsworth, an individual's physical contact experience with the attachment figure would be an integral feature of overall attachment security. A mother's state of mind with respect to the touch in her family of origin would constitute part of her internal working model of attachment behavior (i.e., her cognitive and emotional expectations of how attachment figures respond when they are turned to for support or security). Negative tactile experience could foster a lack of felt security with the attachment figure's physical availability when the need for contact comfort arises. It is such a history that would potentially compromise subsequent attachment-related interactions. For example, Main (1990) found that a mother's aversion to physical contact with her child during a stressful situation was significantly related to the mother's perceived rejection of her own bids for contact as a child and to her infant's insecure attachment behavior (Main & Weston, 1981). Such theoretically-based findings suggest that a mother's felt security regarding her own tactile history may interact with her actual use of touch to influence her infant's security of attachment.

3. **Research aims**

Based upon the theory and research described above, our study had two major aims: 1) to determine whether a mother's frequency of touch or her use of nurturing versus harsh touch are associated with the low birth weight infant's security of attachment, and 2) to determine whether selected moderating variables may interact with maternal touch to influence its relationship to attachment: specifically, a) the mother's sensitivity toward the infant, b) the mother's felt security regarding her own history of touch, c) the infant's degree of biological vulnerability, and d) the infant's gender.

4. Methods

4.1. Sample

The sample included 131 infants and their mothers who were recruited into the study during the infant's first two weeks of life. These dyads were part of a larger research program focused on early development of low birth weight infants. The sample was ethnically diverse, including 46% Caucasian, 28.4% Hispanic, 19.3% African American, and 6.5% Asian or Native American babies. Their weight ranged from 570 g to 2500 g with a mean birthweight of 1487 g (SD = 547). Ninety-four percent of the babies had a gestational age of less than 37 weeks, with a sample mean of 32 weeks. Forty-four percent of the babies were girls and 56% were boys, with 22% known to have been drug exposed in utero. Mothers had a mean age of 29 years (SD = 7), ranging from 16 to 44. They averaged 12.5 years of education, with a spread from 1 to 20 years. Eighty-one percent of the mothers lived with their partner, but not necessarily a spouse. Forty-five percent of the mothers were living below the poverty level. Sixty-one percent were employed at least part-time, with 29% being the sole support for their family.

4.2. Procedures

Families were recruited from the neonatal intensive care units of 3 major teaching hospitals in northern California. Mothers were told that the overall purpose of the research was to understand factors that might influence the health and development of babies who are small at birth. Once an informed consent was acquired, the mother was given a demographic questionnaire to complete regarding both herself and her baby. When the baby was one month old, a research assistant (RA) with clinical expertise in care of neonates reviewed the medical charts of mother and infant to identify the presence or absence of specific perinatal risk factors that constituted the Perinatal Complications Scale. When the baby was 3 months of age, another RA who was a clinical nurse specialist made a home visit to videotape the mother and infant during a typical feeding. Mothers fed the infant in their normal feeding mode, either breast or bottle. The videocamera was set up and turned on as soon as the RA arrived in order to allow time for the mother to adjust to its presence. The camera was then left on the mother and infant while the baby was being fed. The videotape of the feeding was analyzed subsequently using the Tactile Interaction Index (to measure the mother's use of touch) and the Nursing Child Assessment Feeding Scale (NCAFS) to measure the infant's interactive responsiveness and the mother's sensitivity. When the infant was 6 months of age, the RA made another home visit at which time the mother completed a questionnaire regarding her experience with and attitudes toward physical contact. Shortly after the infant's first birthday (corrected for gestational age), an appointment was made for a final home visit to interview the mother and spend approximately 3 hrs observing the mother and child during a playtime and feeding. The interview and observations were used as the major source of input for the RA's completion of the Attachment Q-Set.

4.3. Measures

4.3.1. Infant vulnerability. Vulnerability was measured with an index that combined scores from 3 variables: infant birthweight, perinatal risk status, and interactive responsiveness of the infant at 3 months of age. Birthweight and perinatal risk data were determined by the Perinatal Complications Scale (Littman & Parmelee, 1978; Parmelee et al., 1976). The measure assesses maternal obstetrical history, pregnancy events, perinatal measures of the infant (e.g., gestational age and apgar), and hazardous postnatal events such as need for ventilatory assistance, metabolic abnormality, or surgery. A summary score is based on the number of risk factors incurred by a mother-infant pair, with higher scores indicating greater risk. Risk data were acquired primarily from chart review during the first month postnatal, with supplemental input from the infant's primary nurse. Reliability and validity have been demonstrated for these scales (Francis et al., 1987; Scott et al., 1997). The score for infant responsiveness (which was combined with the perinatal risk score and the birth weight score to yield an infant's vulnerability index) was determined through the NCAFS measure described next.

4.3.2. Maternal sensitivity and infant responsiveness. The NCAFS was used to measure infant responsiveness to the mother as well as maternal sensitivity. The scale is an observational measure with established normative data. It shows evidence of total and subscale internal consistency and test-retest reliability as well as construct, concurrent and predictive validity (Barnard et al., 1989; Sumner & Spietz, 1994). While observations relevant to the entire scale were made, only subscale scores pertinent to this study are described here: 1) the infant subscale for 'responsiveness to caregiver' which was incorporated into the vulnerability index mentioned above, and 2) two maternal subscales for 'sensitivity to cues' and 'responsiveness to distress'. The subscales each consist of binary items which are summed; larger scores indicate greater sensitivity or responsiveness. The measure also provides a combined maternal score which is the sum of the 'sensitivity to cues' and 'responsiveness to distress' scales; this is the score we used in our analysis.

An expert coder was trained and certified as reliable in use of the NCAFS by the University of Washington NCAST office (i.e., met their criterion of at least 85% reliability for each scale on a series of standardized case studies). This individual completed the coding for all infant-mother dyads based upon review of the entire videotape of their feeding situation. The coder was blind to any other information about the mother-infant pairs.

4.3.3. Maternal touch. The specific properties used by mothers in their touching of infants were measured with the Tactile Interaction Index (TII) (Weiss, 1992). The TII includes both a series of training videotapes differentiating various properties of touch as well as a coding system to analyze these properties within a specified interaction. The coding system was created specifically for microanalysis of videotaped or filmed interaction. While it has indices measuring the intensity, location, action and frequency of a touch, only the action and frequency indices were pertinent to the variables under study (i.e., nurturing touch, harsh touch and frequency of touch).

The action index identifies 28 different gestures or movements that can be used in

touching (e.g., grab, push, rub, squeeze). From the raw data regarding specific tactile gestures, 2 percentage scores were developed. The first score rated each mother on the degree to which she used nurturing actions (e.g., stroking, kissing) and the second score identified the degree of harsh actions (e.g., hitting, slapping). In contrast to the action index, the score for frequency of touch was not a percentage score but rather the actual number of times a mother touched her baby.

A standardized 5 minute segment of the infant feeding situation was used for analysis of each mother's touch. The initial few minutes of the feeding were not used in order to allow mother and baby to adjust comfortably to their normal feeding routine. Two subsequent minutes were then coded during active feeding of the baby. Three additional minutes were also coded at the end of the feeding, when mothers were burping the baby and engaging in other interaction with the infant unrelated to the feeding per se. Although we found no significant differences within the sample for overall qualities of touch used by mothers who breast and bottle fed, this latter three minutes of the coding period allowed for a variety of interaction that was independent of the mother's feeding mode. Standardizing the length of time coded for each feeding limited some of the variance in overall frequency of touch. However, it was necessary in light of a number of factors, including the length of some feeds, periods where the baby was sleeping with no interaction taking place, and the time-intensive nature of the tactile coding process. The natural, spontaneous quality of the feeding was preserved by standardizing what was coded rather than rigidly structuring the feeding situation itself.

The content, construct and predictive validity, as well as internal consistency, interrater reliability and test-retest stability of the TII have been established previously (Weiss, 1990; 1992). A trained RA (who had achieved coding reliability of 0.92 or above for each index) reviewed the five minute feeding tapes two separate times, coding the action and frequency indices separately. This RA had no other contact with the families participating in the study, nor any access to information about them.

4.3.4. Maternal history of touch. A mother's history of touch was measured by the Physical Contact Assessment Questionnaire. The 20 item Likert -type questionnaire was developed specifically for the larger research program of which this study was a part. Although there are 3 subscales within the entire measure (I. 'Attitudes toward Touch', II. 'Felt Security regarding Tactile Experience as a Child', and III. 'Felt Security regarding Current Tactile Experience'), only the score from the subscale assessing tactile experience as a child was used in the study described here. This second subscale was the one most relevant to the mother's internal working model of attachment and, in fact, the only subscale which showed a relationship to infant attachment when a preliminary correlation matrix was computed. The self-report items in this subscale measured the degree to which the touch received in the mother's family of origin was perceived as affectionate versus punitive and the degree to which the amount and type of touch met the respondent's needs for affection and comforting as a child. The subscale's alpha reliability within the sample was 0.83. We have found in the larger research program (from data of 185 mothers of low birth weight infants) that the subscale predicts the degree of a mother's rejection of her own child, with less felt security in her past tactile experience predicting greater rejection ($r = -0.24, p < .003$). These data

also indicate that the subscale is correlated with a) the mother's felt security in her current tactile experience ($r = 0.33, p < .000$) and b) the perceived supportiveness of her current relationships ($r = 0.17, p < .04$). Its predictive validity is further evidenced by correlations with family functioning ($r = 0.23, p < .005$) and satisfaction with family interactions ($r = 0.32, p < .000$).

4.3.5. Infant attachment security. Security of attachment was measured with the Attachment Q-Set (Waters & Deane, 1985). This is a 90 item Q Sort using observations of secure based behavior of infants and young children during their interactions with primary caregivers in the home. The items are sorted into 9 categories in terms of whether they are characteristic or uncharacteristic of the child being described. All RAs who were assigned to follow various families longitudinally had been trained in the use of the Q-Set. Each RA completed the Q-Set for a particular child with whom they had worked for a full year prior to the Q-Set completion. As part of the larger research program, each RA had bimonthly contact with a specific group of families for whose data collection they were responsible. This contact involved home visits of about two hours in length when the infant was both 3 and 6 months of age. Although these visits were focused on data collection unrelated to the attachment measure, the RA was able to use this extended experience with a specific family as an additional source of input for sorting the statements.

Specific to the attachment Q-Set, the RA spent approximately 3 hrs in the home shortly after the child's first birthday, observing the child and mother during a playtime and a feeding. As part of our protocol for the observations, the mother was asked to leave the room at one point without telling the child where she was going or when she would return. After a period of observing the child's response, the RA offered the baby a new toy and initiated a play attempt. After about 3–5 minutes, the mother returned. During each of these separate periods of time, the RA observed the infant's level of distress specific to the brief separation and reunion, the various responses to mother and RA, and the interaction of mother and infant. While not attempting to replicate the carefully standardized features of the 'Strange Situation' protocol, this semistructured aspect of the home observation did enhance the RA's ability to characterize the child on the attachment-related behaviors in the Q-Set. Finally, as an additional attempt to create a comprehensive and valid data base from which to determine the child's characteristics, the RA interviewed the mother to acquire her input regarding the behaviors in the Q-Set. For this interview, the 90 statements were converted into a respondent-friendly interview format. Within 24 hrs after this home observation and interview, the RA completed the Q-Set, integrating past experiences with the family, the three hour home observation, and maternal interview data to make judgments regarding the relevance of each statement to the child. Waters and Deane's (1985) criterion set of items for secure attachment was used as the measure of security, with the percentage of agreement for an infant's ranking on the criterion items being the final score for secure attachment.

Studies report interobserver reliability ranging from 0.72 to 0.95 for the Q-Set (Belsky & Rovine, 1990; Solomon & George, 1999; Teti & McGourty, 1996). We found an interobserver reliability of 0.89 for those trained to complete the Q-sorts in our study. Content, construct and predictive validity have been supported (Kerns, 1994; LaFreniere et al., 1992; Posada et al., 1995; Strayer et al., 1995). Concurrent validity is evidenced by the measure's

ability to differentiate attachment classifications using the ‘Strange Situation’ in several but not all studies (Belsky & Rovine, 1990; Mangelsdorf et al., 1996; Vaughn & Waters, 1990).

4.4. Data analysis

Analytic procedures involved three phases. First, we computed a correlation matrix to identify independent and moderating variables with the potential for a significant relationship to security of attachment. Independent variables were the mother’s frequency of touch, nurturing touch, and harsh touch. Moderating variables included the infant’s biological vulnerability and gender as well as the mother’s sensitivity toward the child and her felt security regarding her own tactile experience as a child. Because gender was a discrete variable, we performed *t* tests to determine any potential differences in security of attachment between boys and girls.

In the second phase, we identified any interaction terms that might have a significant effect on attachment. We tested the potential effects of the interaction between each independent variable and each moderating variable through regression models, computing separate equations for each independent variable.

Finally, because we were interested in differentiating any subtle effects of various degrees of maternal touch on attachment, analysis of covariance (ANCOVA) procedures were employed to address our research aims. We computed separate ANCOVA’s for each touch variable as between subjects factors, grouping subjects into 3 categories based on their extensive, moderate or minimal use of each type of touch. Any moderating variables which were identified via preliminary analysis as having significant associations to attachment were also included in the model as covariates or interaction terms using a nested design.

Because only 9 mothers used any harsh touch during the feeding, we could not perform all of the above procedures to examine its link to attachment security. We did, however, compute the correlation between the degree to which mothers used harsh touch and their child’s security. *t* tests were also computed to compare the attachment security scores of children whose mothers used any harsh touch ($n = 9$) with children whose mothers used extensive nurturing touch, that is, at least 75% of their total touch ($n = 12$).

5. Results

5.1. Maternal touch descriptors

Within the standardized feeding period, mothers touched their babies an average of 213 times ($SD=109$), ranging from 41 to 714 touches. As an average, approximately half of a mother’s touch was nurturing (47%), with a range from 0% to 91%. Seventeen percent of the mothers used no nurturing touch at all during the feeding situation. For the 9 mothers who used harsh touch (slapping or hitting), their mean for its use was 2% of their total touch, with a range from 1% to 19%.

Maternal age, income and years of education had no relationship to the frequency of maternal touch. However, a mother’s use of nurturing touch was positively associated with

Table 1

Pearson correlations for the association of infant attachment to other infant and maternal variables

	Infant	Maternal				
	V	FT	NT	HT	Hx	S
<i>Infant</i>						
Attachment Security	-.20*	.12	.22**	.61	.19*	.02
Vulnerability (V)		.07	.07	-.41	.00	-.13
<i>Maternal</i>						
Frequency of Touch (FT)			.06	.11	.05	.09
Nurturing Touch (NT)				.82**	-.02	.02
Harsh Touch (HT)					.29	-.32
History of Touch (Hx)						.09
Sensitivity (S)						

Note: N = 131 except for all correlations involving harsh touch (n = 9).

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

more adequate financial income ($r = 0.19, p < .04$), older age ($r = 0.25, p < .004$), and years of education ($r = 0.34, p < .000$). Once we controlled for these socioeconomic variables, we found no differences across ethnic groups in their patterns of touch.

5.2. Preliminary associations between attachment security and study variables

The preliminary coefficients for potential correlations among study variables are displayed in Table 1. Only one of the independent variables, nurturing touch, showed any significant relationship to infant security of attachment. The correlation between scores for a mother's use of harsh touch and attachment security was substantial and in a positive direction. However, this relationship involved only 9 mothers and was not significant. Two of the moderating variables, infant vulnerability and maternal history of touch, were also associated with attachment security. The t tests to examine potential differences between boys and girls in attachment security or for any other study variables identified no gender differences of any kind.

Only one significant relationship was noted among the independent and moderating variables. Nurturing touch was significantly and positively related to harsh touch for the small subsample of 9 mothers who used any harsh touch. In other words, mothers who used harsh touch with their infants also used a substantial amount of nurturing touch.

In our preliminary regressions to identify any interaction terms which might be associated with attachment security, only one relationship was significant or showed even a trend toward significance. This was the interaction between infant vulnerability and a mother's use of nurturing touch. So we built this interaction into the final analysis of covariance, along with the other variables which had shown significant relationships in the preliminary phases of analysis.

5.3. Final ANCOVA models for frequent and nurturing touch

The results of the model for nurturing touch are shown in Table 2. Nurturing touch, infant vulnerability and the interaction between nurturing touch and vulnerability were all signif-

Table 2
Analysis of covariance for effects of nurturing touch on infant attachment security

Source	df	F
Nurturing Touch (N)	2	4.87*
Infant Vulnerability (V)	1	4.02*
Maternal Touch History	1	3.78
N × V	2	5.00*
Error	124	(1.45)

Note: The value in parentheses represents mean square error.

* $p < .05$.

icantly associated with an infant's security of attachment. Although a mother's felt security regarding her own tactile experience as a child had been significantly associated with her infant's attachment in the preliminary correlations, it showed only a trend toward significance in the final model.

Post hoc contrasts (using a modified Bonferroni procedure) among the three groups of mothers who had used different degrees of nurturing touch showed a significant difference between one of the groups and the other two. The group of children whose mothers used extensive amounts of nurturing touch had significantly higher scores for their security of attachment ($M = 0.78$) than either children whose mothers used a moderate amount of nurturing touch ($M = 0.67, p < .04$) or a minimal amount of nurturing touch ($M = 0.63, p < .03$). However, cross breaks to identify specific effects within the interaction between infant vulnerability and nurturing touch indicated significant differences in the effects of nurturing touch on very vulnerable versus more robust LBW infants. While the effects were in a positive direction for the larger group of more robust infants ($r = 0.29, p < .05$), nurturing touch was negatively associated with security of attachment for the higher risk, more vulnerable babies ($r = -0.40, p < .007$).

As shown in Table 3, frequency of touch showed no relationship to an infant's security of attachment nor did its interaction with any of the moderating variables. However, it is interesting to note that when no variance was accounted for by a mother's actual touch of her infant, her felt security regarding her own tactile history was significantly associated with her infant's security of attachment.

Table 3
Analysis of covariance for effects of frequent touch on infant attachment security

Source	df	F
Frequency Touching	2	.16
Infant Vulnerability	1	4.14*
Maternal Touch History	1	4.80*
Error	126	(4.75)

Note: The value in parentheses represents mean square error.

* $p < .05$.

5.4. Harsh touch

As noted earlier, we were unable to adequately test the relationship between harsh touch and security of attachment. The mean score on security of attachment for children receiving harsh touch ($M = 0.69$) was somewhat lower than the mean score for children receiving high amounts of nurturing touch ($M = 0.78$) but the t test was not significant.

6. Discussion

6.1. Maternal touch and infant attachment

6.1.1. Nurturing touch. The results did indicate that a mother's use of more nurturing touch was related significantly to a secure attachment, but only for more robust LBW infants of larger weight and minimal perinatal risk. For this group, infants of mothers who used nurturing touch as 75% or more of their total touching of the infant were more likely to develop secure attachments than infants whose mothers used either moderate or minimal amounts of nurturing touch. Their attachment scores decreased proportional to the diminishing use of nurturing touch, although the use of moderate vs minimal nurturing touch did not appear to make a significant difference to attachment outcomes. These findings do support previous attachment research which indicates that mothers of securely attached infants use more affectionate and tender touch with their babies than mothers of less secure infants (e.g., Ainsworth et al., 1978; Leyendecker et al., 1997).

However, the results show an opposite effect of nurturing touch for the more vulnerable infants in our sample. For these very low birth weight, minimally responsive babies with many perinatal complications, the use of extensive nurturing touch was associated with less secure attachment. These findings indicate that more vulnerable infants 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. Previous research has shown that high risk infants with more complicated courses exhibit both a diminished ability to modulate their arousal (Aylward et al., 1984) and substantial avoidance of interaction (Bennett, 1997) in an apparent attempt to manage their arousal. Because of their less sophisticated use of regulatory skills such as gaze aversion or crying, very high risk infants have less ability to communicate to their mothers any aversion or overstimulation they may experience during the interaction. In addition, infants who experience more perinatal complications and longer hospital stays may develop tactile aversion as a result of the often painful handling and probing incurred as part of their medical care (DeMaio-Feldman, 1994). These previous findings help to explain our results.

However, we expected that frequent touching rather than nurturing touch might show a potentially detrimental effect for attachment of high risk infants. But, as we considered the results, we noted that patting the infant's back was the most frequently used tactile action by mothers and was thus highly correlated with frequency of touch. In contrast to patting (which in most cases involves minimal stimulation), actions such as stroking, hugging and kissing make contact with numerous areas of the child's body, involving more proprioceptive

stimulation, stronger intensity, and contact with areas of the infant's body having many nerve pathways such as the face, head and hands. It is this combination of factors (rather than affectionate touch per se) which may be excessively arousing or intrusive for the infant, engendering feelings of distress rather than comfort from extensive nurturing touch.

The direct association we found between vulnerability and attachment also suggests that more vulnerable infants are at risk for less secure attachments, irrespective of the nature of touch received. This outcome seems very important in light of previous studies which indicate that prematurity does not adversely affect the attachment relationship (Frodi & Thompson, 1985; Macey et al., 1987). Although the mean attachment scores for our sample do not imply that the infants as a whole are insecurely attached and we did not look at attachment classifications per se, our findings reinforce previous research which has shown that "high risk" premature infants exhibit more insecure attachments than their full term counterparts (Plunkett et al., 1986). These results speak to the need for individualized attention to the low birth weight infant's unique challenges so that intervention can be tailored to assist the highest risk infants and their mothers.

In contrast to the significant effects of infant vulnerability, the child's gender appeared to have no association to attachment. Our findings did not support the prediction that LBW boys are at substantially greater risk than girls for attachment problems as a result of the touch they receive. It is interesting to note that the absence of any gender differences is in concert with much of previous attachment research in which a paucity of sex differences has emerged (Belsky & Cassidy, 1994; Hazan & Shaver, 1994).

6.1.2. Harsh touch. Our ability to address our research aim regarding harsh touch was compromised by its lack of adequate distribution. However, infants of the small subsample of mothers who did use harsh touch did not have significantly lower scores for secure attachment than infants receiving extensive nurturing touch. Their scores were indeed lower ($M = 0.69$ vs 0.78) but the small sample size in this analysis most likely precluded adequate power to achieve any level of significance. It is surprising, however, that infants receiving harsh touch had higher scores for secure attachment ($M = 0.69$) than infants receiving moderate ($M = 0.67$) and minimal amounts ($M = 0.63$) of nurturing touch. In addition, there was a positive and significant correlation between use of harsh touch and use of nurturing touch ($r = 0.82$). This finding suggests that mothers who used harsh touch also were providing fairly substantial amounts of affectionate tactile stimulation; that is, they were tactually expressive mothers whose touch communicated both positive and negative affect. Although the number of mothers using harsh touch seriously limits our ability to generalize from their data, the provocative nature of these findings warrants further study. We need to test the speculation that receiving harsh touch per se may have no major negative effects on a child's development of a secure attachment as long as the child is also receiving appropriate nurturing touch. It is important to remember that mothers in our sample who used harsh touch did so, on average, only 2% of their total touching. Still, to slap or hit a child while being videotaped as part of a study would be more likely to occur if the mother used this type of touch quite spontaneously as part of her typical repertoire of caregiving. In light of this, we question whether it may be the absence of kissing, hugging and caressing (rather than the presence of harsh touch) which places the child at greater risk for insecure attachment. As

long as nurturing touch is also available, a limited degree of harsh touch may not jeopardize an infant's general sense of being safe and secure.

6.1.3. Frequency of touch. The amount of touch received by a child appeared to have no relationship to his/her security of attachment. In fact, the mean score for secure attachment was identical for infants regardless of whether their mothers fell into the group which used very minimal amounts of touch, moderate amounts, or a high frequency of touch. These results differ from some research cited in the introduction to this article, indicating that both too little touch and too much touch may have negative consequences for attachment (e.g., Main & Stadtman, 1981; Vondra et al., 1995). However, our study did not examine maternal aversion to touch nor the intrusive or interfering quality of touch, characteristics which have been associated with minimal touch or overstimulating touch respectively. In addition, our measure of frequency did not differentiate amount of close holding or ventral contact from other types of touch such as holding the child's hand or patting her head. Greater use of ventral contact and close holding are specific types of touch which have been found to enhance attachment outcomes (Anisfeld et al., 1990; Waters et al., 1990) so the frequency of these types of touch may have different implications for secure attachment. Some of the variance associated with close holding and ventral contact may have been accounted for in our measure of nurturing touch but this possibility would need to be explored further. Accounting for such characteristics would speak to the "qualitative" nature of the touch used rather than its strict "quantity." In testing the hypothesis regarding frequent touch, our purpose was to examine the overall amount of physical contact, regardless of its qualitative nature.

There was no evidence that sensitivity played any moderating role between frequency of touch (or nurturing touch) and attachment. Nor did sensitivity show any direct association to attachment. Our study is not alone in finding an absence of any relationship between sensitivity and attachment (e.g., Seifer et al., 1996). In addition, the strength of the relationships which have been found is weak or modest at best, whether in more naturalistic, home-based studies using the Attachment Q-Set or in the laboratory-based strange situation (Solomon & George, 1999; Weinfeld et al., 1999). In fact, DeWolff and van IJzendoorn (1997) concluded from their meta-analysis that sensitivity does not appear to be an exclusive or predominant factor in development of secure attachment.

Still, the lack of any relationship between sensitivity and attachment is puzzling, especially for this population of infants who are at greater risk from the effects of caregiving as a result of their low birth weight status. It is important to remember that maternal sensitivity is a multidimensional concept of which our study measured only certain dimensions. Although the aspects of sensitivity which we examined are commonly held as central features of maternal sensitivity (i.e. sensitivity to infant cues and responsiveness to infant distress), the NCAFS measure allows for a limited assessment of specific behaviors which reflect these aspects of sensitivity. Some of the instruments that have been used to measure sensitivity in other studies determine a larger scope of behaviors indicative of sensitivity. We also question whether differences in the developmental point at which sensitivity is measured may be salient. We assessed the mother's sensitivity toward the infant at 3 months of age because we were most interested in the potential effects of her behavior during the infant's

early months when touch is a primary component of caregiving. But the role of sensitivity may strengthen as the infant becomes a more interactive partner and is more aware of the mother's behavioral contribution to that partnership. For instance, her sensitivity toward the infant at 12 months of age may have interacted significantly with maternal touch to influence attachment. All of these differential features of maternal sensitivity need to be explored in future research in order to better understand how sensitivity may or may not influence the effects of touch on attachment outcomes across the developmental span.

6.2. Maternal tactile history

A mother's state of mind regarding her own tactile history did not appear to modify the effects of her touch but instead was directly associated with her infant's security of attachment. This finding lends credence to attachment theory's implication that a caregiver's own tactile experience as a child constitutes part of her internal working model of attachment. As noted by Ricks (1985), a parent's own childhood experience appears to tap an important source of variance in attachment outcomes for his/her child.

The strength of the association which we found between maternal tactile history and infant attachment attenuated to a trend once the mother's use of nurturing touch was accounted for in the model. However, when we removed tactile history from the model, the strength of the maternal touch variable was diminished. These complex connections between a mother's use of touch and her own tactile history suggest that they make some interrelated contribution to the infant's attachment. The importance of understanding the tactile antecedents in parent-child relations (specifically, the parent's own history of physical affection, discipline or physical neglect) has been emphasized by other investigators (Egeland et al., 1988). Our findings indicate that the mother's felt security about her attachment-related *tactile* experience may represent a core component of her internal working model of attachment which is transmitted to her child, potentially through some facet of her nurturing touch.

7. Conclusion

Maternal touch does appear to play a significant role for low birth weight children in their development of a secure attachment to the mother. Kissing, hugging and caressing are significantly associated with attachment outcomes. However, the degree of an infant's vulnerability appears to influence whether extensive nurturing touch may support or impede the infant's development of a secure attachment. There is some indication that harsh touch per se may not necessarily place these children at risk for insecure attachment as long as nurturing touch is also present in the caregiving. But the subsample using harsh touch was so small that generalizability of their results is extremely limited. The overall frequency of maternal touch appears to have no link to the ultimate quality of a child's attachment, even when the mother shows a high degree of sensitivity in her caregiving. In fact, maternal sensitivity toward the infant at three months of age appeared to have no relationship to later attachment in this sample of low birth weight children, neither a direct association nor a modifying effect on the relationship between maternal touch and attachment. These results

raise some important questions regarding a) the potential for differential effects of sensitivity at various points in the child's development and b) whether specific dimensions or features of sensitivity may be associated with attachment while others are not.

Infants whose mothers felt more secure about their own childhood tactile experience were more likely to develop secure attachments. These results lend support to the idea of intergenerational transmission of working models of attachment and implicate a potential role for the tactile component of the attachment relationship in development of one's internal attachment model.

The results suggest that low birth weight infants who are more vulnerable based on medical complications, diminished responsiveness and very low birth weight are at significantly greater risk for attachment problems in general, with the potential for exacerbation of these problems from the use of extensive nurturing touch. Early identification of these babies may be critical to their later well being, so that interventions can be offered to enhance the mother's use of touch and to assist her in dealing with any unresolved feelings about her own tactile experience as a child.

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