Parental Sensitivity, Infant Affect, and Affect Regulation: Predictors of Later Attachment

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This longitudinal study on 94 families examined the extent to which parent sensitivity, infant affect, and affect regulation at 4 months predicted mother–infant and father–infant attachment classifications at 1 year. Parent sensitivity was rated from face-to-face interaction episodes; infant affect and regulatory behaviors were rated from mother–infant and father–infant still-face episodes at 4 months. Infants’ attachment to mothers and fathers was rated from the Strange Situation at 12 and 13 months. MANOVAs indicated that 4-month parent and infant factors were associated with infant–mother but not infant–father attachment groups. Discriminant Function Analysis further indicated that two functions, “Affect Regulation” and “Maternal Sensitivity,” discriminated infant–mother attachment groups; As and B1–B2s showed more affect regulation toward mothers and fathers than B3–B4s and Cs at 4 months, and mothers of both secure groups were more sensitive than mothers of Cs. Finally, the association between maternal sensitivity and infant–mother attachment was partially mediated by infant affect regulation.

INTRODUCTION

During the first year of life, infants are in the process of forming social relationships with others. According to attachment theorists (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969), one of the most important bonds that is formed is that with the primary caregiver—typically the mother—which is referred to as the infant–mother attachment relationship. Although much less extensively studied than the infant–mother relationship, infants also form attachments with fathers. Although almost all infants will develop affectional ties with their parents, infants will differ in the extent to which their relationships are secure (Ainsworth et al., 1978). Furthermore, a recent meta-analysis indicated that security status with one parent is only modestly related to security status with the second parent, $\Phi = .17$ (van IJzendoorn & de Wolff, 1997). Thus, aspects of one parent–infant relationship that either foster or hinder the development of a secure attachment may be unique to a particular dyad.

Individual differences in infant–mother attachment security have been attributed to variation in maternal sensitivity such that mothers of secure infants have been observed to be more reliable, consistent, sensitive, and accepting of their infants than mothers of insecurely attached infants (see de Wolff & van IJzendoorn, 1997, for a recent meta-analysis of maternal sensitivity and infant–mother attachment). Likewise, a separate meta-analysis involving infant–father data revealed a similar link between paternal sensitivity and infant–father attachment (van IJzendoorn & de Wolff, 1997). It should be noted, however, that the strength of the association between paternal sensitivity and infant–father attachment (.13) was weaker than that for infant–mother attachment (.24). Thus, factors in addition to paternal sensitivity, or maternal sensitivity for that matter, may serve to promote or impede secure infant–parent attachments.

In addition to studies on the antecedents of infant–parent attachment, there is an extensive body of literature—at least for infant–mother dyads—on the sequelae of attachment security. For example, secure attachment has been linked with greater compliance to maternal requests (Londerville & Main, 1981), reduced risk for behavioral problems (Tizard & Hodges, 1978), and increased popularity with peers (Sroufe, Fox, & Pancake, 1983). Recently, researchers and theorists (e.g., Braungart & Stifter, 1991; Bridges & Grolnick, 1994; Cassidy, 1994; Cummings & Davies, 1996; Fox & Calkins, 1993; Kobak & Scerey, 1988; Thompson, Flood, & Lundquist, 1995) have also suggested that possible linkages exist between infant–mother attachment and emotion regulation and that emotion regulation may serve as one of the mechanisms through which attachment security affects some of these later socioemotional outcomes. Thus, it is crucial to better understand the processes involved in the relations among attachment and emotion regulation.

Emotion regulation refers to those behaviors that serve to modulate arousal (Rothbart & Derryberry, 1981). For example, reorientation of gaze (Rothbart, Ziae, & O’Boyle, 1992) and self-comforting behaviors...
(Stifter & Braungart, 1995) have been shown to reduce subsequent levels of distress in infants under 6 months of age. According to Cassidy (1994), infants who are secure in their attachment seem to show appropriate levels of emotion and recovery from distress during situations designed to activate the attachment system (e.g., Strange Situation), whereas insecure infants may either overregulate (avoidant infants) or underregulate (resistant infants) their emotions.

To date, several studies have examined relations between infants’ affect and their attachment classifications; fewer empirical studies have examined associations between regulation or coping behaviors and attachment. Studies examining affect often show converging results in that attachment groups differ in displays of affect—at least during the Strange Situation with mothers (Braungart & Stifter, 1991; Frodi & Thompson, 1985; Mangelsdorf, Gunnar, Kestenbaum, Lang, & Andreas, 1990; Thompson, Connell, & Bridges, 1988; Thompson & Lamb, 1984). Thompson and colleagues (Frodi & Thompson, 1985; Thompson et al., 1988; Thompson & Lamb, 1984) found that infants classified in the insecure-avoidant group (A) and two of the secure subgroups (B1 and B2) were not significantly different in levels of distress during the Strange Situation. Moreover, both groups showed significantly less distress than the insecure resistant (C) group and remaining secure subgroups (B3 and B4), who were equally high in distress. Likewise, maternal ratings of “difficulty” at 3 months, which includes questions about distress, were related to the “split” (A+B1+B2 versus B3+B4+C) infant–mother groups (Belsky & Rovine, 1987), in that infants in the A–B2 groups were rated as less difficult than infants in the B3–C groups. These findings suggest that negative affect may be related to how security or insecurity is expressed but not to security of attachment, per se.

The authors know of only two published empirical studies on regulatory or coping behaviors and infant–parent attachment. Braungart and Stifter (1991) found that infants differed in regulation during the Strange Situation with mothers depending on their degree of distress and security status; secure infants who were distressed during separation episodes (B3s and B4s) showed more regulation (object-focused attention) during reunion episodes than insecure infants who were equally as distressed (Cs). Interestingly, those insecure infants who were less distressed during separations (As) showed more self-competing behaviors than did infants in the secure-low distress subgroups (B1s and B2s), perhaps indicating that avoidant infants (As) were using self-competing as a means of minimizing their arousal. Thus, there is some empirical support for the hypothesis that attachment and regulation are related—albeit, both constructs were measured from the same procedure and at the same age. A more recent study looked at coping and infant–mother attachment at 18 months, where each construct was measured in different contexts. Nachmias, Gunnar, Mangelsdorf, Parritz, and Buss (1996) found that toddlers classified as insecure showed lower levels of coping competence (e.g., affective sharing, social referencing, inquisitive vocalizations) during the presentation of novel stimuli than secure toddlers. No relations with attachment security were found, however, for other forms of coping, such as comfort seeking (e.g., self-stimulate, contact with mother) or distraction (e.g., distract self, divert mother). Because regulation and attachment were measured concurrently, however, determining the processes by which regulation and attachment become associated is difficult.

It is possible that security status must be established before differences in emotion regulation emerge. In other words, once infants have formed a stable internal working model of the parent–infant relationship—somewhere after 7 months of age (Ainsworth et al., 1978; Bowlby, 1969)—their expectations about how the parent will respond to their emotional needs will be established. Thus, these stable expectations, whether positive or negative, may then influence the extent to which infants regulate their own emotions.

We propose, however, that differences in emotion regulation can be detected before the establishment of attachment security status. That is, early-developing regulation skills such as reorientation of gaze and self-competing behaviors may predict later attachment. It is possible that styles of regulation during early infancy reflect an infant’s temperamental style (Rothbart & Derryberry, 1981), such that some infants may be naturally better able to regulate emotions than others. Infants’ experiences with caregivers, however, may also be important to consider; infants whose emotional needs are adequately met may develop better regulation skills than those whose caregivers are unresponsive or rejecting. Thus, infant regulation may reflect the quality of the developing attachment style. The primary goal of the present study was to examine the extent to which affect and regulatory behaviors in addition to mothers’ and fathers’ sensitivity assessed at 4 months of age predict infant–mother and infant–father attachment classification at 12 months of age. The present study used the “still-face” episode (Tronick, Als, Adamson, Wise, & Brazelton 1978) as a stressful context from which to observe 4-month-
olds’ affective and regulatory responses to their parents’ socio-emotional unavailability.

The Still-Face Paradigm

The still-face paradigm (Tronick et al., 1978), a situation in which parents withdraw from interacting with their infants, has been used to further our understanding of infants’ emotional experience. Numerous studies have shown that compared with normal face-to-face interactions, infants exhibit less positive and more sobering or negative affective responses during the still-face (Cohn & Tronick, 1983; Fogel, 1982; Stoller & Field, 1982; Toda & Fogel, 1993; Weinberg & Tronick, 1994), regardless of whether the parent is the mother or the father (Braungart-Rieker, Garwood, Powers, & Notaro, 1998). In addition to affective responses, infants exhibit regulatory behaviors as well. Field (1994) found that 3-month-old infants exhibited more distress and gaze aversions during a still-face situation than during either a face-to-face interaction or a brief separation from mothers, which suggests that infants’ expectations of mothers’ responsiveness had been violated during still-face and that infants were making attempts to regulate their negative arousal.

Individual differences in still-face responses have also been observed. In a sample of clinically depressed mothers, infants whose mothers were more intrusive showed more withdrawal during the still-face than infants whose depressed mothers were more sensitive (Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986). Even in a normative sample of mothers, infants whose mothers were either under- or overcontrolling during interactions made no positive bids during still-face, in contrast with infants whose mothers showed a more optimal interactive style (Tronick, Ricks, & Cohn, 1982). Carter, Mayes, and Pajer (1990) also found that greater maternal positivity during interaction predicted greater amounts of gaze at the mother during still-face. Taken together, these results suggest that maternal interactive behavior partially mediates infant still-face responses. Less is known, however, about the interpretation of infants’ still-face responses with fathers. In a recent study involving the present sample, Braungart-Rieker et al. (1998) found that individual differences in infants’ 4-month still-face responses with both mothers and fathers were predicted by infant and parent characteristics. More specifically, mothers or fathers who were more sensitive during face-to-face interaction had infants who exhibited more parent-focused regulation during still-face. Measures of parent sensitivity also predicted variation in infants’ affective responses during the still-face but only for infant–mother dyads. Thus, the ability to predict infants’ affective responses with mothers but not fathers may reflect differences in infants’ previous experiences with either parent. By 4 months of age, infants’ experiences with fathers may be more limited than those with mothers (Bailey, 1994); thus, internal working models of the infant–father relationship may take longer to develop than those involving the infant–mother relationship.

Thus far, only one study has reported a significant prediction between still-face responses and infant–mother attachment security at 12 months. Cohn, Campbell, and Ross (1992) found that infants who were more positive during still-face at 6 months were more likely to be securely attached than infants who were less positive during still-face. Interestingly, positive affect at 2 and 4 months and negative affect at 2, 4, or 6 months did not significantly distinguish secure versus insecure infants at 12 months. Cohn et al. (1992, p. 373) suggest that infants’ positive responses (or lack thereof) to still-face at 6 months may serve as a “probe into the process of attachment formation” and reflect the infant’s internal working model of the mother–infant relationship. Cohn et al. (1992) did not, however, examine the extent to which regulatory behaviors during still-face reflect the attachment process nor whether any predictions in infant–father attachment could be made. It may be that differences in regulation before the age of 6 months predict later attachment—especially if early regulatory abilities are related to factors affecting the attachment relationship (e.g., parent sensitivity)—as was found in the current sample at 4 months (Braungart-Rieker et al., 1998). The association between regulation and later attachment may, however, also depend on which parent the infant is interacting with.

Hypotheses

The primary question addressed in the present study is the following: To what extent do parent sensitivity and infant still-face behaviors (affective and regulatory) assessed at 4 months predict infant–mother and infant–father attachment classification at 12 months? Two possible ways in which parent sensitivity and infant still-face behaviors relate to later attachment were tested. First, it is possible that the combination of patterns among 4-month parent sensitivity and infant affective and regulatory behaviors distinguish later attachment groups. On the basis of previous research (e.g., de Wolff & van Ijzendoorn, 1997; van IJzendoorn & de Wolff, 1997), we expected that infants whose parents were more sensitive at 4 months would be classified as secure (all B groups) rather than insecure (As and Cs) with mothers and fa-
thers. How security (B1–B2 versus B3–B4) or insecurity (A versus C) is expressed, however, depends on the level of infants’ affective and regulatory responses observed at 4 months (Belsky & Rovine, 1987; Braungart & Stifter, 1991; Frodi & Thompson, 1985; Thompson & Lamb, 1984). Thus, infants with more sensitive parents and who show higher levels of affect regulation (low negativity, high regulation) during the still-face would develop into B1–B2 infants, whereas infants with highly sensitive parents but who show lower levels of affect regulation during still-face would develop into B3–B4 infants. In contrast, low parental sensitivity in combination with high infant affect regulation would lead to an insecure avoidant (A) attachment relationship; low sensitivity coupled with low infant regulation, however, would lead to an insecure resistant (C) attachment relationship. Thus, to test the idea that attachment groups will best be discriminated by understanding earlier patterns of parent sensitivity in combination with infants’ affective and regulatory behaviors, moderator models were examined (Baron & Kenny, 1986).

It is also possible, however, that the associations between parent sensitivity, infant affective and regulatory behaviors, and infant–parent attachment operate in a more process-oriented manner. That is, the link between parent sensitivity and infant–parent attachment is explained by infant affective and regulatory patterns; infants’ still-face responses may partly reflect the developing internal working model of the infant–parent relationship (Cohn et al., 1992). Thus, parents who are more sensitive will have infants who show less negativity and more regulation during a still-face situation. In turn, better regulated infants will later develop a secure attachment with their parents. Once affective and regulatory patterns are entered as predictors, the strength of the association between parent sensitivity and infant–parent attachment will no longer be significant. Thus, mediational models also were tested (Baron & Kenny, 1986).

METHODS

Participants

This study was part of a larger longitudinal investigation of families who were followed when children were 4 months to 3 years of age (original N = 105 families). The present study included data from the first, second, and third wave of data collection when infants were 4, 12, and 13 months of age ± 2 weeks and included 94 mother–infant dyads (50 girls; 44 boys). Two infant–father pairs were missing 4-month data because of technical problems; 8 infant–father pairs were missing 13-month but not 4-month data (father chose not to participate). Thus, analyses involving only infant–mother dyads include a sample size of 94; those involving the entire family include a sample size of 86. The families were primarily White (all but 7) and middle class; 6.6% of families made under $20,000 annually, 55.3% made $20,000–$49,999, and 38.2% made $50,000 or more. Approximately one quarter of the sample had a high-school degree or below (22.1% of mothers and 29.9% of fathers), about half had some college or a college degree (61.1% of mothers and 48.1% of fathers), and less than a quarter of parents had some post-graduate training or degree (16.9% of mothers and 22.1% of fathers). The average age of the parents was 29.6 and 32.5 for mothers and fathers, respectively, at the beginning of the study. Less than half of the infants were first-born children (44.2%), 29.9% had one sibling, and the remainder (26.0%) had two or more older siblings. All families were living in the same household (7 couples were unmarried).

Procedure

Overview

All activities took place in a large carpeted room, furnished with a couch, several chairs, and brightly decorated walls. Two video cameras, situated behind two one-way mirrors, simultaneously recorded the activities.

4-Month Procedure

Following a brief interview with parents and a 4-min warm-up free play situation, a 4.5-min structured situation occurred—part of which provided data for the present study. Parents were instructed to separately engage in three 90-s structured situations with their infants. Half of the mothers interacted first with their infants whereas half served as second parents. No differences in infant or parent behaviors due to order effects were found. Infants also had to be in a non-negative state at the beginning of either parent’s interaction. The infant sat in an infant seat on a table, facing the seated parent. One camera recorded infant behavior; the other camera captured parental behavior. Images from both cameras were fed through a split-screen generator so that recordings were combined into one screen. After a 90-s parent–infant toy-play interaction, in which the parent played with the infant by using toys, a 90-s face-to-face interaction occurred in which the parent was instructed to “play with your child to keep him/her entertained” with-
out using any toys or taking the infant out of the seat. During the final 90-s episode, parents posed a “still-
faced” (e.g., Tronick et al., 1978): the parent was in-
stucted to sit back in the seat and refrain from mak-
ing any facial or vocal expressions. This third episode
was curtailed if the infant became overly distressed.
Following the first parents’ interactions, the second
parents participated in the same set of episodes. Only
data from the face-to-face and still-face episodes were
used for this study.

12- and 13-Month Procedure

Ainsworth and Wittig’s (1969) Strange Situation
was conducted at 12 and 13 months, with at least a 4-
week separation between visits. Mothers attended the
first visit, whereas fathers attended the second
visit. The order of the parent at the 1-year visits was
not counterbalanced given that there has been no ev-
idence of order effects when there is at least a 4-week
separation between assessments (Belsky, Rovine, &
Taylor, 1984; Chase-Lansdale & Owen, 1987; Easter-
brooks & Goldberg, 1984).

This procedure involves seven 3-min episodes de-
designed to elicit attachment or exploratory behavior in
the infants. The parent and infant are alone in the
room (Episode 1). A stranger enters, talks to the par-
ent, and plays with the infant (Episode 2). During the
first separation episode, the parent departs, and
leaves the infant and stranger together (Episode 3).
The parent then returns and the stranger exits (Epi-

dose 4). The second separation involves the parent’s
departure after saying “bye-bye,” leaving the infant
alone in the room (Episode 5), followed by the
stranger’s return (Episode 6). The second reunion
(Episode 7) is identical to Episode 4.

Measures

All coding was conducted from videotapes in
which time (to the nearest second) had been superim-
posed onto the image. Coders were trained to rate
only one set of variables; thus they were unaware of
infants’ or parents’ scores in other domains. More-
over, no coder saw the same infant twice—even within
a domain (e.g., with mother and with father) except
for the purposes of assessing reliability (discussed
later). In addition, coding of 4-month tapes was com-
pleted before any coding of 12- and 13-month tapes. It
is also important to note that when disagreements be-
tween coders occurred during the training portion of
coding, final codes reflected the consensus after dis-
cussions. In addition, none of the training codes served as tapes for reliability assessment. Rather, dif-
ferent cases provided data for assessing interrater re-
lability. To the extent that differences occurred
among lead coders and reliability coders, the lead
coders’ ratings were retained as final codes for the sake of consistency.

Parental Sensitivity

From the 90-s face-to-face episode, sensitivity was
rated on a 5-point scale every 10 s. Sensitivity was
broadly defined as the parent’s ability to perceive in-
fant’s signals accurately and vary his or her behavior
appropriately (e.g., contingent responding, appropri-
ate levels of stimulation in which the infant is neither
under- nor over stimulated). Because parental sen-
sitivity involved somewhat subjective ratings, two
coders simultaneously but independently coded all
interactions. Disagreements were discussed and ad-
justments were made when possible. The scale was as
follows: 0 = no sensitivity (e.g., understimulated,
noncontingent responding) or high intrusiveness; 1 =
some sensitivity, some intrusiveness—neither domi-
nates; 2 = low sensitivity, no intrusiveness; 3 = mostly
sensitive and no intrusiveness but not at optimum
level; and 4 = high sensitivity, no intrusiveness—
exemplary behavior. Total scores included the aver-
age of both coders’ assessments across the nine ep-
ochs. To assess interrater reliability, a third coder sepa-

cate and independently assessed a randomly
selected subsample of 15 mothers and fathers (16% of
the sample). An intraclass correlation of .80 was ob-
tained, which indicates adequate interrater reliability of maternal sensitivity and .83 for paternal sensitivity.

Infant Behaviors at 4 Months

Positive and negative affect. Two components of af-
fact, vocalizations and facial expressions, were rated
on a second-by-second basis on 7-point scales during the
still-face episodes with mothers and fathers. Vo-
calization ratings were scored as follows: −3 (scream-
ing), −2 (crying), −1 (mild fuss), 0 (neutral), 1 (coo), 2
(quiet chuckle or more intense coo), and 3 (squealing
with delight). Similarly, facial expression ratings
ranged from −3 (large grimace, mouth open), −2
(frown, mouth slightly ajar), −1 (small frown, mouth
closed), 0 (neutral expression), 1 (slight or half-smile),
2 (larger smile, mouth open), and 3 (smile with mouth
opened widely). Overall affect scores were created by
averaging vocal and facial scores (Pearson r = .93).
Thus, two measures of affect were created from these
scores: proportion of epochs of positive affect (scores
greater than 0 and proportion of negative affect rat-
ings (scores less than 0). Affect variables were then
log-transformed because of skewness of the distribution (Afifi & Clark, 1984).

Coding and reliability assessment occurred in three steps. (1) Two coders—one for infant–mother and one for infant–father dyads, were trained (by the first author) and continuously evaluated by the trainer until accuracy was acceptable (>90%). At that time, disagreements were discussed, and adjustments in ratings could be made. (2) Once training was achieved, each coder independently rated all remaining infants. (3) To determine interrater reliability, a third coder, also trained by the first author and blind to all factors except for regulatory behaviors (see next section), rated a randomly selected 15% subsample of infants. The intraclass correlation between pairs of coders was .90 for negative affect and .82 for positive affect (infant–mother dyad) and .88 for negative affect and .84 for positive affect (infant–father dyads). Because there was a substantial gap in time in coding affect and regulation (4 months) and because reliabilities were in the acceptable range, there is no reason to believe that observing regulatory behaviors biased the reliability coders’ ratings for affect.

Regulatory behaviors. Again, two separate coders, one for infant–mother and one for infant–father dyads, were involved in the rating of regulatory behaviors (both trained by the third author). Previous research on infant regulation has suggested that infants may display several modes of regulation and that they can be distinguished by whether infants attempt to use others for regulating (person-focused regulation) or the self (self-focused behaviors; e.g., see Braungart & Stifter, 1991). Thus, two sets of behaviors were rated every 5 s as present or absent from the 90-s still-face episode—Self-regulation and Parent-focused regulation. Self-regulation included comforting (e.g., thumb/finger sucking, rubbing hair, etc.) and attentional behaviors that were focused (gaze was greater than 1 s within a 5-s epoch) and directed away from the mother. When infants’ gaze focused on the mother’s face for more than 1 s, Parent-focused regulation was coded as present. One other set of behaviors—escape—was rated when the infant made an attempt to get out of the seat (e.g., arching or twisting of back). Escape, however, occurred with little frequency, so it was dropped from our analyses. Two summary scores were created by averaging self-regulation or parent-focused regulation behavior across the 18 epochs. Regulatory variables were then log-transformed because of skewness of the distribution (Afifi & Clark, 1984).

Training, coding, and reliability assessment for regulatory behaviors occurred in the same process as described in the previous section. Again, the lead coders were blind to the hypotheses and all other ratings at that time. The reliability coder was also blind to the hypotheses and all other ratings, except for affect, but had completed the affect coding approximately 8 months earlier. A random subsample of infants, 16% of the total sample, was chosen to assess interrater reliability. Intraclass correlations of .93 and .80 were obtained for self-regulation and parent-focused regulation for infant–mother pairs and correlations were .89 and .87 for infant father pairs.

Infant–Parent Attachment at 1 Year

Three coders, who had been trained by L. Alan Sroufe and had successfully passed the reliability test, classified infants’ attachment security. One coder rated approximately one-third of the infant–mother cases; a second coder rated the remaining infant–mother dyads and one-third of the infant–father dyads. The third coder rated the remaining infant–father dyads. Again, no coder observed the same infant more than once. On the basis of infants’ interactive behavior toward the parent during the reunion episodes and, to a much lesser extent, behavior toward the stranger, infants were classified into one of three major groups—insecure avoidant (A), secure (B), and insecure-resistant (C) and their subgroups (see Ainsworth et al., 1978, for scoring procedures). Because the sample was a low-risk group, the decision was made at the time to exclude the disorganized-D category because it was thought that this category is more appropriate for infants at risk (Carlson et al., 1989). Recently, however, there is reason to believe that the D-category may be somewhat relevant to middle-class samples (van IJzendoorn, Schuengel, & Bakermans-Kranenburg, 1999); thus, one limitation of the present study is that disorganized attachments were not examined. There were three infant–mother cases and five infant–father cases that were earmarked as difficult to classify. These cases were eventually forced into a category (all resulted in a secure classification) on the basis of the discussion of two of the coders. These cases were not used in the assessment of reliability. For the purposes of this study, the B1 and B2 infants were combined to form one B subgroup, and the B3 and B4 infants were combined to form a second B subgroup. To determine interrater reliability, each coder independently rated a subset of the other coder’s infants, thus overlapping on 16% of the total sample. This subsample of 15 infant–mother and 15 infant–father dyads (all involving different infants) was chosen by the first author to ensure that reliabil-
Descriptive Analyses

Differences in infant–mother and infant–father dyads are examined as well as congruencies in patterns of behaviors within and across infant–parent dyads for 4- and 12- to 13-month factors. It should be noted that more extensive comparisons of 4-month parent and infant variables have been presented elsewhere (Braungart-Rieker et al., 1998). Descriptive comparisons of 4-month factors are presented in this study, however, to serve as a context from which to interpret longitudinal models.

Table 1: Descriptive Characteristics and Tests for Differences by Parent for 4-month and 12- to 13-month variables

<table>
<thead>
<tr>
<th></th>
<th>Mother (N = 94)</th>
<th>Father (N = 92)</th>
<th>Paired Comparison F(1, 90)</th>
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<tr>
<td>4-Month Variables</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
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<tr>
<td>Parent sensitivity</td>
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<td>.67</td>
<td>2.61</td>
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<tr>
<td>Infant positive affect</td>
<td>.18</td>
<td>.12</td>
<td>.18</td>
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<td>Infant negative affect</td>
<td>.39</td>
<td>.27</td>
<td>.41</td>
</tr>
<tr>
<td>Infant self-regulation</td>
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<td>.18</td>
<td>.33</td>
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<tr>
<td>Infant parent-focused regulation</td>
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<td>.19</td>
<td>.37</td>
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<th>12- to 13-Month Attachment Group</th>
<th>N</th>
<th>%</th>
<th>N</th>
<th>%</th>
<th>McNemar’s Test (χ², 1 df)</th>
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<tbody>
<tr>
<td>A</td>
<td>10</td>
<td>10.6</td>
<td>7</td>
<td>8.1</td>
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<tr>
<td>B1–B2</td>
<td>40</td>
<td>42.6</td>
<td>30</td>
<td>34.9</td>
<td>1.32</td>
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<tr>
<td>B3–B4</td>
<td>34</td>
<td>36.2</td>
<td>28</td>
<td>32.6</td>
<td>0.33</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>10.6</td>
<td>21</td>
<td>24.4</td>
<td>8.00**</td>
</tr>
</tbody>
</table>

** p < .01.

Differences in Infant–Mother and Infant–Father Dyads

Table 1 presents means and standard deviations for 4-month predictor variables: parent sensitivity, infant positive and negative affect, infant self-regulation, and infant parent-focused regulation. Five paired comparison tests were also conducted to examine whether means for infant–mother dyads differed significantly from those for infant–father dyads.

As can be seen in Table 1, mothers and fathers did not differ significantly in parental sensitivity at 4 months. Additionally, the proportions of time infants spent in a positive or negative state during still-face were not significantly different with mothers versus fathers. Differences in regulation patterns emerged, however. Infants showed significantly more self-regulation with mothers and more parent-focused regulation with fathers.

Table 1 also presents the frequencies of infants’ attachment classifications with mothers and fathers. McNemar’s tests for paired proportions were conducted to examine the extent to which the distribution patterns for attachment classifications differed for infant–mother versus infant–father dyads. Three of the four tests were nonsignificant: The proportion of infants classified as A, B1–B2, or B3–B4 were not significantly different for infant–mother versus infant–father pairs. The proportion of infants classified as C, however, was significantly greater for infant–father dyads compared with infant–mother dyads. Overall, the distribution patterns for infant–mother attach-
ment classifications are comparable to those reported by others with middle-class, nonrisk samples (e.g., Frodi & Thompson, 1985; Owen, Easterbrooks, Chase-Lansdale, & Goldberg, 1984). For infant–father dyads, however, there does seem to be a greater number of C-classifications when compared with the numbers reported in middle-class nonrisk samples.

Congruency among Infant–Mother and Infant–Father Variables

Intra- and interparental correlations among maternal sensitivity, infant positive and negative affect, infant self-regulation, and infant parent-focused regulation are presented in Table 2. There was significant congruence in parent and infant behavior across infant–mother and infant–father dyads. As shown on the diagonal of Table 2, infants whose mothers were more sensitive had fathers who were more sensitive. Similarly, infants who exhibited more positive affect, more negative affect, more self-regulation, or more parent-focused regulation during infant–mother still-face also showed greater levels during infant–father still-face.

Within each infant–parent dyad, many of the 4-month factors were significantly related; the patterns of associations were also fairly consistent for infant–mother and infant–father dyads. Not surprisingly, infants who showed more positive affect showed less negative affect during still-face. In addition, greater levels of positive affect and lower levels of negative affect were associated with greater levels of self-regulation and parent-focused regulation during infant–mother and infant–father still-face. Interestingly, self- and parent-focused regulation were not significantly correlated for infant–mother or infant–father situations. Also interesting was that maternal but not paternal sensitivity significantly correlated with all four infant still-face factors: infants whose mothers were more sensitive showed more positive affect, less negative affect, more self-regulation, and more parent-focused regulation. Infants whose fathers were more sensitive during play showed more parent-focused regulation; paternal sensitivity, however, was not significantly related to infants’ positive affect, negative affect, or self-regulation during infant–father still-face.

To examine the rate of congruency in infants’ attachment classifications with mothers and fathers, a 4 (Infant–Mother Attachment Group) × 4 (Infant–Father Attachment Group) \( \chi^2 \) analysis was conducted. The observed and expected frequencies across each group are presented in Table 3. The \( \chi^2 \) was significant, \( \chi^2 (9, N = 86) = 34.41, p < .001 \), which indicates that infants’ attachment classification with mothers was significantly related to their attachment classification with fathers.

Predictions between 4-Month Characteristics and Attachment at 1 Year

The prediction of infant–parent attachment from 4-month parent sensitivity and infant still-face responses was tested in two ways. First, two separate MANOVAs—one involving infant–mother attachment and the other involving infant–father attachment—were conducted to determine if parent sensitivity and infant affect and regulation behaviors differed at 4 months for attachment groups. If significant differences in attachment groups were detected from the MANOVA and follow-up univariate ANOVAs, a second set of analyses involving the use of discriminant function analysis (DFA) was conducted. DFA is a multivariate data analytic technique that tests the extent to which a group of optimally weighted variables (4-month sensitivity and infant still-face responses),

Table 2 Inter- and Intraparental Correlations Among 4-Month Factors

<table>
<thead>
<tr>
<th>Infant–Mother Variables</th>
<th>Parental Sensitivity</th>
<th>Infant Positive Affect</th>
<th>Infant Negative Affect</th>
<th>Infant Self-Regulation</th>
<th>Infant Parent-Focused Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental sensitivity</td>
<td>.26*</td>
<td>.18</td>
<td>-.19</td>
<td>.03</td>
<td>.27**</td>
</tr>
<tr>
<td>Infant positive affect</td>
<td>.22*</td>
<td>.37***</td>
<td>-.56***</td>
<td>.56***</td>
<td>.35***</td>
</tr>
<tr>
<td>Infant negative affect</td>
<td>.39**</td>
<td>-.56***</td>
<td>.52***</td>
<td>-.71***</td>
<td>-.38***</td>
</tr>
<tr>
<td>Infant self-regulation</td>
<td>.26**</td>
<td>.23**</td>
<td>-.61***</td>
<td>.59***</td>
<td>.11</td>
</tr>
<tr>
<td>Infant parent-focused regulation</td>
<td>.32**</td>
<td>.40***</td>
<td>-.40***</td>
<td>-.02</td>
<td>.25*</td>
</tr>
</tbody>
</table>

Note: Correlations on the diagonal represent interparental correlations. Correlations above the diagonal are intraparental correlations among infant–father variables, whereas correlations below the diagonal are intraparental correlations among infant–mother variables. *p < .05; **p < .01; ***p < .001.
Table 3  Observed and Expected Frequencies of Infant–Mother and Infant–Father Attachment Groups

<table>
<thead>
<tr>
<th>Infant–Mother Attachment Classification</th>
<th>A</th>
<th>B1–B2</th>
<th>B3–B4</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed (Expected)</td>
<td>Observed (Expected)</td>
<td>Observed (Expected)</td>
<td>Observed (Expected)</td>
<td>Observed (Expected)</td>
</tr>
<tr>
<td>A</td>
<td>4 (.73)</td>
<td>4 (3.14)</td>
<td>0 (2.93)</td>
<td>1 (2.20)</td>
</tr>
<tr>
<td>B1–B2</td>
<td>3 (3.01)</td>
<td>15 (12.91)</td>
<td>11 (12.05)</td>
<td>8 (9.03)</td>
</tr>
<tr>
<td>B3–B4</td>
<td>0 (2.52)</td>
<td>9 (10.81)</td>
<td>16 (10.09)</td>
<td>6 (7.57)</td>
</tr>
<tr>
<td>C</td>
<td>0 (.73)</td>
<td>2 (3.14)</td>
<td>1 (2.93)</td>
<td>6 (2.20)</td>
</tr>
</tbody>
</table>

referred to as discriminators (Brown & Tinsely, 1983), can collectively distinguish subjects’ membership in particular groups (attachment classification).

MANOVAs

Two separate one-way MANOVAs, involving either infant–mother attachment group or infant–father attachment group (A, B1–B2, B3–B4, C) were performed to examine the association between 4-month parent and infant still-face behaviors and 1-year infant–parent attachment. The dependent variables include: parent sensitivity, infant positive affect, infant negative affect, infant self-regulation, and infant parent-focused regulation. Both infant–mother and infant–father 4-month factors were included in each MANOVA because it is possible that infant–parent behaviors for one dyad are related to the development of the infant–parent attachment relationship for the other dyad.

The MANOVA involving infant–father attachment categories was not significant, $F(30, 216) = 1.02$, $p = .45$, which indicates that 12-month infant–father attachment groups did not significantly differ on 4-month infant–mother and infant–father factors. Given the lack of significant findings, no subsequent analyses involving infant–father attachment classifications were conducted.

The MANOVA involving infant–mother attachment classifications, however, was significant, $F(30, 240) = 1.62$, $p = .03$. Of the 10 possible univariate ANOVAs tested, six reached significance (four infant–mother and two infant–father factors). Table 4 indicates which univariate ANOVAs were significant as well as which means were significantly different on the basis of paired comparison tests. Not surprisingly, infant–mother attachment groups differed in maternal sensitivity at 4 months such that mothers of infants in the C-group showed significantly less sensitivity than mothers of infants in the B1–B2 or B3–B4 groups. The two ANOVAs involving infant positive and negative affect during infant–mother still-face were both significant, and follow-up comparisons mirrored each other: Infants in the B1–B2 group showed more positive and less negative affect during still-face compared with infants in the B3–B4 and C groups. For self-regulation during infant–mother still-face, infants in the C group showed significantly less self-regulation than infants in the A and B1–B2 groups. In addition, B3–B4 infants showed marginally significantly more self-regulation than Cs and marginally less self-regulation than B1–B2s ($p < .09$).

Two univariate ANOVAs involving infant–father still-face factors were also significant—negative affect and self-regulation. Follow-up comparisons indicated that infants in the A and B1–B2 infant–mother attachment groups showed significantly less negative affect toward fathers during still-face than infants in the B3–B4 groups. Infants in the C group also showed significantly more negative affect than infants in the B1–B2 group and marginally significantly ($p < .08$) more negative affect than infants in the A group. Finally, infants in the A and B1–B2 groups showed significantly more self-regulation during infant–father still-face than infants in the B3–B4 and C groups.

Discriminant Function Analysis

As a next step, a DFA was conducted to examine the degree to which 4-month characteristics distinguished 12-month infant–mother attachment groups. The discriminators in the present study included those six factors that yielded significant ANOVA results in the previous section: maternal sensitivity, infant negative affect with mother, infant positive affect with mother, self-regulation with mother, infant negative affect with father, and self-regulation with father.

The prior probabilities for the classification groups were .11 (A), .43 (B1–B2), .36 (B3–B4), and .11 (C), which reflects the random probability of classifying individuals correctly. For the discriminant analysis to
Table 4  Means, Standard Deviations, and Follow-Up Tests of Significance of Standardized Scores for Parent Sensitivity, Infant Affect, Infant Self-Regulation, and Infant Parent-Focused Regulation for Infant–Mother Attachment Groups

<table>
<thead>
<tr>
<th>12-Month Infant–Mother Attachment Classification</th>
<th>ANOVA A</th>
<th>B1–B2</th>
<th>B3–B4</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4-Month Factor</strong></td>
<td>F(3, 88)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Parent sensitivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal</td>
<td>2.69*</td>
<td>-.31 (.77)</td>
<td>.14 (.97)*</td>
<td>-.02 (1.03)*</td>
</tr>
<tr>
<td>Paternal</td>
<td>.56</td>
<td>-.50 (1.44)</td>
<td>-.05 (1.06)</td>
<td>-.02 (1.04)</td>
</tr>
<tr>
<td>Infant positive affect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With mother</td>
<td>2.78*</td>
<td>.07 (1.19)</td>
<td>.20 (1.05)*</td>
<td>-.33 (1.72)*</td>
</tr>
<tr>
<td>With father</td>
<td>.54</td>
<td>-.28 (.65)</td>
<td>.09 (1.00)</td>
<td>-.14 (1.07)</td>
</tr>
<tr>
<td>Infant negative affect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With mother</td>
<td>4.20**</td>
<td>-.22 (.97)</td>
<td>-.33 (.98)*</td>
<td>.34 (.97)*</td>
</tr>
<tr>
<td>With father</td>
<td>4.72**</td>
<td>-.32 (1.10)*c</td>
<td>-.26 (.91)*</td>
<td>.48 (.97)*</td>
</tr>
<tr>
<td>Infant self-regulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With mother</td>
<td>3.63*</td>
<td>-.25 (.95)*</td>
<td>.23 (.91)*</td>
<td>-.18 (.99)</td>
</tr>
<tr>
<td>With father</td>
<td>6.67***</td>
<td>.17 (1.15)*a</td>
<td>.33 (.88)*</td>
<td>-.48 (.89)*</td>
</tr>
<tr>
<td>Infant parent-focused regulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With mother</td>
<td>.75</td>
<td>-.21 (.73)</td>
<td>.14 (1.07)</td>
<td>-.09 (1.00)</td>
</tr>
<tr>
<td>With father</td>
<td>1.12</td>
<td>-.34 (1.04)</td>
<td>.09 (.93)</td>
<td>-.23 (1.15)</td>
</tr>
</tbody>
</table>

Note: Means with different superscripts are significantly different from each other.

*p < .05; **p < .01; ***p < .001.

be significant, the canonical discriminant functions must correctly classify individuals better than the chance probabilities. Of the three possible discriminant functions, two were statistically significant. This first function accounted for 70.4% of the variance and had a canonical correlation of .48, Wilks’s λ = .77, F(3, 88) = 8.82, p < .001; the second function accounted for 29.6% of the variance and had a canonical correlation of .34, Wilks’s λ = .88, F(3, 70) p < .05. Table 5 presents the correlations between the discriminators and the canonical discriminant function as well as Wilks’s λs for each discriminator. Note that Wilks’s λ is equal to 1–R², thus higher lambda values represent less explained variance.

On the basis of the correlations presented in Table 5, the first function is defined by positive loadings for infant positive affect with mother, self-regulation with mother, and self-regulation with father, with negative loadings for infant negative affect with mother and father. Maternal sensitivity also loaded moderately low on this first function but loaded more strongly on the second function. All other factors loaded weakly with the second function, although it is noteworthy that negative affect with mother and father loaded on this function in a positive direction. Thus, Function I was labeled “Infant Affect Regulation” and Function II was labeled “Maternal Sensitivity.” As can be seen in Figure 1, the first function separated As and B1–B2s from B3–B4s and Cs, as indicated by the higher group centroid scores for affect regulation in As and B1–B2s. The second function distinguished secure from insecure infants. Two ANOVAs and follow-up comparisons tested which group centroids were significantly different from each other. The ANOVA involving the Infant Affect

Table 5  Wilks’s λs for Discriminators and Correlations between Discriminators and the First and Second Canonical Discriminant Functions (Structure Matrix)

<table>
<thead>
<tr>
<th>Discriminator</th>
<th>Function I Loadings “Infant Affect Regulation”</th>
<th>Function II Loadings “Maternal Sensitivity”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal sensitivity</td>
<td>Wilks’s λ</td>
<td>.92*</td>
</tr>
<tr>
<td>Negative affect with mother</td>
<td></td>
<td>.88**</td>
</tr>
<tr>
<td>Positive affect with mother</td>
<td></td>
<td>.91*</td>
</tr>
<tr>
<td>Self-regulation with mother</td>
<td></td>
<td>.89*</td>
</tr>
<tr>
<td>Negative affect with father</td>
<td></td>
<td>.86**</td>
</tr>
<tr>
<td>Self-regulation with father</td>
<td></td>
<td>.82***</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01; ***p < .001.
Regulation function was significant, $F(3, 88) = 8.82$, $p < .001$; of the six comparisons tested (As versus B1–B2s, As versus B3–B4s, As versus Cs, B1–B2s versus B3–B4s, B1–B2s versus Cs, and B3–B4s versus Cs), the only comparisons that were not significant were for As versus B1–B2s and B3–B4s versus Cs. Infants who later became As or B1–B2s showed significantly more affect regulation than infants who later became B3–B4s or Cs. The ANOVA involving the Maternal Sensitivity function was also significant, $F(3, 88) = 3.69$, $p < .01$; Cs had significantly lower centroid scores than either secure groups. Infants in the A group had marginally significant lower Maternal Sensitivity function scores, $p = .06$, than B3–B4s.

In addition to yielding descriptive information on how the discriminators best distinguished attachment groups, the DFA also yielded information pertaining to the percent of infants correctly classified by the canonical discriminant functions. Table 6 presents the frequencies and percentages of hits (diagonal cells) and misses (off-diagonal cells) in classification on the basis of the discriminators included in the model. The resulting percentage of children correctly classified, on the basis of the discriminators entered, is evaluated in terms of its statistical significance level ($z$; Huberty, 1984):

$$z = \frac{(o - e)\sqrt{N}}{\sqrt{e(N - e)}}$$

where $N$ is the total sample size, $o$ equals the sum of frequencies of correctly classified individuals ($n_{gg}$) for each group, and $e$ is the total-group chance frequency of hits, which is equal to the sum of the squared frequencies for each group ($n_{g}$) divided by $N$.

The percentage of children who were correctly classified (64.0%) from the discriminant function analysis was significant ($z = 6.04$, $p < .001$). Thus, it appears that the discriminators, collectively, distinguish attachment groups. An overall $\kappa$ was also computed to determine the strength of the prediction ($\kappa = .46$). In addition, a leave-one-out procedure was performed to determine if the discriminant function analysis was valid. The resulting percent of individuals correctly identified was 56.5%, which was significant, $z = 4.71$, $p < .001$, thus providing cross-validation evidence for the discriminant analysis conducted on the entire sample.

In addition to a test of the overall percent of children correctly classified, separate-group hit rates can be computed and tested to examine whether certain groups are more distinguishable from the function than others (Huberty, 1984) by using the formula:

$$z = \frac{(n_{gg} - e)\sqrt{n_{g}}}{\sqrt{e(n_{g} - e)}}$$

where $n_{gg}$ is equal to the number of correctly identified individuals for that group, $n_{g}$ is equal to the number of individuals in the group, and $e$ is the expected frequency of hits due to chance for that same group ($n_{g}^2 / N$). Again, $\kappa$s were calculated to inform us about the strength of these hit-rates for each group (e.g., A versus not A). As can be seen in Table 6, the hit rates for each group were statistically significant, albeit the magnitude of these hit-rates were fairly modest—as evidenced by the $\kappa$s.

Because many of the discriminators are correlated, determining if sets of discriminators were actually adding any unique variance to the predictions was also of interest. Three reduced discriminant function models were thus tested. In Reduced Model I, we excluded infants’ self-regulation scores with mothers and fathers, thus leaving maternal sensitivity, infants’ positive affect with mother, and infants’ negative affect with mother and father. Table 7 presents the overall fre-
frequencies and percents of infants correctly classified from this reduced model; z statistics on hit-rates for all groups as well as separate groups are also reported.

As can be seen in Table 7, the overall percentage of infants correctly classified by this reduced discriminant function model that excluded self-regulation data remained significant. In addition, three of the four groups were significantly discriminated—B1–B2s, B3–B4s, and Cs. Avoidant infants, however, were no longer successfully discriminated once self-regulation information was excluded.

A second reduced model was tested to determine if any remaining infant–father data was adding any unique prediction. Thus, in Reduced Model II, the remaining predictors included maternal sensitivity and infants’ positive and negative affect toward mothers during still-face; infants’ negative affect with father was dropped. As can be seen in Table 7, very little change in prediction occurred from the previous reduced model. The hit rate for the whole sample remained significant as did the separate hit rates for the B1–B2, B3–B4, and C groups. Again, the hit rate for predicting the A group was not significant.

Finally, a third reduced model, Reduced Model III, was tested to further explore the extent to which infant affect and regulatory factors were important in distinguishing the four groups beyond the prediction of maternal sensitivity. Thus, the second reduced model included only one discriminator—maternal sensitivity. As can be seen in Table 7, the overall percent of infants correctly identified by this reduced model was significant. Only one group, however, was successfully distinguished from the others—B1–B2 infants. Maternal sensitivity as a sole discriminant did not significantly discriminate As, B3–B4s, or Cs.

Mediation Model

Finally, we tested the possibility that affect regulation mediates the association between maternal sensitivity and infant–mother attachment. The canonical functions, however, do not reflect pure indexes of these constructs given that the discriminators for each function are optimally weighted to maximize the differences between groups; the two functions are also not allowed to covary. Thus, a purer test of the processes involved among maternal sensitivity, infant affect regulation, and attachment includes the raw variables for each construct. To create a composite affect regulation score that was comparable to the first discriminant function, the mean of the following standardized and unweighted variables was computed for each infant: positive affect with mother, self-regulation with mother and father, and reverse scored negative affect with mother and father. Cronbach’s α for this composite score was .83, which indicates sufficient internal consistency (also see the correlations among these factors in Table 2). In addition, the raw score, rather than the function score for Maternal Sensitivity, was used.

Empirical support for mediation requires four steps (Baron & Kenny, 1986): (1) maternal sensitivity significantly predicts the infant affect regulation composite, (2) maternal sensitivity significantly predicts infant–mother attachment, (3) the infant affect regulation composite significantly predicts attachment, and (4) once affect regulation is added to the equa-

<table>
<thead>
<tr>
<th>Table 7</th>
<th>Frequencies, Percents, and Z-Statistics of Hit Rates from Reduced Discriminant Function Analyses Models</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduced Model I</td>
</tr>
<tr>
<td>Discriminators Excluded</td>
<td>Self-regulation with mother and father</td>
</tr>
<tr>
<td>Included</td>
<td>Maternal sensitivity, infant affect with mother and father</td>
</tr>
<tr>
<td>Hit Rates</td>
<td>n</td>
</tr>
<tr>
<td>All groups</td>
<td>49</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>B1–B2</td>
<td>23</td>
</tr>
<tr>
<td>B3–B4</td>
<td>20</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: N = 92.

*p < .05; **p < .01; ***p < .001.
tion, the prediction between sensitivity and attachment is no longer significant. Simple regression was used to test Step 1, given that sensitivity and affect regulation scores were both based on continuous scales. Steps 2–4, however, involved discriminant function analyses because the dependent variable—attachment classification—involves four categories. In all steps, however, the $R^2$ values can be compared and tested for significance.

Figure 2 depicts the results from these analyses. For Step 1, regression results indicate that mothers who are more sensitive have infants with higher affect regulation at 4 months, $F(1, 92) = 8.78, p = .004$. Sensitivity also significantly discriminated infant–mother attachment groups, $F(3, 90) = 2.66, p = .05$ (Step 2). Recall from the previously reported ANOVA results that mothers of infants who later became secure were significantly more sensitive than mothers of infants who later became insecure Cs. Step 3 establishes that 4-month infant affect regulation significantly discriminates 12-month attachment groups, $F(3, 90) = 7.30, p = .001$. (Again, refer to previously reported ANOVA results for a more explicit description of group differences). Finally, to accomplish Step 4, a stepwise DFA was conducted in which maternal sensitivity was entered first and affect regulation was entered second. As can be seen in Figure 2, the previously significant $R^2$ value for sensitivity dropped to a nonsignificant level, whereas the $R^2$ value for affect regulation remained highly significant. It should be noted that when the reverse process was conducted—affect regulation entered first and sensitivity entered second—the same basic results are obtained in that affect regulation remained a significant discriminator of attachment but maternal sensitivity did not. Because the $R^2$ for sensitivity did not drop to a zero value, however, it cannot be concluded that affect regulation completely mediates the relation between sensitivity and attachment; however, it can be concluded that affect regulation at least partially mediates sensitivity’s prediction of attachment.

It should also be noted that if the outcome variable involves security status (A+C versus Bs) or A versus B versus C, rather than the four-group scoring system, the mediational model is not supported. In a DFA, maternal sensitivity significantly predicts security status, $R^2 = .06, F(1, 92) = 6.20, p = .015$, similar to the previously discussed Step 2. But the model including infants’ affect regulation composite as a sole discriminator (Step 3) of security status is not significant, $R^2 = .01, F(1, 92) = .73, p = .40$. Thus, because infants’ affect regulation does not distinguish secure from insecure infants but rather distinguishes the type of security or insecurity, a mediational model is not supported if only security status is examined as an outcome.

**DISCUSSION**

This study examined the extent to which parent sensitivity, infant affect, and regulation discriminated infant–mother and infant–father attachment groups at 12 months. Results indicated that infant–father attachment groups were not discriminated from the 4-month factors, but infant–mother attachment groups were. In brief, infants whose mothers were more sensitive at 4 months were more likely to be classified as secure rather than insecure in attachment with their mothers at 12 months. But how security or insecurity was expressed depended on the level of infants’ affective and self-regulatory responses at 4 months. More specifically, infants who scored high on a linear discriminant function reflecting infants’ affect regulation to mothers and fathers during still-face at 4 months were more likely to become avoidant (A) or B1–B2 secure, whereas infants scoring low on the affect regulation function were more likely to develop into resistant (C) or B3–B4 secure infants. Thus, support for a moderational model was obtained in that the attachment group in which an infant was later classified de-
A mediation model was also tested in this study; partial support for this model emerged. In short, infants’ whose mothers were more sensitive showed more affect regulation at 4 months. In turn, affect regulation served as a significant predictor of attachment classification. By itself, maternal sensitivity significantly discriminated attachment groups, but once affect regulation was added as a predictor, the association between maternal sensitivity and infant–mother attachment was no longer significant, which indicates that affect regulation was mediating the association between maternal sensitivity and infant–mother attachment. Two points, however, are also important to note. First, the strength of the prediction of maternal sensitivity did not drop completely to zero; thus affect regulation only partly explained the link between sensitivity and attachment (Baron & Kenny, 1986). Second, the mediational model was supported only when the four-category attachment classification system was employed as the outcome—not when security status or traditional attachment scoring (A-B-C) served as outcomes. Thus, results from the mediational and moderational models appear to be telling a similar story in terms of how maternal sensitivity, infants’ affect regulation, and infant–mother attachment become related. Although infants whose mothers are more sensitive will likely show more affect regulation during still-face, greater affect regulation—at least at 4 months—does not necessarily indicate that an infant will achieve greater attachment security per se. Rather, what greater levels of affect regulation reflect appears to depend on the quality of the caregiving environment.

**Avoidant Infants**

Infants who later became avoidant showed high affect regulation during the still-face, relative to their insecure counterparts (Cs) and secure B3–B4s. Avoidant infants, however, did not differ in the amount of affect regulation compared with the secure B1–B2 group. Indeed, avoidant infants were equally as likely to be misclassified by the DFA as B1–B2s as they were to be accurately classified as As. There was some evidence, however, that the caregiving environment in which avoidant infants live tended to be less optimal—at least compared with B3–B4s. Thus, the processes involved in the development of affect regulation may differ for infants who later become classified as avoidant versus secure.

Main (1990) has suggested that A infants develop an avoidant strategy as a way to override or suppress attachment-related emotions. Thus, perhaps heightened levels of self-regulation in the face of a less sensitive mother at 4 months is an early sign of a developing avoidant style. By the time infants’ attachment style is more firmly established, infants classified as avoidant show heightened levels of self-regulation during the Strange Situation compared with B1–B2 and B3–B4 infants (Braungart & Stifter, 1991). Another explanation, not necessarily in contrast to Main’s, is that infants who later become avoidant have an easier temperament—a propensity to be less fussy and better able to self-regulate. Indeed, Belsky and Rovine (1987) found that mothers rated infants later classified as A or B1–B2 as less fussy in temperament at 3 months. Perhaps when a relatively easy infant is raised in a less sensitive caregiving environment, they are at risk for developing an avoidant attachment relationship. Alternatively, easygoing infants whose mothers are more sensitive are more likely to develop a B1–B2 style of attachment.

Another finding worth noting pertains to the individual components that make up the composite affect regulation score. Even though infants who showed more self-regulation were more likely to show less negative affect during the still-face, the two constructs are not merely opposite ends of one continuum (Rothbart & Derryberry, 1981). Self-regulation, in addition to affective responses, appears to facilitate the prediction of the avoidant category. In a reduced model that excluded raw self-regulation scores, avoidant infants were no longer able to be significantly distinguished from other groups. Similarly, a study on the relation between affect (but not regulation) and later attachment showed that infants’ affective responses during still-face at 4-months did not distinguish avoidant infants from other infants (Cohn et al., 1992). Thus, it may be particularly important to obtain a more inclusive array of behaviors when studying the development of avoidance, given that avoidant infants’ behavior may be more subtle or illusive. For example, Malatesta, Culver, Tesman, and Shepard (1989) found that avoidant infants during the Strange Situation show more “pressed lip” behavior—a fairly subtle expression of anger. Thus, interpreting avoidant infants’ behaviors may be more challenging. Indeed, avoidant infants in the present sample were the most difficult to discriminate (40%), compared with the hit rate for the other three groups (62.5%–80%)—even when their self-regulatory behaviors were considered. Thus, infants’ self-regulatory responses to still-face, in conjunction with information on their affective responses and mothers’ sensitivity, provides insights about the developing internal working model of the avoidant infant—even at 4 months of age.
Resistant Infants

Infants later classified as insecure-resistant (Cs) had mothers who were rated lower in sensitivity compared with B1–B2 or B3–B4s and had lower affect regulation compared with As or B1–B2s. It is possible that infants in the C category have decreased levels of affect regulation because their mothers are less responsive to their affective needs. Thus, having heightened and dysregulated emotionality is a strategy for eliciting greater attention from their less responsive mothers (Cassidy, 1994; Main, 1990). It may also be, however, that C infants are temperamentally more reactive by nature. A meta-analysis involving 18 studies on temperament and attachment found evidence that distress proneness served as a significant predictor of resistance (Goldsmith & Alansky, 1987). Furthermore, by 12 months of age, C infants showed low levels of regulation—self and other-focused—during the Strange Situation, even when variance due to distress levels was statistically removed (Braungart & Stifter, 1991). Thus, findings from the present study offer similar conclusions as those presented in a review of the insecure-ambivalent/resistant category (Cassidy & Berlin, 1994) and other empirical research: A high tendency for distress, coupled with less sensitive parenting, appears to lead to a resistant attachment style.

Secure Infants

Interestingly, infants who later became B3–B4s in the present study were as upset during the 4-month still-face as were those who later became Cs. Mothers of B3-B4s, however, were more sensitive to their infants. It is also important to note that the “Maternal Sensitivity” function score derived in this study consisted not only of positive loadings for observer-rated maternal sensitivity itself but also positive loadings for infants’ negative affect with mother and father and self-regulation with mother. Thus, the maternal sensitivity function score contains information about the dyad, not just the mother’s behavior; a mother who scored higher on this function was able to do so in the face of a fussier, albeit somewhat regulating infant. Interestingly, B3–B4 infants had relatively higher maternal sensitivity function scores compared with all other groups, and significantly so compared with Cs. Thus, perhaps the development of a B3–B4 status reflects a good fit between mother and infant. To the extent that parent sensitivity and infant distress operate in a reciprocal manner—each influencing the other over time—mothers who are able to interact with their relatively fussier infants in an optimal way may be more likely to foster a positive internal working model. In turn, such infants develop a B3–B4, rather than a C, attachment status.

It is also interesting that although B3–B4s were just as distressed and low in positivity as were Cs at 4 months, their raw self-regulation scores during infant–mother still-face were somewhere in the moderate range—between the high-regulating A and B1–B2 infants and low-regulating C infants (with marginally significant differences between B3–B4 and Cs). Thus, despite being relatively fussy during still-face, B3–B4 infants were able to recruit moderate amounts of self-regulatory behaviors, even though such behaviors did not seem to reduce their distress at 4 months. It may be that the extent to which self-regulatory behaviors become effective takes time to develop (Rothbart & Derryberry, 1981). Indeed, Braungart and Stifter (1991) found that although B3–B4 infants were as upset as C infants during the maternal separation of the Strange Situation, their object-focused attention was higher and distress was lower than Cs during reunion, which suggests that B3–B4’s regulation was more effective than Cs by the age of 12 months. Thus, by being a reactive infant yet having a sensitive mother, B3–B4 infants may learn to effectively modulate their arousal.

Infants later classified as B1–B2 secures looked very different from their B3–B4 secure counterparts at 4 months. Infants in the B1–B2 group were found to be less fussy and more positive, at least compared with B3–B4s and Cs. Other studies have found similar results in that B1–B2 infants were rated as less fussy by parents at 3 months (Belsky & Rovine, 1987) and were less fussy during the Strange Situation (Braungart & Stifter, 1991; Frodi & Thompson, 1985). Such results may suggest that B1–B2 infants may be temperamentally easier babies. In turn, it may be easier for mothers to show sensitivity toward these relatively positive and well-regulated infants. Thus, mothers of B1–B2s may have a somewhat less challenging task of being sensitive, compared with mothers of more fussy infants. It is important, however, that mothers of relatively easygoing infants maintain an optimal pattern of responding. Otherwise, maternal rejection or unavailability—even toward a relatively easy infant—may promote an avoidant style.

Null Findings

It is important to point out the findings that did not emerge in this study. One null finding in the present study pertained to the measure of parent-focused regulation; parent-focused regulation did not serve as a discriminator of any attachment groups. Interestingly, parent-focused regulation at 4 months was sig-
significant related to maternal and paternal sensitivity; infants whose parents were more sensitive during interaction showed more parent-focused regulation during still-face. It may be, however, that 4 months is too young an age to allow interpretation of the meaning behind parent-focused regulation. Perhaps parent-focused regulation partly reflects an infant’s developing but not yet organized internal working model of the infant–parent relationship. To the extent that greater parent-focused regulation reflects an infant’s expectation that the parent will become re-engaged with an infant under normal circumstances, it would be interesting in future studies to examine parent-focused regulation in infants whose internal working models may be more established. For example, Nachmias et al. (1996) found that by 18 months, secure toddlers were more likely to orient (visually and vocally) toward their mothers when faced with a challenging task than were insecure infants.

Another null finding in this study was that the infant–father attachment relationship was not predicted by any of the factors employed in the present study. This seems especially surprising given that attachment classification across infant–mother and infant–father dyads was significantly congruent; furthermore, 4-month parent sensitivity and infants’ still-face responses were significantly correlated across the two dyads. Just because individual behaviors are correlated, however, it doesn’t necessarily follow that patterns and processes among multiple behaviors are organized in the same way for infant–mother versus infant–father dyads. For example, even though 4-month factors showed congruence across parents, relations among parent sensitivity and infant still-face responses differed within each dyad. Increased levels of maternal sensitivity during face-to-face interaction predicted less infant negative affect, more positive affect, more self-regulation, and more parent focused regulation during the still-face with mothers; increased paternal sensitivity, on the other hand, was related only to greater parent-focused regulation, not to affect or self-regulation. Thus, different processes may be involved in the development of the infant–father attachment relationship compared with the infant–mother attachment relationship.

Several studies seem to suggest that background characteristics of the family may be particularly important to consider for the infant–father dyad. Factors such as family earner status (Braungart-Rieker et al. 1987; Volling & Belsky, 1992), the presence of marital conflict (Owen & Cox, 1997), and infant gender (Belsky & Rovine, 1988; Chase-Lansdale & Owen, 1987) may serve as salient features in the developing infant–father attachment relationship. Although several other studies have found that paternal sensitivity can distinguish secure from insecure infant–father dyads, the strength of the association tends to be fairly weak (van IJzendoorn & de Wolff, 1997). The fact that paternal sensitivity did not predict later infant–father attachment even weakly in this study may suggest that the context in which paternal sensitivity was assessed was not a valid indication of a father’s actual behavior at home. Longer periods of observation and information about the quantity of time in which a father interacts with his infant may yield more valid information about the infant–father dyad. It should be noted, however, that paternal sensitivity showed concurrent validity in that infants whose fathers were rated as more sensitive during face-to-face interaction showed more parent-focused regulation toward them during still-face.

The present sample also contained more infant–father C dyads than expected in such a low-risk sample. Of the 28 infants rated as insecure with fathers, 21 of them were in the C rather than the A category. Thus, there may be something unique about the present sample compared with other low-risk samples involving fathers (e.g., Easterbrooks & Goldberg, 1984). It may also be, however, that because the D-category was not assessed in this study, critical information about the infants’ relationship was not obtained. In other words, some of the infants coded as Cs, As, or even Bs may actually be closer to a D-category, especially if a disorganized attachment partly reflects a less firmly established internal working model of a secondary caregiver. Thus, the traditional scoring system for classifying attachment may be less applicable to infant–father dyads. Future studies involving fathers (and mothers) should include the D-category in the scoring system of attachment to present a more complete assessment of infant–parent attachment.

It is also important to note, however, that even though 4-month infant–father behavior did not predict 12-month infant–father attachment, aspects of infants’ behaviors toward fathers during still-face were predictive of the infant–mother attachment relationship at 12-months. More specifically, infants’ negative affect and self regulation during infant–father still-face loaded strongly on the affect regulation canonical function. Thus, consistent negative affect and self-regulation patterns across parents may reflect an organized behavioral system. It is less clear, however, what this congruence indicates. It is possible that negative affect and self-regulation at 4 months reflect temperament. They may also reflect, however, a more generalized or global internal working model of
the overall caregiving environment. It would be interesting in future studies to see if over time, infants’ negative affect and self-regulation toward fathers becomes more differentiated from mothers.

Future studies should also examine other aspects of regulation not addressed in the present study. The measures of affect regulation in this study involved only behavioral manifestations. Physiological or neurological reactions were not examined; such information might illuminate the processes involved in explaining the behaviors. For example, infants in the A and B1–B2 categories were equally high in affective and regulatory responses. But the two groups differed in that mothers of A infants were rated as somewhat less sensitive than mothers of B1–B2 infants. It would be interesting to see whether underlying arousal levels differed among groups whose behavioral responses appear similar.

In sum, results from this study show that maternal sensitivity during face-to-face interaction in addition to infant affective and regulatory responses during a still-face procedure at 4 months serve as indicators of whether infants will develop a secure versus insecure attachment relationship with their mothers and how that security or insecurity becomes expressed. Future studies should assess relations between parental sensitivity and affect regulation in a more process-oriented manner. Correlations between maternal sensitivity and affect/ regulation could mean that greater sensitivity leads to more effective regulatory skills or that infants who have a better developed regulatory system are less easily overstimulated, thus making maternal sensitivity easier to achieve. Repeated assessments of parent sensitivity and the developing affective and regulatory styles of infants would illuminate the processes by which affect, regulation, parent sensitivity, and attachment become related. Moreover, given that the sample consisted of primarily White, middle-class families, two dilemmas resulted: (1) obtaining a large enough sample of insecurely attached infants was more problematic, and (2) the generalizability of our findings is limited to nonrisk populations. Future studies should include samples of parent-infant pairs in which parents are depressed, less mature, or stressed or in which infants have congenital problems. Another direction for future research is to include multiple contexts when assessing parenting and infant behavior. Our conclusions about parental sensitivity, infant affect and regulation, and infant–parent attachment may be confounded by the structured contexts in which we examined those constructs. For example, the still-face situation is considered to be a mildly stressful situation; a context that elicits stronger emotions and presumably a need for greater regulation might yield interesting results. Further, Goldberg and colleagues recently suggested that parent sensitivity should be assessed during contexts in which the infant is already distressed; a parent who is sensitive during a play interaction may not necessarily be sensitive when faced with a crying infant (Goldberg, Grusec, & Jenkins, 1999). Such distinctions may be particularly important when studying the development of internal working models, infants’ felt security, and attachment. Nonetheless, the still-face paradigm allowed us to investigate how individual differences in affect and affect regulation during early infancy as well as maternal sensitivity relate to later mother–infant attachment.

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