Infant and parent factors associated with early maternal sensitivity: A caregiver-attachment systems approach

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Abstract:
We examined variations in maternal sensitivity at 6 months of child age as a function of child negativity and maternal physiology. We expected maternal vagal withdrawal in response to infant negative affect to facilitate the maintenance of sensitivity, but only for mothers of securely attached children. One hundred and forty-eight infant-mother dyads were observed in multiple contexts at 6 months of child age, and associations among maternal and child variables were examined with respect to 12-month attachment quality. Mothers of later securely attached children were more sensitive than mothers of avoidant children. However, sensitivity decreased for all mothers at high levels of infant negative affect. Furthermore, for mothers of avoidant children, vagal withdrawal was associated with sensitivity to child distress. No association was found between vagal withdrawal and sensitivity for mothers of securely attached children. This suggests that mothers of avoidant children may be uniquely challenged by the affective demands of their infants. © 2007 Published by Elsevier Inc. Keywords: Infant; Parent; Caregiver

Article:

The conception of parental sensitivity as a stable personality attribute that directly benefits attachment security has been challenged by meta-analyses (De Wolff & van IJzendoorn,1997) identifying child factors as important contributors to attachment formation (Goldsmith & Alansky, 1987) and showing that the relation between maternal sensitivity and attachment security is not as strong as initially proposed by Ainsworth, Blehar, Waters, and Wall (1978). Two reports by Crockenberg (1981) and van den Boom (1994) that highly irritable infants tend to receive less sensitive care and are at greater risk for developing insecure relationships to their caregiver were especially compelling in this regard. Their findings suggest that sensitive parenting might be challenged and reduced by infant negativity, but enhanced when the child positively stimulates the mother and responds to her bids for interaction (see also Atkinson et al., 1999; Cox, Owen, Henderson, & Margand, 1992; Kochanska, 2001; Thompson, 1997; van den Boom, 1997).

In this light, both van den Boom (1997) and Thompson (1997) have pressed for amore dyadic/contingent concept of caregiver sensitivity that takes into account the infant's changing affective state. Additionally, the notion that there may be caregiver regulatory qualities that, via

their effects on sensitivity, promote or compromise security of attachment (van IJzendoorn, 1995) has also gained visibility in attachment research (Adam, Gunnar, & Tanaka, 2004; Kochanska, Murray, & Harlan, 2000; Pederson, Gleason, Moran, & Bento, 1998; Pedersen & Moran, 1995). In this study, we examine how maternal sensitivity at 6 months of child age varies as a function of child distress and the mother's ability to physiologically self-regulate in response to this distress.

1. CHILD FACTORS, MATERNAL SENSITIVITY, AND ATTACHMENT SECURITY

Bowlby's (1969) attachment theory highlighted the importance of shifts between positive and negative affect as the primary mechanism of communication for infants. Accordingly, while positive affect promotes affiliation and the acquisition of competence through play and exploration, shifts to negative affect serve as potent signals of distress and the need for comfort from the caregiver. The caregiving system must adequately detect and attend to these shifts in order to support the development of a secure attachment relationship. The coordination of caregiving behaviors with the infant attachment system is a benchmark of sensitive parenting, which is exemplified by child-centered responses to the physical and emotional needs of the infant (Ainsworth et al., 1978; Bowlby, 1969). Repeated experience with this type of caregiving allows the child to develop a sense of efficacy and agency and to use the full repertoire of emotional communication in a well-regulated manner (Tronick,1989). The fact that the caregiving system must respond appropriately to a variety of emotional needs from the child highlights the relevance of examining parenting across a spectrum of interactive contexts. Although experiencing sensitive caregiving is important for children in all contexts, experiencing effective soothing and comfort when distressed may be particularly important for the development of self-regulation. In contrast, the inability to rely on the caregiver for comfort when distressed may lead the child to develop coping strategies, such as avoidance, that in the long term are maladaptive. Several researchers, such as Thompson (1997), have proposed that "sensitivity expressed when the child is fearful, anxious or distressed might be more prognostic of a secure attachment than sensitivity displayed during nonstressful episodes . . . " (p. 596).

Although several studies have examined the relationships between infant affect, maternal sensitivity, and attachment security (Braungart & Stifter, 1991; Frodi & Thompson, 1985; Mangelsdorf, Gunnar, Kestenbaum, Lang, & Andreas, 1990; Thompson & Lamb, 1984), to date only a few longitudinal studies explicitly considered early child influences on maternal sensitivity and later attachment classification (Braungart-Reiker, Garwood, Powers, & Wang, 2001; Posada et al., 1999). Although these studies identify independent effects of early maternal sensitivity and infant affective displays on later attachment classification, they also highlight the difficulty of establishing clear causal links between maternal and infant behaviors. In spite of these limitations, there is much to be gained by examining how these behaviors are coordinated, especially with respect to the dyad's emerging attachment relationship.

For the purpose of the present research, we measured maternal sensitivity at 6 months of child age under three different conditions of increasing stress for the dyad. We expected that these conditions would differ in terms of the probability of observing child negative affect. These conditions included a free play session, a book reading session, and the recovery period that followed two challenge procedures known to elicit infant distress. Based on previous findings that mothers of insecurely attached children (especially of avoidant children; Cassidy, 1999) have more difficulties with their own emotion regulation and parental function under conditions

of infant distress than mothers of secure children, we hypothesized that mothers of children later categorized as secure would be better able to maintain sensitivity under conditions of infant distress than mothers from insecure dyads.

2. MOTHER'S SELF-REGULATION IN RESPONSE TO INFANT DISTRESS

Bowlby (1969) posited that negative affect is the most potent tool of communication available to the infant because of its distinctness and saliency for the mother in almost any situation. Although being aroused by a crying infant is certainly an adaptive feature of the caregiving system, infant distress can also be quite dysregulating for mothers, especially when persistent and intense. Consider the current definitions of parental sensitivity, including attentiveness and awareness of child signaling, emotional availability, consistency, appropriate emotional tone, and lack of irritation and anger (Ainsworth et al., 1978; NICHD Early Child Care Research Network, 1999; Posada et al., 1999; van den Boom, 1997). Each of these descriptive aspects requires some degree of behavioral self-regulatory capabilities on the part of the mother. Given this, our second goal was to determine whether physiological measures of maternal self-regulation were associated with sensitive caregiving in response to changes in the infant's affective state.

In measuring maternal emotion regulation it was important to consider that differential maternal responding to infant distress signals may be associated with and supported by differences in maternal reactivity and self-regulation, both of which have known biological bases in the autonomic and central nervous systems (Rothbath & Derryberry,1981). Thus, the quality of a mother's response to her child's needs may depend in part on the degree to which her physiological stress regulation supports active attention and engagement with the needs of the child. There is ample evidence from the animal literature that such physiological support for organized parenting behavior is necessary (e.g., Boccia & Pederson, 2001; Porges, 1998; Winslow et al., 2000; Wotjak et al., 1996). Of special relevance to this topic is the demonstration by Porges (1998) that mammalian pair-bonding is supported by the vagal system, which physiologically mediates social engagement, facial expressivity, and vocalization. Thus, as part of the broader caregiving system, maternal vagal regulation in response to infant distress signals may provide a psychophysiological support system for the organization of effective parenting behaviors.

One commonly used index of vagal regulation and autonomic functioning is heart-rate variability, a measure of parasympathetic activity. Heart-rate variability, or vagal tone, has been linked to several measures of cognitive and emotional processes involving attention and stimulus appraisal (Lacey & Lacey, 1958; Porges, Arnold, & Forbes, 1973; Richards, 1987; Wenger, 1941). Similarly, a decrease of vagal tone during periods of environmental challenge has been linked to self-regulation and the ability to engage the source of stimulation or take distance from it (Calkins, 1997; Kagan, 1994; Porges, 1996, 1998; Stifter & Fox, 1990; Stifter & Jain, 1996). Interestingly, polyvagal theory (Porges, 1995) suggests that somatomotor and visceromotor nerve fibers that innervate organs such as the larynx, pharynx, bronchi, and heart act synergistically to promote social interaction. Porges explains that under most conditions, heart rate is kept low and heart-rate variability high via the nucleus ambiguous serving as a vagal "brake" in order to curb the use of psychophysiological resources. However, under challenging conditions, this "brake" is released and the resulting decrease in heart-rate variability and increase in cardiac output facilitates active engagement and monitoring with respect to a set goal. Although there are multiple methods for measuring this change, Porges (1985, 1991, 1996) has

developed a commonly used method that indexes heart-rate variability at the frequency of breathing, known as respiratory sinus arrhythmia (RSA). A decrease in RSA from baseline levels (i.e., vagal withdrawal) is believed to reflect the parasympathetic influence of vagal regulation, whereby the withdrawal of parasympathetic control of the heart allows for sympathetic activity and thus increases in heart rate and cardiac output. As such, effective vagal withdrawal has been examined as an index of self-regulation and may underlie the behavioral attention strategies necessary for regulation of arousal (Huffman et al., 1998; Posner & Rothbart, 2000). Although most studies of vagal withdrawal and behavior focus on children, there is both theoretical and empirical evidence to suggest that similar patterns of vagal-behavior associations exist among adults (Beauchaine, 2001). As vagal withdrawal facilitates the flexible shift of resources from a stable state to one that can meet environmental demands, we expected elevated withdrawal to be associated with the maintenance of sensitive care even under conditions of high child distress. Furthermore, we hypothesized this relationship to be particularly characteristic of mothers whose infants would later show secure attachments.

3. HYPOTHESES

The goals of the current research were (1) to determine whether associations between child negative affect and maternal sensitivity at 6 months of child age were constant across later attachment classifications, and (2) to determine whether mother's physiological regulation, as indexed by vagal withdrawal, mediates or moderates associations between infant negativity and maternal sensitivity. Specifically, the first hypothesis predicted that infant negative affect would be more strongly associated with maternal sensitivity among mothers of insecurely attached children. In contrast, we expected little to no measurable effects of infant negativity on maternal sensitivity among securely attached dyads. For our second hypothesis, we predicted that for mothers of secure children, high maternal vagal withdrawal would be associated with the maintenance of sensitivity when mothers were faced with high levels of infant negative affect. In contrast, low levels of vagal withdrawal in response to elevated infant negativity were expected to be associated with less sensitive care among mothers of insecurely attached children.

The current analyses are limited to dyads with organized attachment relationships at 12 months of age. Although mothers of children with a disorganized primary classification are an interesting subgroup, there is no conceptual basis for including them in the present analyses. Specifically, several studies have shown that these mothers are as sensitive as mothers with children in other attachment classifications, secure or otherwise (van IJzendoorn, Schuengel, & Bakermans-Kranenburg, 1999). Rather, disorganized attachments have been linked to maternal behaviors such as disruptive affective communication (Lyons-Ruth, Bronfman, & Parsons, 1999), overt familial risks such as maltreatment (Carlson, Cicchetti, Barnett, & Braunwald, 1989), or other broad environmental factors such as the death of a caregiver (van IJzendoorn,1995). In fact, within disorganized samples the forced ABC classification of children is often differentiated by maternal sensitivity, with forced secure children receiving sensitive care to a similar degree as primarily secure children (Mills-Koonce, Gariepy, Sutton, & Cox, under review). Given these findings, the current research focuses on mothers of children with secure, insecure-avoidant, and insecure-resistant attachment classifications.

4. METHOD

4.1. Participants

The participants in the current study were 173 families recruited by the Durham Child Health

and Development Study. For this study, recruitment procedures specified an approximately equal number of European- and African- American families sampled from both lower- and higher-income groups. The family's race was determined by the race of the mother (or primary caregiver), while income status was determined by whether families were above or below 200 percent of the federally established poverty threshold. Birth order or family structures were not used as inclusion criteria. Families were drawn from a largely urban community via fliers and postings at birth and parenting classes, as well as through phone contact via birth records. There was a 10 percent rate of attrition from the first to the second time point, resulting in a total sample of 155 families that completed all assessment protocols. Of those, 7 families were excluded due to audio-visual difficulties that made their videotaped assessments impossible to code. The final sample of 148 families used for the current analyses was 56 percent African-American and 44 percent European-American. Approximately 53 percent was low income (below 200 percent of the poverty level). A total of 13 percent of mothers had no high school degree, 43 percent had either a high school diploma or a G.E.D., 11 percent had some college or vocational school, and 33 percent had a 4-year bachelors degree or higher. The ages of mothers in this sample ranged from 18 to 40 (M= 28.3, SD = 5.6). In addition to the focal child, 69 families in this sample had additional children in the household. When present, the number of additional children in the household ranged from 1 to 10 (M=1.6, SD = 2.7). All siblings were older than the focal child, ranging from 1.5 to 13 years of age (M= 5.0, SD = 2.7). The sample was almost evenly split based on the sex of the child, with 51 percent male. The distribution of 12-month attachment classifications in the present sample consisted of 96 children classified as secure, 37 children classified as insecure-avoidant, and 15 classified as insecure-resistant.

4.2. Assessment Procedures

4.2.1. 6-Month free play observations

Mothers and children were observed in the home for the free play session, during which time mothers were asked to interact with their children as they normally would during a typical day. A standard set of toys was provided for the mother and child to use, and the pair was asked to sit on a blanket that was laid out across the floor. This session was videotaped for later coding, with researchers monitoring the camera discreetly to minimize interference with the ongoing interaction.

4.2.2. 6-Month book reading observations

Within 2 weeks of the home visit, mothers and children participated in a 6-month laboratory visit. During this time mothers were asked to try to involve their child with a picture book provided by the researchers. The book involved pictures without words to control for any effect of illiteracy among the parents. Mothers were responsible for creating a storyline that followed the illustrations in the book. Like the free play session in the home visit, this procedure took place on the floor with the child positioned between the mother and a single camera. Mothers were allowed up to 10 min for this activity.

4.2.3. 6-Month challenge tasks observations

The challenge tasks administered in the laboratory visit were the Still Face Paradigm (Tronick, Als, Adamson, Wise, & Brazelton, 1979) and the arms restraint procedure (Goldsmith & Rothbarth, 1994). For these purposes the mother was asked to secure her child in a car seat situated on top of a large, sturdy table. Prior to the still face episode, the mother was instructed to

talk and interact with her child for 2 min as she normally would do if they were traveling and the child was fastened in the car seat. The mother was then asked to turn her head away from the child for 15 s. When she returned to face her child, she was instructed to maintain a fixed stare at her child and to refrain from facial movements or displays of affect for 2 min. The mother was again asked to turn her head away for 15 s, after which she was instructed to interact with her child for 2 min. After this recovery period, the mother was instructed to again turn her head away from her child, but this time she was also asked to gently hold her child's arms down and to do so with just enough pressure to prevent arm movements. This procedure lasted for 60 s, after which the mother was again instructed to interact freely with her child for 2 min. Because many children find one if not both of these procedures to be highly dysregulating, mothers were informed that they could take their child out of the car seat if necessary during the recovery. This entire set of procedures was filmed using two cameras, one aimed at capturing the infant's face and body and the other aimed at capturing the face and behavior of the mother. Scores for maternal and child behaviors from the two recovery periods were used, and a summary score was derived by collapsing across the two 2-min interactive episodes that followed the challenge procedures.

4.2.4. 12-Month Strange Situation Paradigm

At 12 months of child age another laboratory visit was scheduled, during which mothers and children participated in the Ainsworth Strange Situation Paradigm (SSP). This procedure followed the protocol developed by Ainsworth et al. (1978) for observing and classifying infants into discrete categories of attachment quality.

4.3. Measures

4.3.1. Infant negative affect

During each 6-month observation (free play, book reading, and challenge recovery), child negative affect was coded in 5-s intervals using a 3-point scale adapted from previous studies (Haley & Stansbury, 2003). Children were given a score of 1 if they displayed little to no negative affect during the 5-s interval. They were given a score of 2 if they exhibited mild levels of negativity and 3 if they showed high levels of negativity, such as prolonged crying, intense protest, or venting. Interrater reliability was calculated based on randomly double coding 20 percent of the sample across coders. The average intraclass correlation among coders was .89 across all contexts of observation. An overall infant negative affect score was calculated for each observational context as the percentage of 5-s intervals during which the child was rated as 2 or higher in negative affect.

4.3.2. Maternal cardiac data

Cardiac data were collected from mothers for each observational context. At the beginning of each visit, electrodes were place on the mother's chest and were connected to a preamplifier, the output of which was transmitted to a heart rate monitor (VTM-1, Delta Biometrics, Inc., Bethesda, MD) for R-wave detection. A data file containing the heart interbeat intervals (IBIs) for the entire period of collection was transferred to a computer for editing artifacts that result from excess movement. During the home assessment, heart rate data were collected for a 2-min baseline measure as well as during the free play session. During the laboratory visit cardiac data were also collected for a 2-min baseline vagal tone measure and then during the book reading and challenge tasks.

Following each visit, data files containing the heart interbeat intervals (IBIs) for the entire period of collection were transferred to a computer for artifact editing. Artifacts are fairly common in cardiac data collected in this manner because bodily movements are also detected and erroneously recorded as cardiac data. To detect and eliminate these anomalous data points, IBI files were edited by MXEdit-reliable researchers and analyzed using MXEdit software (Delta Biometrics, Bethesda, MD). Data files that required editing of more than 10 percent of the data were not included in the analyses. Missing data due to high levels of artifact editing or equipment malfunction accounted for approximately 25 percent of cases from each observational context (data analytic procedures described below allow for the inclusion of missing data in the current analyses). Because of child movement at this age and the brevity of some of the observational protocols, this level of missing data often occurs among studies including non-resting cardiac data (Stevenson-Hinde & Marshal, 1999; Stifter, Spinrad, & Braungart-Rieker, 1999). After editing and processing the IBI files, measures of respiratory sinus arrhythmia (RSA) were extracted using Porges' (1985) method. This procedure applies an algorithm to the sequential IBI data using a moving 21-point polynomial to detrend periodicities in heart period slower than RSA.

Then, a band-pass filter extracts the variance of the IBIs within the frequency band of spontaneous respiration in adults (0.12–0.40). This estimate of RSA is derived by calculating the natural log of this variance and is reported in units of ln(ms)2. RSA was calculated every 15 s during each 2-min episode and every 30 s for procedures lasting more than 2 min. While these epoch durations are relatively brief, they are typical for studies of short duration tasks and have been validated by previous research (Huffman et al., 1998). Vagal tone was indexed by the mean RSA of the 15 or 30 s epochs within each episode. The difference in vagal tone from baseline provides a measure of vagal withdrawal during each task. Positive values of vagal withdrawal indicate a decrease in vagal tone from baseline, and therefore increased vagal withdrawal that putatively reflects attempts to regulate emotion and deploy attention.

4.3.3. Maternal sensitivity

Parenting during each interactive context was coded using 5-point rating scales adapted from Egeland and Hiester (1995) and the NICHD Early Child Care Research Network (1997). A *global sensitivity* scale rated mother's responses to the child's gestures, facial expressions, and signals as she responded to the child's emotional and physical needs. The average intraclass correlation across coders was .82 based on double coding 20 percent of the parent-child interactions from all three contexts of observation. An *intrusiveness* scale rated the degree to which the interaction was more adult-centered than child-centered with the mother imposing her agenda over the needs of the child. The average intraclass correlation across coders was .80. The *negative regard* scale rated maternal expressions of negative affect and behaviors towards the child. The average intraclass correlation across coders was .81. An overall sensitivity composite was constructed by summing each mother's scores on these three codes. This composite was suggested by factor analyses showing that the ratings from these scale scores loaded heavily onto one common factor. The factor loadings for sensitivity, intrusiveness, and negative regard were .88, .89, and .75 respectively in the free play context; .88, .86, and .75 in the book reading context; and .91, .90, and .40 in the challenge tasks context. Although the factor loading for negative regard in the challenge tasks context was low, the eigenvalues from the factor analysis

remained consistent with a one-factor solution. The average intraclass correlations across coders for the sensitivity composite thus derived in the free play, book reading, and challenge recovery were .87, .85, and .9 1, respectively.

4.3.4. Attachment security

Patterns of child behaviors observed during the Strange Situation Paradigm are used to classify children into the following three broad categories: secure, insecure-avoidant, and insecure-resistant based on the procedures outlined by Ainsworth et al. (1978). Typically a secure child positively greets her mother upon reunion if not distressed, or immediately seeks proximity and contact with her if distressed. Avoidant children are distinguished by their conspicuous avoidance and reticence to engage their mother upon reunion, regardless of their level of distress upon separation. Finally, resistant children are those who resist contact and soothing when it is provided while repeatedly exhibiting attachment behaviors indicative of their need for comfort. Two coders trained and certified by the Sroufe attachment group coded videotapes for attachment quality. Cohen's kappa for these coders was k = .85 for 30 percent of the full sample. Any disagreements were resolved by conferencing.

5. RESULTS

Results are presented in three sections. The first section provides descriptive statistics and correlations among model parameters used in the current analyses. This information is presented for the sample as a whole as well as across attachment classifications. The second section examines differences in model parameters across contexts of observation and across attachment classifications. The third section uses hierarchical linear modeling to examine the association between infant negative affect and maternal sensitivity for different attachment dyads across multiple observations of parent-child interaction. Additional analysis expands this model to test for the mediating or moderating effects of maternal vagal withdrawal on the relationship between infant negativity and maternal sensitivity.

5.1. Descriptive statistics and correlations among covariates

Means and standard deviations for model parameters in each observational context are presented in Table 1 (variables were standardized within each context of observation). Correlations were examined between model parameters and demographic factors. Income was positively correlated with maternal sensitivity in the contexts of free play (r=.34, p<.001) and book reading (r=.27,

Table 1
Means and standard deviations of model parameters (z-scores)

Construct by context	Avoidant	Secure	Resistant
Maternal sensitivity			
Free play	−0.42 (1.21)	0.15 (.91)	0.16 (.57)
Book reading	−0.19 (.99)	0.11 (.99)	−0.31 (1.09)
Challenge	−0.18 (1.03)	0.11 (1.00)	−0.41 (.82)
Overall	−0.26 (1.08)	012 (.97)	−0.19 (.82)
Infant negative affect			
Free play	−0.13 (.53)	0.14 (1.28)	−0.20 (.29)
Book reading	0.14 (1.16)	−.044 (.94)	0.07 (1.42)
Challenge	−0.03 (1.01)	−0.22 (.78)	0.85 (1.23)
Overall	−0.08 (.92)	0.07 (1.06)	−0.11 (.84)
Mother vagal withdrawal			
Free play	0.03 (1.19)	0.02 (.94)	−0.17 (1.09)
Book reading	−0.18 (1.01)	0.09 (1.05)	−0.26 (1.25)
Challenge	−0.12 (1.01)	−0.08 (1.00)	0.48 (1.31)
Overall	−0.05 (.73)	0.04 (.66)	−0.14 (.78)

p<.001) and was negatively correlated with child negative affect during the challenge task (r= —.18, p <.05). African-American mothers were observed to be less sensitive in the contexts of free play (t = 2.69, p <.0 1) and book reading (t = 4.82, p <.01) and displayed less vagal withdrawal during the challenge task (t= 2.09, p <.05). Correlations among model parameters are presented in Table 2. Within each observational context there were limited correlations among covariates. In the challenge context infant negativity was positively correlated with mother's vagal withdrawal. In the book reading context maternal sensitivity was negatively correlated with infant negative affect. There were no correlations among covariates in the free play context. Within each construct there were also correlations across contexts. Maternal sensitivity was positively correlated across each context of observation. Mother's vagal withdrawal during book reading was positively correlated with vagal withdrawal during challenge. There were no significant correlations across context for infant negative affect.

Table 2
Correlations among covariates

Context	Construct	2	3	4	5	6	7	8	9
Free play	1. MS	−.98	.16	.53**	−.19*	−.03	.30**	.04	.06
	2. INA	–	.05	−.06	.07	.23*	.05	.03	.04
	3. MVW		–	.15	.02	.20	.15	.00	.10
Book reading	4. MS			–	−.26**	−.01	.41**	−.11	.02
	5. INA				–	−.05	−.08	.07	−.17
	6. MVW					–	.14	−.17	.63**
Challenge	7. MS						–	−.11	.07
	8. INA							–	.21*
	9. MVW								–

Note: MS = maternal sensitivity; INA = infant negative affect; MVW = mother's vagal withdrawal.
* $p < .05$.
** $p < .01$.

5.2. Differences in model parameters across contexts and attachment classifications

5.2.1. Observational contexts

Differences in model parameters across observational contexts were examined using one-way ANOVAs. Maternal sensitivity differed significantly across contexts [F(2, 423) = 21.27,p <.001] with post hoc analyses revealing maternal sensitivity to be higher in the contexts of book reading and challenge as compared to free play. Infant negative affect differed across contexts [F(2, 259)=48.46,p<.001] with post hoc analyses revealing negativity to be significantly higher during challenge than either free play or book reading. Vagal withdrawal was also significantly different across contexts [F(2, 428) =15.27, p <.001] with post hoc analyses revealing maternal withdrawal to be lower during book reading than free play or challenge.

5.2.2. Attachment classifications

Differences in model parameters across attachment classifications were similarly examined using one-way ANOVAs. Maternal sensitivity was observed to be significantly different across attachment classifications [F(2, 367) = 6.19, p<.01] with post hoc analyses revealing sensitivity to be higher among mothers of securely attached children as compared to mothers of children with avoidant attachments. Infant negative affect was also observed to be different across attachment classifications [F(2, 367) = 3.52, p <.05] with post hoc analyses revealing children

with resistant attachments to be more negative than children with secure attachments. No differences in mother's vagal withdrawal were found across attachment classifications.

5.3. Maternal sensitivity, infant negative affect and mother's vagal withdrawal across attachment classifications

Hierarchical linear modeling (HLM) was used to examine differences in maternal sensitivity across contexts and across attachment classifications. HLM is ideally suited to accommodate the features of the current data set, including both the nested nature of the observations within the parent-child dyads and the need for statistical power to test complex interactions within a limited sample size (Littell, Milliken, Stroup, & Wolfinger, 1996). Models were constructed to examine the associations between infant negativity and maternal sensitivity across attachment classifications. An additional utility of HLM is that these associations can also be tested for differences across contexts of observation. Thus, the current analyses consider not only whether infant negativity is differentially related to maternal sensitivity for each attachment classification, but also if that interaction is stable across contexts. Controlling for ethnicity and income, infant negative affect was found to be positively related to maternal sensitivity [$F(1, 350) = 10.79$, $p < .01$]. Attachment classification was also related to sensitivity [$F(2, 350) = 5.88$, $p < .01$], with a priori contrasts showing that mothers of children later classified as avoidant were significantly less sensitive at 6 months than mothers of securely attached children [$F(2, 350) = 11.76$, $p < .01$]. There was no interaction, however, between attachment classification and infant negative affect, suggesting that all mothers, regardless of attachment quality, were less sensitive in the face of elevated child negativity. There were also no interactions among model parameters with context of observations, suggesting that this effect is also constant across context. Furthermore, in addition to controlling for ethnicity and income, interaction effects involving model parameters and demographic variables were tested. No such interactions were observed, suggesting that these effects were constant across ethnicity and income.

There was no indication that mother's vagal withdrawal differed across attachment relationships, nor were there associations between vagal withdrawal and maternal sensitivity. There was therefore no indication that vagal withdrawal mediated the association between infant negative affect and maternal sensitive behavior. To test whether differences in maternal vagal withdrawal moderated the association between infant negative affect and maternal sensitivity, the previous hierarchical linear model was expanded to include vagal withdrawal and all subsequent interactions. In this model no single main effect on maternal sensitivity or two-way interactions were observed. However, a significant three-way interaction among infant negative affect, vagal withdrawal, and attachment classification was found to predict maternal sensitivity [$F(2, 178) = 3.48$, $p < .05$].

Procedures outlined by Aiken and West (1991) and Cohen, Cohen, West, and Aiken (2003) were used to probe this interaction. These analyses revealed that vagal withdrawal does moderate the association of infant negative affect with maternal sensitivity at 6 months, but only for mothers of children who were avoidant at 12 months [$F(1, 25) = 5.05$, $p < .05$; Fig. 1]. Specifically, when faced with high levels of infant negativity, low vagal withdrawal was associated with significantly less maternal sensitivity in avoidant dyads only. Due to the relatively small sample of children with resistant attachments we were unable to successfully probe these interactions for mothers of resistant children. However, when the two insecure classifications were collapsed, a

similar pattern of associations emerged [$F(2, 178) = 6.07$, $p < .05$] such that among insecurely attached dyads low levels of maternal vagal withdrawal in concert with elevated infant negativity was associated with lower levels of maternal sensitivity.

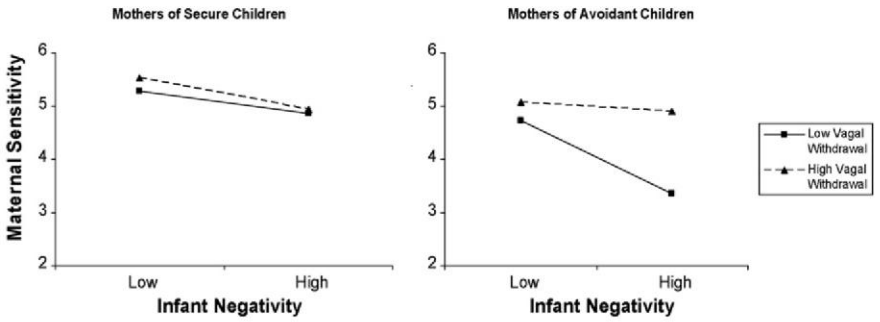

Fig. 1. Low vagal withdrawal among mothers of avoidant children is associated with significant decreases in sensitivity, but only during interactions marked with high levels of infant negative affect.

6. DISCUSSION

As part of the broader caregiving system, sensitive parenting must be considered as not just a trait characteristic of the mother, but rather a fluid array of behaviors that responds to the changing physical and emotional needs of her infant. Bowlby (1969) suggested that the parent's caregiving system must be in alignment with the needs of the child's attachment system in order to facilitate the formation of a secure attachment relationship. The sensitive parent must be able to recognize these shifts in the child's emotional needs, as well as attend to those needs in a manner that supports the child's use of the mother as a secure base for both play and comfort. The purpose of this study was to examine maternal sensitivity at 6 months of child age under conditions of multiple infant affective states, with specific regard to how the mother's own self-regulation was related to her behavior. The attachment literature provided a theoretical and empirical rationale for making specific hypotheses about the relationships between these variables. As compared to mothers of children who would later evidence secure attachments, we hypothesized that mothers of later insecurely attached children would show decreases in sensitivity when infant negative affect was high. We also hypothesized that mothers' self-regulation, as measured by vagal withdrawal, would moderate this effect.

As expected, the mothers of children who would later develop secure attachment relationships were significantly more sensitive than mothers of children who would develop avoidant attachments. No differences were found for mothers of children with resistant attachment relationships. This may be due, in part, to the relatively small sample of resistant children, or it may be that at 6 months of child age maternal sensitivity does not effectively differentiate 12-month secure and resistant dyads. While not part of the original focus of this study, it is interesting to note that at 6 months of child age, in the context of challenge recovery, children who would later be classified as resistant were significantly more negative than secure children. Given this finding, a lack of attachment group differences in maternal sensitivity differentiating resistant dyads might suggest a temperamental difference among these children. Of course, it is also possible that there are interactive parent-child characteristics that are not captured by our observations that might explain these findings.

Regarding infant negative affect, we originally predicted that heightened negativity would pose a unique challenge to the caregiving systems of mothers of insecurely attached children. In doing so we expected that mothers of later securely attached children would maintain high levels of sensitivity despite varying levels of infant negativity, while mothers of later insecurely attached children would display decreases in sensitivity in the face of high infant negative affect. These hypotheses were partially supported. As expected, interactions rated high in infant negative affect were rated lower in maternal sensitivity than interactions with low to moderate infant negativity. However, this effect was consistent across attachment classifications. Thus, we failed to find significant evidence that infant negative affect is a greater challenge for mothers of insecurely attached children.

It should be emphasized that both infant negativity and maternal sensitivity reflect scores assigned within the same contexts of observation, and therefore no attribution of causality or disaggregating of the caregiver-attachment systems can be made with the current data. However, sensitivity was rated according to how appropriately the mother responded to her child's emotional needs, and thus did incorporate the contextual effect of child behavior. This allows us to assume the following: (1) Initial levels of negative affect are related to sensitivity ratings only to the degree to which mothers do not appropriately detect and respond to their infant's signals, (2) prolonged increases in infant negative affect during the interaction are likely due to interactive error and lack of maternal reparations, and (3) it is possible that the bi-directional nature of the caregiver-attachment system causes this effect to be reciprocal, with parenting error increasing infant negative affect, and this further undermining sensitivity. Although we did not expect these processes to affect mothers of securely attached children to the degree that they would impact mothers of insecure children, such a finding is consistent with Tronick's (1989) description of parent-child interactions as naturally punctuated by episodes of interactive "error" and "reparation." Whereas mothers of securely attached children, as sensitive caregivers, effectively recognize interactive error and adjust their behavior accordingly, they nonetheless make those errors and do so at greater rates in the context of elevated infant negativity. While this seems to be the case for all mothers, it is important to remember that mothers of later secure infants remained more sensitive than mothers of avoidant children at all levels of infant negativity.

Our next question focused on whether the joint effects of increased infant negative affect and maternal physiological regulation would predict maternal behavior, and whether these relations would differ across attachment dyads. We hypothesized that heightened infant negativity would be particularly problematic for dyads in which the mother displayed low levels of vagal withdrawal. Again, our hypothesis was partially supported. The significant three-way interaction between attachment, infant negativity, and vagal withdrawal did provide evidence of physiological moderation of the infant negativity-maternal sensitivity association; however, this moderating influence was found for mothers of insecure-avoidant children, not mothers of securely attached children. Among mothers from avoidant dyads, the combination of high infant negative affect and low vagal withdrawal was of particular importance for predicting lower maternal sensitivity. Interestingly, we did not find high vagal withdrawal in response to high infant negativity to be predictive of sensitive parenting in mothers of securely attached children. Given these findings, we are led to conclude from the current data that maternal vagal

withdrawal is an important physiological response system to increased child negativity, but only for mothers of later avoidant children.

This raises an interesting question: Why does vagal withdrawal moderate the relation between parenting behaviors and high infant negative affect for mothers of avoidant children and not for the other two attachment groups? Porges' (1995) polyvagal theory proposes that vagal withdrawal is critical for individual functioning during periods of challenge. Because the relevance of vagal withdrawal is limited to mothers of avoidant children, this suggests that these mothers are uniquely challenged by elevated infant negativity. Assuming this to be the case, there are at least two possible interpretations for this finding. Recall that the literature portrays these mothers as more irritable, less adaptable, and more easily dysregulated than mothers of secure children (Egeland & Farber, 1984; Mangelsdorf et al., 1990). Thus, for avoidant mothers it may be that elevated infant negativity is a highly potent source of arousal, and the maintenance of some level of sensitivity under these circumstances requires the physiological support of vagal withdrawal for the regulation of their arousal. This we refer to as the "arousal-dysregulation hypothesis" because it assumes that it is the mother's arousal and dysregulation in response to elevated infant negativity that must be overcome to mobilize sensitive caregiving. This interpretation suggests that, for mothers in avoidant dyads, low vagal withdrawal compromises the ability to regulate emotions and effectively attend to the needs of the infant. The absence of an effect of vagal withdrawal on the behavior of mothers of securely attached children may then suggest that these mothers are not significantly aroused or dysregulated by infant negativity, and thus have no need for increased physiological support for their parenting behavior.

An alternative hypothesis is that the difference in socio-affective dispositions between mothers of avoidant children and mothers of securely attached children provides a unique challenge for the mothers of avoidant children. This hypothesis suggests that the mother of the avoidant child must overcome both a patterned response of disengagement and a sense of parenting inefficacy in order to attend to the needs of her distressed child. This we refer to as the "disengagement-engagement hypothesis" because for avoidant mothers overcoming a natural tendency to disengage in the face of their child's negativity (Cassidy, 1999; Egeland & Farber, 1984) would require the energetic mobilization of vagal withdrawal, without which effective parenting would be compromised. In this scenario, it is not maternal dysregulation that challenges the caregiving system, but rather a natural tendency to distance oneself from the child. To illustrate this point, consider that we and others have found that mothers of avoidant children are less sensitive than secure mothers even under conditions of low infant negativity. As infant negativity increases across contexts of observations, it may be that mothers of avoidant children continue to remain just as insensitive and disengaged as before, but because their children are now sending them clear distress signals, these mothers are being rated as less sensitive and more negative than in other contexts, even though their actual behavior has changed very little. In this case, it is the context of the interaction as defined by the infant's behavior that is causing avoidant mothers to be considered less sensitive. Interestingly, this means that low vagal withdrawal may be related to a consistency in insensitive behaviors rather than an increase in these behaviors. High vagal withdrawal for these mothers would represent an effortful shift from disengagement to engagement. It is possible that this shift does not occur in mothers of securely attached children because they are consistently engaged, physically and emotionally, with their children's needs,

which may explain why there is no effect of vagal withdrawal on their behavior even in times of high infant distress.

Both the arousal-dysregulation hypothesis and the disengagement-engagement hypothesis are interesting possibilities, and unfortunately neither can be adequately supported or refuted with the current data. Furthermore, because of the small sample of resistant children we were unable to estimate and test these associations as related to vagal withdrawal for this subgroup. Although in many respects they appeared similar to mothers of secure children at 6 months of age, more research with a larger sample of these dyads is necessary for truly testing these hypotheses for this group. However, it was interesting to see that at 6 months there were already differences in infant behavior following a stressful situation akin to how these infants will respond 6 months later in reunion periods of the strange situation. Again, whether this is indicative of attachment processes already at work or differences in temperament is an interesting and provocative question that requires more investigation.

The current research highlights the importance of analyzing the attachment and caregiving systems simultaneously and at multiple levels of family and individual functioning. To understand any behavior, one must understand the context of its expression, which is never truer than when considering parenting behavior with its many evolutionary and developmental underpinnings. Furthermore, it is important to remember that the context for the organization of parenting behavior is not limited to exogenous factors, but also includes the endogenous emotional and cognitive background of the parent. In this research we focused on the psychophysiological regulation of distress when dealing with infant negative affect, although clearly there are other processes at work for mothers, possibly cognitive models of their own attachment history that moderate this association. Also, although attempting to disaggregate the effects of the child attachment system from the parent caregiving system is a worthy goal, this study was methodologically unable to disentangle these two influences on the parent-child interaction. However, because parent and child behaviors are intrinsically linked and influential on development, it is just as important to understand how they combine to function as a single unit. A particular strength of this research is that multiple levels of the caregiving system are simultaneously examined, including both environmental and physiological contributors to parenting. Adopting a systems perspective on parenting requires that both context and child effects be considered in conjunction with multiple levels of the caregiving system.

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