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# Mothers' Physiological and Affective Responding to Infant Distress: Unique Antecedents of Avoidant and Resistant Attachments

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In a sample of 127 mother–infant dyads, this study examined the predictive significance of mothers' physiological and observed emotional responding within distressing and nondistressing caregiving contexts at 6 months for infant attachment assessed with Fraley and Spieker's (2003) dimensional approach and the categorical approach at 12 months. Findings revealed that a lesser degree of maternal respiratory sinus arrhythmia withdrawal and higher levels of maternal neutral (vs. positive) affect within distressing (vs. nondistressing) caregiving contexts were distinctive antecedents of avoidance versus resistance assessed dimensionally (but not categorically), independent of maternal sensitivity. Discussion focuses on the usefulness of examining mothers' physiological and affective responding, considering the caregiving context, and employing the dimensional approach to attachment in identifying unique antecedents of patterns of attachment insecurity.

According to attachment theory (Bowlby, 1969/1982), infants are biologically predisposed to establish attachment relationships with caregivers. Importantly, there are individual differences in the quality, or security, of parent–infant attachments, and evidence from nearly 5 decades of research suggests that early attachment security has modest yet enduring significance for children's socioemotional development (Groh, Fearon, Van IJzendoorn, Bakermans-Kranenburg, & Roisman, 2016). Given such evidence, understanding the factors that contribute to individual differences in the quality of attachment relationships is important for promoting early attachment security, and in turn, positive child adjustment.

According to attachment theory (Bowlby, 1969/1982), individual differences in infant attachment have their origins in the quality of the caregiving environment. Supporting this claim, behavioral genetic research, including twin and adoption studies (see Bokhorst et al., 2003; Dozier, Stoval, Albus, & Bates, 2001), and meta-analytic research examining the empirical overlap of infant temperament and attachment (Groh et al., 2017) have provided evidence that shared genes and infant characteristics play little role in determining the quality of mother–child attachment and, instead, suggest a focus on the caregiving environment. Sensitive caregiving, including acknowledging and accurately interpreting infant signals and responding to infant signals in an appropriate and contingent manner, is a key aspect of the caregiving environment that has been theorized to shape attachment quality. Specifically, sensitive caregiving is thought to contribute

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to attachment security because it promotes infants' confidence that attachment needs will be met by caregivers (Ainsworth, Blehar, Waters, & Wall, 1978). Specific types of insensitivity are thought to contribute to distinctive patterns of insecure attachment. Specifically, harsh, rejecting caregiving is theorized to contribute to avoidant attachment—a pattern of insecurity characterized by a tendency to not seek out caregivers in times of uncertainty and to restrict the expression of negative affect—because such caregiving serves to minimize infants' expression of attachment behavior. Inconsistent or unresponsive caregiving is theorized to contribute to resistant attachment—a pattern of insecurity characterized by a tendency to become emotionally overwhelmed in times of uncertainty—because such caregiving serves to heighten infants' expression of attachment signals (Cassidy, 1994).

Although it is well established that maternal sensitivity is associated with attachment security (De Wolff & Van IJzendoorn, 1997; Verhage et al., 2016), evidence regarding the distinctive caregiving antecedents of specific patterns of insecure attachment has been less conclusive. Indeed, despite evidence for links between different patterns of maternal caregiving behavior and avoidant and resistant attachment, there is a great deal of inconsistency in the literature (e.g., Belsky, Rovine, & Taylor, 1984; Lyons-Ruth, Connell, Zoll, & Stahl, 1987; Miyake, Chen, & Campos, 1985; Seifer, Schiller, Sameroff, Resnick, & Riordan, 1996; Smith & Pederson, 1988). As such, the developmental processes guiding the establishment of specific patterns of insecure attachment remain underspecified.

There are several potential reasons for the inconsistencies in the current literature. First, research on the latent structure of infant attachment conducted by Fraley and Spieker (2003) provided evidence that the traditional categorical coding system for assessing infant attachment may not best represent the latent structure of attachment. Second, although distinctive caregiving strategies are theorized to contribute to specific patterns of insecure attachment, distinguishing such strategies can be challenging based on observations of caregiving behavior. Indeed, some parenting scholars have argued for increased research on multilevel indicators of mothers' responding (e.g., physiological responding, observed emotional responding) within parent–child interactions, suggesting that such research might help differentiate distinctive processes underlying insensitive caregiving (Teti & Cole, 2011). Moreover, in light of an historical lack of evidence for distinctive behavioral correlates of patterns of insecure adult attachment, Roisman (2007) argued for and provided evidence that the use of multilevel indicators of responding might prove useful in identifying unique correlates of patterns of insecurity (Roisman, 2007; Roisman, Tsai, & Chiang, 2004). Third, evidence suggests that variation in infant attachment is more strongly associated with maternal responding to infant distress (vs. nondistress; McElwain & Booth-LaForce, 2006) and within distressing (vs. nondistressing) caregiving contexts (Leerkes, 2011). However, prior research has typically examined maternal responding within relatively nondistressing caregiving contexts.

In this study, we addressed these issues that might have limited the ability of prior research to identify distinctive antecedents of avoidant and resistant attachment by applying a multilevel biobehavioral approach to investigating antecedents of avoidant and resistant attachment as assessed with the traditional categorical coding system and Fraley and Spieker's (2003) dimensional approach. Specifically, we examined the predictive significance of mothers' physiological and observed emotional responding to their infants within distressing and nondistressing caregiving contexts at 6 months for avoidant and resistant attachment dimensions and categories at 12 months.

### *The Latent Structure of Infant Attachment*

The most widely used measure of attachment in early childhood is the strange situation procedure (SSP; Ainsworth et al., 1978) in which infants undergo a series of increasingly stressful separations from the parent and then subsequent reunions. Traditionally, individual differences in infant attachment are evaluated using a categorical coding system. Briefly, infants who use their attachment figure to effectively relieve their separation distress are classified as *secure*. Insecure infants who tend to ignore or avoid their attachment figure upon return are classified as *avoidant*, whereas insecure infants who simultaneously seek and angrily resist their attachment figure upon return are classified as *resistant*. Finally, *disorganized* infants display sometimes momentary but striking anomalous behaviors reflective of fear, apprehension, and confusion toward the caregiver, suggestive of a "breakdown" of their usual attachment-related strategy (Main & Solomon, 1990).

Although not explicit in the traditional coding system, two assumptions are inherent in the way in which individual differences in infant attachment

are typically coded: (a) that they are best represented categorically and (b) that the factor structure is best reflected by contrasts of security versus insecurity, in which insecurity comprises two mutually exclusive patterns of either avoidance or resistance (see Haydon, Roisman, & Burt, 2012). Although this traditional characterization has been generative, research has called these assumptions into question. Specifically, taxometric and factor analytic work on the distributional properties and factor structure of infant behavior during the SSP based on the NICHD Study of Early Child Care and Youth Development (SECCYD)—one of the largest studies of infant attachment conducted to date ($N$ = 1,364)—provided evidence that variation in attachment security may be compatible with a model in which individual differences are continuously distributed (Fraley & Spieker, 2003). Moreover, findings suggested that attachment-related individual differences vary along two weakly correlated factors. The first factor, *avoidance versus proximity seeking* (composed of avoidance, proximity seeking [reversed], and contact maintenance [reversed] indicators), reflects the extent to which the infant avoids rather than seeks out the caregiver during reunion episodes of the SSP. The second factor, referred to as *resistance* (composed of resistance and disorganization indicators), reflects the extent to which the infant becomes emotionally overwhelmed and inconsolable during the SSP (Fraley & Spieker, 2003).

These findings might have implications for research on the distinctive correlates of patterns of infant attachment insecurity. Specifically, in light of such evidence, prior research might have been limited in its ability to detect distinctive antecedents of avoidant and resistant attachments because applying a categorical structure to individual differences that vary continuously can undermine power (Cohen, 1983) and because the factor structure of variation in attachment might not be best captured by the traditional coding system. Thus, we employed both the dimensional and categorical approaches to representing variation in infant attachment in our biobehavioral investigation of the antecedents of infant attachment.

## *Mothers' Physiological and Observed Emotional Responding*

### *Physiological Responding*

According to Porges' (2007) polyvagal theory, vagal tone plays a central role in the regulation of social interaction. As such, it might be expected to be an important component of mothers' responding within attachment-relevant interactions with their infants. Vagal tone reflects neural regulation of the heart via the vagus nerve and is commonly measured in terms of respiratory sinus arrhythmia (RSA), which indexes high-frequency variability in heart rate associated with respiration that is mediated by the parasympathetic branch of the autonomic nervous system. Although resting RSA is often conceptualized as a correlate of emotional responding, a more informative and process-oriented way of thinking about the functioning of the parasympathetic system is to consider how it responds under conditions of stress or challenge. Here, a decrease in RSA from baseline levels (i.e., RSA withdrawal) is thought to reflect the *withdrawal* of parasympathetic control of the heart that allows for increased cardiac output. As such, when confronted with a situation that presents a challenge that requires active (as opposed to passive) coping, individuals are expected to exhibit RSA withdrawal, a pattern of physiological responding that is thought to support behaviors indicative of active coping. Thus, a lesser degree of RSA withdrawal relative to others during environmental challenges is thought to reflect less efficient behavioral and emotional control.

It has been argued that maternal RSA withdrawal within challenging caregiving contexts, such as when the infant is distressed, is an indicator of mothers' physiological self-regulation that facilitates the organization of an effective caregiving response (Mills-Koonce et al., 2007; Moore et al., 2009). Supporting such claims, previously reported findings from the current sample indicate that mothers who exhibited a lesser degree of RSA withdrawal following a distressing social disruption interacted less sensitively with their infants (Moore et al., 2009; see also Ablow, Marks, Feldman, & Huffman, 2013; Joosen, Mesman, Bakermans-Kranenburg, Pieper, & Van IJzendoorn, 2013). Especially relevant to the current study, Mills-Koonce et al. (2007) found that mothers who exhibited a lesser degree of RSA withdrawal within challenging caregiving contexts responded more harshly to their infants. Importantly, such associations were only found among mother–infant dyads who established avoidant attachment relationships. This finding suggests that mothers of avoidant infants might become irritable, have difficulty regulating their irritability, and respond more harshly to infant attachment signals—caregiving behavior thought to contribute to infant avoidance (Cassidy, 1994)—because when

confronted with attachment-relevant challenges, these mothers exhibit physiological signs of emotional dysregulation. Moreover, findings previously reported from the current sample indicated that during the SSP, mothers of avoidant (vs. secure) infants exhibited a lesser degree of RSA withdrawal from baseline levels during the final reunion episode of the procedure (Hill-Soderlund et al., 2008), providing further evidence that maternal physiological self-regulation during an attachment-relevant challenge might be especially relevant to avoidant attachment. Although this prior research did not directly examine whether mothers' RSA withdrawal within challenging parent–child contexts predicted individual differences in the quality of mother–infant attachment insecurity, findings from these studies lend support to the idea that lesser degrees of maternal RSA withdrawal within such contexts might undermine infant attachment security, and pose particular risk for insecure avoidance.

### *Observed Emotional Responding*

A mother's expression of emotion provides a direct window for the child into her emotional state and influences the dynamics of mother–child interactions (Dix, 1991). Thus, the emotion mothers display in response to infant attachment signals might be an important source of information for children, communicating the emotional availability of the mother and, in turn, likely influencing infant attachment quality.

To date, relatively few studies have investigated links between mothers' expressed emotion during parent–child interactions and infant attachment, and findings from these studies have been mixed. For example, Malatesta et al. (1989) found that mothers' expression of higher levels of positive affect was associated with infant security, whereas Belsky et al. (1984) found that higher levels of maternal positive affect expression, vocalization, and stimulation were predictive of insecure-avoidant attachment. Similarly, mothers' expression of higher levels of negative affect has been linked with both attachment security (Main, Tomasini, & Tolan, 1979) and insecurity (Pauli-Pott & Mertesacker, 2009).

One potential reason for these mixed findings might be that prior research has primarily focused on mothers' overall levels of expressed emotion without taking into consideration the caregiving context. Although overall levels of positive and negative emotions are important components of parenting, the appropriateness of mothers' affect given children's emotional states has been suggested to play a particularly important role in shaping parent–child interactions (Dix, 1991). Indeed, there is some evidence to suggest that mothers' emotional responding, particularly to infant distress, is uniquely predictive of infants' negative emotional expressiveness. Specifically, over the course of the first 2 years of the infant's life, mothers who tended to not affectively respond to their infants' cues of sadness or pain (but not other emotional cues, such as happiness) were found to be more likely to have infants who subsequently exhibited greater levels of negative affect during parent–child interactions (Malatesta et al., 1989). These findings suggest that when mothers are not particularly emotionally responsive to infant distress, it might lead to a strategy in which the infant heightens the expression of negative affect, perhaps in an effort to elicit a response from the mother. These findings are striking because an emotional strategy of heightening negative affect conceptually converges with the motivational strategy that characterizes resistant infants (i.e., heightening of emotional expression; Cassidy, 1994). Thus, it might be expected that mothers who are more affectively neutral in terms of their emotional responding to their infants' distress are especially likely to have an infant who exhibits greater levels of attachment-relevant resistance.

### *Maternal Physiological, Observed Emotional, and Sensitive Responding*

Associations between mothers' physiological and observed emotional responding within parent–child interactions and infant attachment variation might be explained by or independent of maternal sensitive caregiving behavior. Specifically, Dix (1991) has argued that parents' emotional responding while interacting with children plays an important role in organizing caregiving behavior, which in turn influences children's behavior. Similarly, Teti and Cole (2011) have argued that mothers' physiological and emotional responding underlie caregiving behavior, and thus, the impact of mothers' physiological and emotional responding on children's adaptation would be expected to be accounted for by caregiving behavior. Alternatively, Leerkes, Su, Calkins, O'Brien, and Supple (2017) have proposed three ways in which mothers' physiological and emotional responding within mother–

child interactions might directly contribute to child outcomes independent of sensitive caregiving, including (a) *genetic transmission*—mothers and infants might share a common genetic risk for emotional dysregulation; (b) *emotional contagion*—mothers' physiological responding might contribute to their outward expression of emotion that, in turn, contributes to infants' matching of mothers' internal state; and (c) *physiological synchrony*—mothers' physiological responding might directly contribute to infants' physiological responding via synchronization of biological rhythms.

Evidence reviewed above linking maternal RSA withdrawal with caregiving behavior relevant to infant attachment (Ablow et al., 2013; Joosen et al., 2013; Mills-Koonce et al., 2007; Moore et al., 2009) lends support to the idea that the association between maternal physiological responding and infant attachment might be explained by maternal sensitivity. However, support for a direct association between maternal physiological responding and infant attachment also exists. Specifically, although we are aware of no studies examining the predictive significance of maternal RSA withdrawal for infant attachment avoidance and resistance, one study has provided evidence that maternal physiological arousal (as indexed by electrodermal reactivity) in the absence of physiological regulation (as indexed by RSA withdrawal) within a distressing caregiving context predicted greater levels of infant disorganization, independent of maternal sensitivity (Leerkes et al., 2017). Concerning mothers' emotional responding, evidence has been mixed. Specifically, mothers' self-reported anxiety in response to an audiorecording of infant crying was directly associated with infant resistance independent of sensitivity, whereas the association between mothers' self-reported feelings of anger to infant crying and infant avoidance was mediated by mothers' reported punitive responses to infant distress (Leerkes, Parade, & Gudmundson, 2011). Importantly, unlike self-reported emotion, mothers' expressed emotion is directly observed by the infant, and thus, might be directly associated with infant attachment independent of maternal sensitivity. To test whether associations between maternal physiological and observed emotional responding and infant attachment are independent of maternal sensitivity, we examined whether such associations were robust to the inclusion of maternal sensitivity in analyses. Given mixed prior evidence, we did not have specific predictions about whether associations would be independent of maternal sensitivity.

### *The Current Study*

A biobehavioral research design was employed to examine mothers' physiological and observed emotional responding to their 6-month-old infants within distressing and nondistressing caregiving contexts as distinctive antecedents of infant avoidant and resistant attachment as assessed dimensionally and categorically when infants were 12 months old. The still-face procedure (SFP; Tronick, Als, Adamson, Wise, & Brazelton, 1978) was employed to examine mothers' responding in a nondistressing (i.e., *normal play* episode in which the mother and infant engage in normal play) and distressing (i.e., *reunion* episode in which the mother resumes normal interaction with the infant following a distressing social disruption) caregiving context. It was hypothesized that a lesser degree of maternal RSA withdrawal—reflective of less physiological self-regulation—during the reunion episode of the SFP would be associated with higher levels of attachment-relevant avoidance. It was also expected that higher levels of maternal neutral affect during the reunion episode of the SFP would be associated with higher levels of attachment-relevant resistance. Both the dimensional and categorical systems for representing individual differences in infant attachment were used to allow for comparisons of findings across methodological approaches. We also examined whether associations between maternal physiological and emotional responding and infant attachment were independent of maternal sensitivity. Finally, to control for potential variation in infant distress elicited by the SFP, we included infant negative affect during the still-face episode of the SFP in analyses.

## Method

### *Participants*

Participants were selected from a larger sample ($N = 206$) of families recruited by the Durham Child Health and Development Study, which included approximately equal numbers of African American and European American families from lower and higher income groups. Families were recruited from a largely urban community via flyers and postings at birth and parenting classes, as well as through birth records. Infants were healthy, full term, and born without significant birth complications. Mother–infant dyads (51% male infants) who completed the SFP at 6 months (laboratory visits conducted between April 2002 and September 2003)

and the SSP at 12 months (laboratory visits conducted between October 2002 and March 2004) comprised the sample for this report ($N = 127$). Reasons for attrition included either the family missed a scheduled visit due to illness and became too old to complete assessment, moved away from the area, or were unable to be reached. Family's race was determined by self-reported race of the mother, and income status was determined as high versus low based on whether the family was above or below 200% of the federal poverty threshold, respectively. Mother–infant dyads were 54% African American and 46% European American. Approximately half of the families (45%) were low income. There were no significant differences between the current sample and the full sample on demographic or key study variables.

### *Procedure*

Mother–infant dyads visited the laboratory within 1 week of the infant's 6-month birthday and completed the SFP. In-home observations of maternal sensitivity were conducted within 2 weeks of the laboratory visit. Within 1 week of the infant's 12-month birthday, mother–infant dyads returned to the laboratory and completed the SSP.

### *Measures*

#### *Still-Face Procedure*

Mothers placed infants in an infant seat and sat in a chair directly in front of the infants. Mothers were given instructions for each episode of the SFP (normal play, still face, reunion) prior to beginning the procedure. For the normal play episode, mothers were instructed to play with their babies for 2 min as they normally would at home. After turning away from the baby for 15 s, the mother initiated the still-face episode, looking at her child for 2 min without any facial movement or vocalization. After another 15-s break, the mother turned back toward her baby for 2 min, responding in any way that she felt was appropriate.

*Physiological monitoring.* At the beginning of the visit, electrodes were placed on the mother's chest and were connected to a preamplifier, the output of which was transmitted to a monitor configured to collect heart interbeat intervals (IBI; Mini Logger 2000; Mini-Mitter Corp., Bend, OR). During a 2-min baseline period, mothers were asked not to interact with or provide toys to their infant so that IBI could be measured as accurately as possible during a neutral and calm state. IBI data were continuously collected throughout the SFP.

IBI data were edited and analyzed using MXEdit software (Delta Biometrics, Bethesda, MD). Data files that required editing of more than 10% of the data or that were incomplete due to technical problems (e.g., electrode fell off during the procedure) were not included in analyses. This resulted in missing data for individual episodes (see below). After editing, measures of RSA were derived using Porges' (1985) method. First, RSA was calculated in 15-s epochs during baseline and each 2-min episode of the SFP. Second, mean values of RSA during baseline and during each episode of the SFP were computed for use in analyses.

Because the focus of this study was on mothers' responding during (non)distressing caregiving contexts, we were interested in mothers' change in RSA from baseline to the normal play and reunion episodes, respectively. Change in RSA for the normal play and reunion episodes was calculated by subtracting mean-level RSA during each episode from RSA during baseline, providing a measure of RSA withdrawal during each episode. Positive values of RSA withdrawal indicated a larger decrease in RSA from baseline and, therefore, a greater degree of RSA withdrawal that putatively reflects attempts to regulate emotion and deploy attention.

*Mother observed affect.* The episodes of the SFP were video recorded, and mothers' affective behaviors during the normal play and reunion episodes were coded. Facial affect was coded at 1-s intervals as positive, neutral, or negative. If coders could not see the mother's face (e.g., mother turned away), affect was coded as obscured/missing. Coders were initially trained to reliability using a large pool of video-recorded SFP interactions. To assess interobserver agreement in the current study, 15% of the interactions were selected randomly and coded by a second coder. Agreement was calculated as both coders observing the same behavior within 1 s of each other and quantified using kappa to correct for chance agreement. Overall, coders reliably identified affect ($\kappa = .83$). To determine the total amount of time during the normal play and reunion episodes that a mother was in a specific affective state, the total number of seconds in which positive, neutral, and negative affect occurred was calculated for each SFP episode. Affect scores were computed as percentages of total valid (nonmissing) interaction time.

Because we were particularly interested in the extent to which mothers were emotionally responsive when interacting with their infants and because

mothers displayed primarily neutral or positive affect during the normal play ($M_{neutral}$ = 0.32, $SD$ = 0.27; $M_{positive}$ = 0.67, $SD$ = 0.27; $M_{negative}$ = 0.01, $SD$ = 0.02) and reunion ($M_{neutral}$ = 0.40, $SD$ = 0.27; $M_{positive}$ = 0.58, $SD$ = 0.27; $M_{negative}$ = 0.02, $SD$ = 0.09) episodes, only mothers' neutral and positive affect were considered in this report. Mothers' positive and neutral affect during the normal play and reunion episodes were highly negatively correlated (normal play: $r = -.99$; reunion: $r = -.95$). Thus, to index the extent to which mothers were affectively neutral, mothers' neutral affect and positive affect (reversed) were averaged within each episode resulting in dimensions of mothers' *neutral (vs. positive)* affect during the normal play and reunion episodes, respectively.

*Infant negative affect.* Infant negative affect was coded during the still-face episode following the procedure outlined above for coding mothers' affect and was used as a control for how distressed the infant became by the still face. Specifically, infants' facial affect was coded at 1 s intervals by a second team of coders who were not involved in the coding of mother affect. Interrater reliability calculated on a random sample of 15% of the interactions was $\kappa = .89$. The total amount of time the infant displayed negative affect during the still face was calculated and infant negative affect was computed as a percentage of total valid interaction time.

### *Maternal Sensitivity*

As part of the broader aims of this longitudinal study, maternal sensitivity was assessed during a free-play context and during the reunion episode of the SFP. As reported in prior publications on this sample, maternal RSA withdrawal during SFP reunion was significantly associated with maternal sensitivity assessed during a free play conducted in the home (Moore et al., 2009), but not during SFP reunion (Mills-Koonce et al., 2009), perhaps due to constraints on maternal behavior during the SFP (e.g., mother and infant interact while seated across from one another). In light of such evidence, here we focus on maternal sensitivity assessed during free play to provide a more rigorous test of whether associations between maternal physiological and affective responding and infant attachment are independent of maternal sensitivity. Importantly, we repeated the analyses reported below with maternal sensitivity during SFP reunion as a more direct test of mediational processes, and the pattern and significance of findings remained the same (see Table S1).

Video recordings of 10 min in-home mother–infant free play interactions at 6 months were coded offline by independent coders according to a revision of a coding system used by the NICHD Study of Early Child Care (NICHD Early Child Care Research Network, 1997). Seven subscales of maternal behavior were coded (sensitivity/responsiveness, intrusiveness, detachment/disengagement, positive regard, negative regard, stimulation of cognitive development, and animation) on a scale from 1 to 5, indicating the degree to which the behavior characterized the interaction. Given our interest in maternal sensitivity, the sensitivity/responsiveness dimension was used in analyses. All interactions were double coded, and the intraclass correlation (ICC) for the sensitivity dimension was 0.92 (see Moore et al., 2009).

### *Infant Attachment*

At 12 months of age, the mothers and infants participated in the SSP (Ainsworth et al., 1978). SSPs were video recorded and coded offline following procedures outlined by Ainsworth et al. (1978) and Main and Solomon (1990) by two coders trained and certified by Sroufe and Carlson. Four 7-point interactive behavior scales in the two reunion episodes (Episodes 5 and 8) of the SSP were coded: proximity/contact seeking, contact maintenance, avoidance, and resistance. Disorganization during the SSP was rated on a 9-point scale. On the basis of the score pattern of these scales, each participant was classified as secure, insecure avoidant, insecure resistant, or disorganized. Of the 127 infants included in this report, 74 (58%) were classified as secure, 26 (21%) were classified as avoidant, 9 (7%) were classified as resistant, and 18 (14%) were classified as disorganized. Coders overlapped on 30% of the cases, and intercoder agreement for attachment classification was $\kappa = .85$. For the four interactive behavior scales and disorganization scale, intercoder agreement determined by Pearson's correlation ranged from .81 to .92.

As a first step to using Fraley and Spieker's (2003) dimensional approach, we aimed to replicate their factor analytic findings. Specifically, we standardized and submitted the four interactive behavioral scales during the two reunion episodes of the SSP and the disorganization scale to principal-axis factoring with oblique rotation. Consistent with Fraley and Spieker's findings, results revealed that a two-component solution best accounted for the data. The first component explained 35% of the variance and reflected Fraley and Spieker's (2003) *avoidance versus proximity seeking* dimension

(avoidance, proximity seeking [reversed], contact maintenance [reversed]). The second component explained 19% of the variance and reflected Fraley and Spieker's (2003) *resistance* dimension (resistance, disorganization). Each scale uniquely loaded onto its respective component at or above .50, and the Cronbach α's for the aggregates were .84 and .71, respectively (see Table 1 for factor loadings). To compare findings using the attachment dimensions to those using the attachment categories, two dummy variables that capture the variation reflected by the dimensions were created: *avoidant versus not avoidant* (i.e., infants classified as avoidant vs. all other infants) and *resistant versus nonresistant* (i.e., infants classified as resistant or disorganized vs. all other infants). Of note, the pattern and significance of findings did not change when the dummy variables were created using the three-way secure, avoidant, resistant classification system, in which the alternative organized classification was used for infants classified as disorganized.

### *Missing Data*

Missing data on the sample of 127 mother–infant dyads ranged from 6% to 33% ($M$ = 15%) on antecedent variables (mother RSA, mother affect, infant affect, mother sensitivity). Missing values were imputed using multiple imputation with 10 iterations (Rubin, 1987). Given that participants with and without missing data did not significantly differ in terms of demographic or study variables and data were "missing completely at random" (Little's Missing Completely at Random (MCAR) test), $\chi^2(94) = 100.98$, $p = .29$, this approach allowed testing of hypotheses with improved power over other commonly used techniques (e.g., listwise deletion; Little & Rubin, 1987).

Table 1
*Factor Loadings From Two-Factor Solution of Strange Situation Behavioral Scales*

| | Factor 1 | Factor 2 |
|---|---|---|
| Proximity seeking (Episode 5) | **.76** | .17 |
| Contact maintenance (Episode 5) | **.72** | .35 |
| Avoidance (Episode 5) | **−.64** | .11 |
| Resistance (Episode 5) | .13 | **.63** |
| Proximity seeking (Episode 8) | **.77** | −.10 |
| Contact maintenance (Episode 8) | **.69** | .15 |
| Avoidance (Episode 8) | **−.71** | .24 |
| Resistance (Episode 8) | .11 | **.91** |
| Disorganization | −.15 | **.51** |

*Note.* Loadings > |.50| appear in boldface.

## Results

### *Preliminary Analyses*

Descriptive statistics for the avoidance and resistance dimensions by attachment classifications are displayed in Table 2 and suggest that the dimensional approach allows for the detection of individual differences among infants classified in the same global attachment category while retaining the categories' dominant features. We examined whether demographic variables and infant negative affect during the still-face episode were correlated with mothers' physiological and observed emotional responding during normal play and reunion episodes of the SFP, maternal sensitivity, and infant attachment (see Table 3). Because infant sex, ethnicity, poverty status, and infant negative affect were (marginally) significantly associated with one or more variables of interest, they were entered as covariates in regression analyses presented below. Infant avoidance and resistance dimensions were marginally significantly correlated. As such, the resistance dimension was entered as a covariate in analyses predicting the avoidance dimension and vice versa to examine whether significant effects were specific to the attachment dimension of interest rather than to shared variance with the other attachment dimension.

Associations between maternal sensitivity and avoidance and resistance dimensions were weak (avoidance: $r = -.15$, $p < .10$; resistance: $r = .01$, *ns*). Given that (to the best of our knowledge) this is the first study to examine associations between maternal sensitivity and infant attachment dimensions, to more closely approximate the insecure versus secure contrast typically used in the infant attachment literature, we computed the product of the standardized avoidance and resistance dimensions and examined it in relation to maternal sensitivity. Similar to findings with each of the dimensions, the product term (higher vs. lower avoidance and resistance) was weakly, nonsignificantly correlated with maternal sensitivity ($r = -.08$), as was the correlation between infant insecurity status (insecure vs. secure) determined using the categorical system and maternal sensitivity ($r = -.10$).

### *Maternal Psychological Responding and Infant Attachment*

Focusing first on the dimensional approach, we hypothesized that a lesser degree of maternal RSA withdrawal during a distressing caregiving context at 6 months would predict greater infant avoidance

Table 2
*Means and Standard Deviations on Avoidance (vs. Proximity Seeking) and Resistance Attachment Dimensions by Attachment Classifications*

| | Avoidance (vs. proximity seeking) | | Resistance | |
|---|---|---|---|---|
| | *M* (*SD*) | Range | *M* (*SD*) | Range |
| Avoidant | 1.11 (0.59) | 0.00 to 2.17 | −0.27 (0.33) | −0.52 to 0.46 |
| Secure | −1.02 (1.14) | −3.33 to 1.33 | −0.34 (0.32) | −0.52 to 0.97 |
| Resistant | −1.19 (1.05) | −2.83 to 0.50 | 1.25 (0.58) | 0.18 to 1.96 |
| Disorganized | −0.94 (1.64) | −3.33 to 2.00 | 1.33 (1.23) | −0.47 to 3.62 |

Table 3
*Descriptive Statistics and Correlations Among Study Variables*

| | *M*/% | *SD* | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Avoidance dimension | −0.58 | 1.41 | — | — | — | — | — | — | — | — | — | — | — | — |
| 2. Resistance dimension | 0.03 | 0.87 | −.14$^{+}$ | — | — | — | — | — | — | — | — | — | — | — |
| 3. Avoidant status | 21% | — | .61** | −.18* | — | — | — | — | — | — | — | — | — | — |
| 4. Resistant status | 21% | — | −.16$^{+}$ | .77** | −.26** | — | — | — | — | — | — | — | — | — |
| 5. RSA withdrawal: normal | −0.21 | 0.99 | −.06 | −.01 | −.07 | −.01 | — | — | — | — | — | — | — | — |
| 6. RSA withdrawal: reunion | 0.07 | 1.06 | −.24* | .11 | −.14 | .10 | .77** | — | — | — | — | — | — | — |
| 7. Neutral affect: normal | 0.32 | 0.26 | −.01 | .07 | .01 | .02 | −.13 | −.05 | — | — | — | — | — | — |
| 8. Neutral affect: reunion | 0.41 | 0.27 | −.06 | .19* | .00 | .16$^{+}$ | −.04 | .03 | .74** | — | — | — | — | — |
| 9. Sensitivity | 2.83 | 0.98 | −.15$^{+}$ | .01 | −.07 | −.04 | .07 | .22* | −.08 | −.16 | — | — | — | — |
| 10. Infant negative affect | 0.17 | 0.27 | −.10 | .08 | −.07 | .09 | .17 | .16 | .15 | .22* | −.10 | — | — | — |
| 11. Infant sex | 51% | — | .02 | .16$^{+}$ | .11 | .08 | .20* | .20* | −.08 | −.08 | .04 | .07 | — | — |
| 12. Ethnicity | 54% | — | −.08 | .06 | −.11 | .14 | .03 | .17 | −.05 | −.19* | .30** | −.04 | .04 | — |
| 13. Income status | 45% | — | .17$^{+}$ | .02 | −.07 | −.01 | .00 | −.14 | .13 | .19* | −.24** | .30** | −.04 | −.10 |

*Note.* Sex: 1 = male, 0 = female; ethnicity: 1 = African American, 0 = Caucasian; income status: 1 = below 200% poverty threshold, 0 = above 200% poverty threshold; avoidant status: 1 = avoidant, 0 = not avoidant; resistant status: 1 = resistant/disorganized; 0 = not resistant/disorganized. RSA = respiratory sinus arrhythmia.
$^{+}p < .10$. *$p < .05$. **$p < .01$.

at 12 months. Supporting this hypothesis, a significant, negative bivariate association was found between maternal RSA withdrawal during the reunion episode of the SFP and infant avoidance (vs. proximity seeking; see Table 3). To more rigorously test this association, we conducted a hierarchical linear regression in which infant avoidance (vs. proximity seeking) was regressed on the following blocked sets of predictors. In the first step, demographic variables (infant sex, ethnicity, income status), infant negative affect, and infant resistance were entered to examine whether the association was robust to potential covariates. In the second step, maternal sensitivity, neutral (vs. positive) affect during normal play and reunion episodes, and maternal RSA withdrawal during

normal play were entered to examine whether the association was independent of maternal sensitive caregiving, mothers' observed emotional responding, and mothers' physiological responding in a nondistressing caregiving context. In the third step, mothers' RSA withdrawal during the reunion episode was entered.

As seen in Table 4, the full model was significant, $F(10, 116) = 2.03$, $p < .05$, and accounted for 15% of the variance. In addition, maternal RSA withdrawal during reunion was significantly, negatively associated with infant avoidance in the full model and its addition to the model significantly increased $R^2$, $F(1, 116) = 6.10$, $p < .05$, $\Delta R^2 = .05$. As expected, this finding indicates that a lesser degree of maternal RSA withdrawal within a distressing caregiving context was associated with higher levels of infant attachment avoidance. A median split of the sample by infant avoidance revealed that infants higher on avoidance had mothers who, on average, failed to show RSA withdrawal from the resting baseline to the reunion episode ($M = -0.13$, $SD = 1.07$; note, RSA withdrawal = RSA at rest − RSA during reunion, thus a negative value indicates an increase in RSA from rest to reunion, see Method), whereas infants lower on avoidance had mothers who, on average, exhibited decreases in RSA from rest to the reunion episode ($M = 0.26$,

Table 4
*Regression Analyses of Mothers' Physiological and Observed Emotional Responding Within Distressing and Nondistressing Caregiving Contexts Predicting Infant Attachment Dimensions*

| | Avoidance | | | | Resistance | | | |
|---|---|---|---|---|---|---|---|---|
| | *B* (*SE*) | β | *p* | $R^2$ | *B* (*SE*) | β | *p* | $R^2$ |
| Step 1 | | | | .08+ | | | | .05 |
| Infant sex | 0.18 (.25) | .13 | .47 | | 0.27 (.15) | .31 | .08 | |
| Ethnicity | −0.16 (.25) | −.12 | .52 | | 0.09 (.16) | .10 | .57 | |
| Income | 0.60 (.27) | .43 | < .05 | | 0.08 (.17) | .09 | .64 | |
| Infant negative affect | −0.84 (.55) | −.16 | .13 | | 0.12 (.32) | .04 | .70 | |
| Avoidance | — | — | — | | −0.09 (.06) | −.15 | .11 | |
| Resistance | −0.23 (.15) | −.14 | .11 | | — | — | — | |
| Step 2 | | | | .10 | | | | .10 |
| Infant sex | 0.20 (.26) | .14 | .45 | | 0.28 (.17) | .32 | .10 | |
| Ethnicity | −0.12 (.28) | −.08 | .67 | | 0.06 (.17) | .07 | .74 | |
| Income | 0.55 (.27) | .39 | < .05 | | 0.10 (.18) | .12 | .57 | |
| Infant negative affect | −0.75 (.59) | −.14 | .20 | | 0.06 (.36) | .02 | .86 | |
| Avoidance | — | — | — | | −0.07 (.06) | −.11 | .26 | |
| Resistance | −0.21 (.15) | −.13 | .18 | | — | — | | |
| Sensitivity | −0.17 (.14) | −.12 | .25 | | −0.04 (.09) | −.04 | .70 | |
| RSA withdrawal (normal) | −0.06 (.17) | −.04 | .73 | | −0.21 (.17) | −.24 | .21 | |
| Neutral affect (normal) | 0.37 (.81) | .07 | .65 | | 0.17 (.33) | .05 | .61 | |
| RSA withdrawal (reunion) | — | — | — | | 0.20 (.17) | .25 | .24 | |
| Neutral affect (reunion) | −0.59 (.84) | −.11 | .48 | | — | — | — | |
| Step 3 | | | | .15* | | | | .14* |
| Infant sex | 0.23 (.26) | .17 | .38 | | 0.30 (.17) | .35 | .08 | |
| Ethnicity | 0.00 (.29) | .00 | .99 | | 0.14 (.18) | .16 | .42 | |
| Income | 0.39 (.29) | .28 | .17 | | 0.06 (.18) | .07 | .74 | |
| Infant negative affect | −0.62 (.57) | −.12 | .28 | | 0.00 (.35) | .00 | .99 | |
| Avoidance | — | — | — | | −0.06 (.06) | −.10 | .32 | |
| Resistance | −0.16 (.16) | −.10 | .32 | | — | — | — | |
| Sensitivity | −0.10 (.14) | −.07 | .47 | | −0.01 (.09) | −.02 | .88 | |
| RSA withdrawal (normal) | 0.32 (.23) | .23 | .16 | | −0.19 (.16) | −.22 | .23 | |
| Neutral affect (normal) | 0.33 (.86) | .07 | .71 | | −0.56 (.47) | −.17 | .24 | |
| RSA withdrawal (reunion) | −0.52 (.23) | −.37 | < .05 | | 0.16 (.19) | .20 | .40 | |
| Neutral affect (reunion) | −0.49 (.91) | −.07 | .69 | | 1.03 (.50) | .32 | < .05 | |

*Note.* Sex: 1 = male, 0 = female; ethnicity: 1 = African American, 0 = Caucasian; income: 1 = below 200% poverty threshold, 0 = above 200% poverty threshold. RSA = respiratory sinus arrhythmia.
+$p < .10$. *$p < .05$.

*SD* = 1.01). This finding indicated that mothers who exhibited less RSA withdrawal—indicative of less physiological self-regulation—when interacting with their infants following a challenging social disruption at 6 months were significantly more likely to have infants who exhibited higher levels of attachment avoidance (vs. proximity seeking) at 12 months. Importantly, the association between maternal RSA withdrawal during reunion and infant avoidance was significant with maternal sensitivity entered into the model, indicating that this association was independent of maternal sensitivity. As expected, maternal RSA withdrawal during normal play and maternal neutral (vs. positive) affect during normal play and reunion were not significantly associated with infant avoidance, indicating that maternal RSA withdrawal during a *distressing* caregiving context was uniquely predictive of infant avoidance.

Concerning the categorical approach to attachment, we conducted a hierarchical logistic regression in which avoidant status was regressed on the same blocked sets of antecedent variables and covariates described earlier (excluding resistant status, as classification on one attachment variable is highly related to classification on the other, making the significance level of the overall model difficult to interpret). The model was not significant, $\chi^2(9, 117) = 9.46$, $p = .41$, and findings remained nonsignificant even when using the more common analysis of variance framework. However, although not significant, the bivariate association between maternal RSA withdrawal during reunion and avoidant status was in the expected direction and comparable to the association when the dimensional approach was used (see Table 3).

### *Maternal Observed Emotional Responding and Infant Attachment*

We first present findings for the dimensional approach, followed by those for the categorical approach. We hypothesized that higher levels of maternal neutral (vs. positive) affect during a distressing caregiving context at 6 months would be predictive of greater infant attachment resistance at 12 months. As expected, a significant positive bivariate association was found between maternal neutral (vs. positive) affect during the SFP reunion episode and infant resistance (see Table 3). To more rigorously test of this association, we conducted a hierarchical linear regression in which infant resistance was regressed on the same blocked sets of predictors described above, except that maternal RSA withdrawal during reunion was entered in the second step and maternal neutral (vs. positive) affect during reunion was entered in the third step. As seen in Table 4, the full model was significant, $F(10, 116) = 1.91$, $p < .05$, and accounted for 14% of the variance. In addition, maternal neutral (vs. positive) affect during reunion was significantly, positively associated with infant resistance in the full model and its addition to the model significantly increased $R^2$, $F(1, 116) = 5.45$, $p < .05$, $\Delta R^2 = .04$. This finding indicated that mothers who were more affectively neutral when interacting with their infants following a challenging social disruption at 6 months were significantly more likely to have infants who exhibited greater resistance at 12 months. Similar to avoidance findings, the association between maternal neutral (vs. positive) affect during reunion and infant resistance was significant with sensitivity entered into the model, indicating that this association was independent of maternal sensitivity. As expected, maternal neutral (vs. positive) affect during normal play and maternal RSA withdrawal during normal play and reunion were not significantly associated with infant resistance, indicating that maternal neutral affect during a distressing, but not nondistressing, caregiving context was uniquely predictive of infant resistance.

Concerning the categorical approach to attachment, we conducted a hierarchical logistic regression in which resistant status was regressed on the same blocked sets of antecedent variables and covariates described earlier (excluding avoidant status). The model was not significant, $\chi^2(9, 117) = 14.90$, $p = .12$, and findings remained nonsignificant even when the more common analysis of variance framework was used. However, as with avoidant status, although not significant, the bivariate association between maternal neutral (vs. positive affect) during reunion and resistant attachment status was in the expected direction and comparable to the association when the dimensional approach was used (see Table 3).

## Discussion

This study provided further insight into the developmental origins of patterns of infant attachment insecurity by applying a biobehavioral approach to examining maternal responsiveness within distressing and nondistressing caregiving contexts in relation to infant attachment assessed dimensionally and categorically. Consistent with arguments that

multilevel indicators of emotional responding might help differentiate distinctive correlates of patterns of insecurity (Roisman, 2007), this study provided evidence that mothers' physiological and observed emotional responding within a distressing caregiving context served as unique antecedents of avoidant versus resistant attachments, respectively, independent of maternal sensitivity. Moreover, mothers' physiological and observed emotional responding following a challenging social disruption, but not during normal play, was predictive of infant attachment. Such evidence builds on findings that infant attachment variation is more strongly associated with responding to infant distress (vs. nondistress; McElwain & Booth-LaForce, 2006) and provides further evidence that variation in attachment might be particularly related to responding within contexts that generate attachment-relevant distress (Leerkes, 2011). Importantly, distinctive caregiving antecedents of infant attachment were found only when using the dimensional, not the categorical, approach to representing individual differences in attachment.

We found that mothers who exhibited a lesser degree of RSA withdrawal when interacting with their infants following a challenging social disruption were more likely to have infants who exhibited higher levels of avoidant attachment behavior. RSA withdrawal under challenging conditions is an indicator of physiological self-regulation that reflects the mobilization of physiological resources that facilitate active engagement with the environment (Porges, 2007). Thus, when confronted with a challenging caregiving context, mothers of infants higher on avoidance exhibited lower levels of physiological self-regulation, suggesting that mothers' ability to physiologically self-regulate within challenging caregiving contexts is uniquely tied to infants' tendency to avoid versus seek out the mother when confronted with attachment-relevant challenges. Indeed, it may be that infants of mothers who exhibit less physiological self-regulation within a distressing caregiving context—a pattern of responding not expected to support active attention to and engagement with the needs of distressed infants—find their mothers as a less effective source of comfort in times of need, ultimately leading to an attachment strategy in which infants tend to not seek out their mothers in times of uncertainty.

Evidence that mothers' RSA withdrawal during a distressing caregiving context was uniquely predictive of infant avoidance is striking when considering findings from research on adult attachment and mothers' physiological responding to infant distress. Specifically, mothers with insecure-dismissing states of mind—who minimize the importance of early attachment-relevant experiences and/or normalize harsh caregiving experiences within the context of the Adult Attachment Interview (Main & Goldwyn, 1998)—have been found to exhibit less RSA withdrawal when confronted with infant crying than mothers with secure-autonomous states of mind (Ablow et al., 2013). Findings from this prior research together with those from the current study provide convergent evidence that mothers' RSA withdrawal to infant distress is both associated with dismissing states of mind in adulthood and predictive of avoidant attachment in infancy. Given that mothers with dismissing states of mind and their infants are especially likely to establish an insecure-avoidant attachment relationship (Verhage et al., 2016), such evidence suggests that mothers' lesser RSA withdrawal within a distressing caregiving context might serve as a physiological pathway by which avoidant attachment is transmitted across generations.

Although mothers' RSA withdrawal during a distressing caregiving context was uniquely predictive of infant avoidance, mothers' observed emotional responding within a distressing caregiving context at 6 months was uniquely predictive of infant resistance at 12 months. Specifically, mothers who were more affectively neutral (vs. positive) when interacting with their infants following a challenging social disruption were more likely to have infants who exhibited greater levels of resistance in the SSP. Given evidence that mothers' affective unresponsiveness to infant distress over the course of the first years of life is predictive of higher levels of infant negative affect at age 2 (Malatesta et al., 1989), our findings might suggest that mothers who are more affectively neutral during a distressing caregiving context are more likely to have a resistant attachment relationship with their infants because an emotionally muted response from the mother when the infant is distressed might lead the infant to heighten the expression of attachment-relevant distress. Moreover, evidence from this study that mothers' affective responding to their infants following a challenging social disruption, but not during normal play, was predictive of infant attachment might help reconcile prior mixed evidence concerning links between maternal affect and infant attachment. In most studies, mothers' overall affect while interacting with their infants was examined (Belsky et al., 1984; Main et al., 1979; Malatesta et al., 1989; Pauli-Pott & Mertesacker, 2009), and

findings from this study suggest that taking into consideration mothers' affect with respect to the caregiving context might be important when examining links with infant attachment.

Associations between maternal physiological and observed emotional responding within a distressing caregiving context and infant attachment were independent of maternal sensitivity. However, it should be noted that associations between maternal sensitivity and avoidance and resistance dimensions were weak. These findings do not appear to be an artifact of the dimensional approach, as similarly weak associations were found using the categorical approach. Instead, these findings might be attributed to approximately half of the families in this study living below 200% of the federal poverty line. Indeed, the association between maternal sensitivity and lower levels of infant avoidance identified here ($r$ = .15) matched the meta-analytic estimate for the association between maternal sensitivity and security in lower socioeconomic samples ($r$ = .15), which meta-analytic evidence suggests is weaker than for higher socioeconomic samples ($r$ = .27; De Wolff & Van IJzendoorn, 1997).

That said, our findings that associations were independent of maternal sensitivity converge with prior evidence that associations between maternal physiological and subjective emotional responding and infant attachment were not mediated by sensitivity (Leerkes et al., 2011, 2017). This growing evidence suggests that physiological and emotional responding within challenging caregiving contexts capture important variation in maternal responding that has unique predictive significance for infant attachment independent of sensitive caregiving. As such, it is important to consider mechanisms other than caregiving behavior that might explain such associations. Mothers' expressed emotion within parent–child interactions might directly influence infant behavior by communicating mothers' emotional state and availability. Regarding mothers' physiological responding, Leerkes et al. (2017) have proposed three potential mechanisms by which maternal physiological responding might influence children's behavior, including genetic transmission, emotional contagion, and physiological synchrony. Given that twin studies have estimated the heritability component of infant attachment security to be essentially 0% (e.g., Bokhorst et al., 2003), genetic transmission is unlikely to explain the associations identified here. Similarly, our finding that mothers' physiological responding was associated with infant avoidance independent of observed emotional responding provides little support for the role of emotional contagion in explaining this association. Given evidence linking infant attachment with physiological responding during the SSP (see Fearon, Groh, Bakermans-Kranenburg, Van IJzendoorn, & Roisman, 2016), the idea that maternal physiological responding might contribute to infant attachment behavior by influencing infant physiological responding is intriguing and warrants further investigation.

To the best of our knowledge, the developmental origins of infant attachment as measured by the dimensional approach identified by Fraley and Spieker (2003) have yet to be examined (but for associations between infant attachment dimensions and adult attachment representations, see Groh, Roisman, Booth-LaForce, et al., 2014). This is arguably an important task given that the retrodictive validity of the SSP in terms of having its origins in the caregiving environment is one of the main factors contributing to its consideration as a "gold-standard" attachment measure. Thus, in addition to replicating the bidimensional factor structure identified by Fraley and Spieker and extending prior evidence to an ethnically and economically diverse sample, this study provided the first evidence that avoidance and resistance dimensions were uniquely predicted by distinctive aspects of mothers' responding during distressing caregiving contexts.

Moreover, findings from this study demonstrate some benefits of the dimensional approach. Specifically, because all infants receive scores on the attachment behavioral dimensions comprising the resistance dimension, the dimensional approach does not suffer from the problem often confronted by researchers of having too few infants classified as resistant to conduct proper statistical analyses due to the low base rate of resistant attachment. Similarly, Fraley and Spieker (2003) have argued that the dimensional approach might improve statistical power because applying a categorical structure to individual differences that vary continuously and not accurately capturing the factor structure of attachment can compromise power. Although these issues would not be expected to influence the significance of findings in large, well-powered studies, differences between the dimensional and categorical approaches would be expected in small/moderate-sized samples, as was the case in this study. As the majority of studies on attachment comprise relatively small/moderate-sized samples, our findings highlight the usefulness of the dimensional approach for improving statistical power in such studies.

### *Limitations and Future Directions*

In this study, physiological data used to index RSA were sampled from mothers, limiting our focus to mothers' parasympathetic (i.e., RSA) responding to infant distress. However, the growing literature on the psychophysiology of attachment has provided evidence that individual differences in adult attachment are associated with brain activity and autonomic (both sympathetic and parasympathetic) responding to infant distress (Ablow et al., 2013; Groh & Roisman, 2009; Groh, Roisman, Haydon, et al., 2015; Riem, Bakermans-Kranenburg, Van IJzendoorn, Out, & Rombouts, 2012; Schoenmaker et al., 2015; but see Leerkes et al., 2015). Thus, future research might examine a broader range of measures of mothers' physiological responding in relation to infant attachment (see Leerkes, Su, Calkins, Supple, & O'Brien, 2016 for a similar argument with regard to links between maternal physiological and behavioral responding). Because evidence from this study suggests that mothers' RSA withdrawal is uniquely related to infant avoidance, future research might explore other aspects of mothers' physiological responding to infant distress that would be expected to be uniquely related to resistance.

Although findings from this study highlight some benefits of Fraley and Spieker's (2003) dimensional approach, we would be remiss if we did not highlight at least two caveats. First, although we replicated the factor structure identified by Fraley and Spieker (2003) in an ethnically and economically diverse sample, due to the modest sample size (due to attrition, which, although the full and current samples did not differ on study variables, is a limitation of this study), we were unable to perform formal statistical analyses to examine measurement invariance across ethnic and economic groups (see Haltigan et al., 2013 for an example with adult attachment). Second, although it is noteworthy that, similar to Fraley and Spieker (2003), indicators of resistance and disorganization loaded onto the same factor, both the NICHD SECCYD (the sample used by Fraley and Spieker) and the current sample would not be considered high risk and, thus, would not be expected to yield higher rates of disorganization. Indeed, the percentage of infants classified as disorganized (14%) is in line with estimates of disorganization in normal population samples from recent meta-analyses (16%; Groh et al., 2017). This is notable, as the resistance and disorganization scales might be distinguished in higher risk samples in which greater variation in such attachment behavior is observed. Thus, in addition to further examining the antecedents and correlates of infant attachment dimensions and comparing findings to those achieved with the traditional categorical system, the issues noted here should be addressed by future research to rigorously evaluate the dimensional approach.

### *Conclusion*

Findings from this study suggest that mothers' physiological self-regulation when confronted with an attachment-relevant challenge is uniquely tied to infants' tendency to seek out (vs. avoid) the mother as a secure base and safe haven in times of uncertainty, whereas mothers' muted affective responding within a distressing caregiving context is uniquely related to infants' heightened expression of attachment-relevant distress. Such evidence highlights the usefulness of a biobehavioral approach and careful consideration of the caregiving context in teasing apart distinctive correlates of insecure attachment patterns and might inform more targeted efforts aimed at promoting attachment security. Indeed, these findings suggest that such efforts might specifically focus on mothers' responding within distressing caregiving contexts and on specific challenges mothers face (e.g., physiological self-regulation, affective expression) within such contexts. In addition, although the field has been slow to embrace Fraley and Spieker's (2003) dimensional approach, findings from this study provided evidence in favor of using the avoidance and resistance dimensions. Indeed, our findings suggest that leveraging the dimensional approach can contribute to the identification of unique associations that might not otherwise have been detected with the traditional categories. Such evidence is encouraging and suggests that further research employing the infant attachment dimensions might provide a richer understanding of the distinctive antecedents and sequelae of avoidant and resistant attachments.

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## Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's website:

**Table S1.** Regression Analyses of Mothers' Physiological and Observed Emotional Responding Within Distressing and Nondistressing Caregiving Contexts Predicting Infant Attachment Dimensions