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Responding to Distressed Infants: Does Mothers' Positive Versus Negative Affect Matter for Infants' Behavior and Physiology?

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M.A., Emory University, 2017
B.A., Williams College, 2012

Advisor: Sherryl H. Goodman, Ph.D.

An abstract of
A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
in partial fulfillment of the requirements for the degree of
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Abstract

Responding to Distressed Infants: Does Mothers' Positive Versus Negative Affect Matter for Infants' Behavior and Physiology?

By Meeka S. Maier

How mothers respond to infants' distress has implications for infants' development of self-regulation and social competence. In a sample of 35 mothers and their 4- to 8-month-old infants, the current study evaluated the question of how different maternal affective responses to infant distress might directly predict infant recovery from that distress. Using a within-subjects design, we induced infant distress using an arm restraint task and compared infants' observed affect and physiological responses under two conditions: 1) when mothers were instructed to respond with positive affect and 2) when mothers were instructed to respond with negative affect. Based on theoretical and empirical support that suggest that mothers should match their infants' negative affect, we predicted that infants' duration of negative affect would be shorter, infants' average affect intensity would be less negative, and infants' respiratory sinus arrythmia (RSA) withdrawal would be lower when mothers respond with negative, relative to positive affect. Opposite to our hypotheses, we found evidence in support of alternative theory that suggests that mothers' display of mild positive affect when infants are distressed may be helpful for infants. Results showed that when mothers responded to their distressed infants with negative affect versus positive affect, infants spent significantly more time in negative affect, their intensity of expressed negative affect was greater, and their RSA withdrawal was greater. The current findings, with the strength of the experimental design, add to accumulating evidence that the way in which mothers respond with their affect to their distressed infants can produce observable differences in infants' duration and intensity of negative affect, as well as their physiology. Findings have the potential to inform future research that investigates how mothers can most effectively reduce their infants' distress and intervention that targets the moment-to-moment behaviors in mother-infant reciprocal interactions.

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Responding to Distressed Infants: Does Mothers' Positive Versus Negative Affect Matter for Infants' Behavior and Physiology?

Maternal sensitivity has long been defined as the appropriate and timely responsiveness to infants' cues, which depends on mothers' ability to notice and understand her infant's signals (Ainsworth, 1979). Mothers' sensitive parenting during infancy plays an important role in the development of infants' social, emotional, behavioral, physical health, and physiological processes. Bowlby (1969/1982) and Ainsworth, Blehar, and Waters (1978) theorized that the extent to and consistency with which mothers parent sensitively contributes to how infants view themselves relative to the world, whereby: 1) infants whose needs are responded to appropriately and consistently develop a view of the self as worthy and others as those they can trust to help meet their needs and 2) infants whose needs are not responded to consistently or at all develop a view of the self as unworthy of care and others as those who cannot be trusted for help and support. Thus, mothers' early sensitivity has been understood to be critical for establishing infants' relational expectations.

Consistent with this theory, meta-analytic reviews have shown moderate relationships between maternal sensitivity and infants' secure attachment (De Wolff & Van Ijzendoorn, 1997; Verhage et al., 2016), with secure attachment being subsequently linked to the later development of internalizing and externalizing symptoms, and social competence (Groh, Fearon, van IJzendoorn, Bakermans-Kranenburg, & Roisman, 2017). Others have found sensitive parenting within the first year of life to be directly associated with social behaviors and externalizing symptoms of 2-3 year-old children (Leerkes, Blankson, & O'Brien, 2009) and internalizing problems during preschool years (Kok et al., 2013). Sensitive parenting over the first three years of life has also been found to predict long term outcomes, such as social competence at multipletimepoints through age 15 (Fraley, Roisman, & Haltigan, 2013), academic functioning from early childhood to adulthood (Fraley et al., 2013; Raby, Roisman, Fraley, & Simpson, 2015), and obesity at 15 years of age (Anderson, Gooze, Lemeshow, & Whitaker, 2012). Physiologically, maternal sensitivity during infants' first year of life has been related to infants' neurobiological regulation of their stress response system (Conradt et al., 2016; Gunnar & Quevedo, 2007). Given that maternal sensitivity predicts a host of concurrent and prospective child functions related to well-being, it is essential to understand the specific maternal behaviors that characterize appropriate responsiveness to infants' signals.

Sensitivity to Infant Distress versus Nondistress

The consensus on the importance of mothers' sensitivity to their infants, as just described, treats sensitivity as a single construct. Yet some have argued for the need to consider, differentiate, and specify parents' qualities of sensitivity and child outcomes based on the situation in which sensitivity is assessed (Grusec & Davidov, 2010). Grusec and Davidov (2010) argued for the need to "unpack" the construct of socialization broadly, and parental responsivity specifically, in order to identify what is effective parenting in different domains of socialization. One of those domains is "protection," a domain that is initiated by child distress cues, which subsequently elicits parent help or support. It was this aspect of sensitive responding that Ainsworth described when referring to caregivers responding sensitively to children's need for protection. That is, parents responding sensitively to children's needs for protection facilitates children's developing sense of security and of the reliability of caregivers, and ultimately contributes to children's ability to self-regulate their distress. Conversely, parents' responding insensitively in these situations contributes to children's developing sense that parents are not reliable sources of support and to challenges in self-regulation. Given that parenting with protection and comforting would not be appropriate when the child is not distressed, i.e. in need of protection, then knowledge of sensitive parenting studied in other contexts or domains is not likely to generalize to the protection domain.

Researchers find mothers' sensitivity to infants' nondistress and distress to be related, but distinct constructs (Leerkes, 2011; Leerkes, Weaver, & O'Brien, 2012). Though sensitivity in both the context of nondistress and distress involves mothers' appropriate and prompt responding to infant signals, sensitive responsiveness in nondistress situations facilitates learning and reciprocal interaction goals, while sensitivity to infants' distress (typically sadness, fear, or anger) facilitates goals of support and comfort (Leerkes et al., 2012). Further, infants' distress versus nondistress signals relate differently to caregivers' hormone and brain processes (Groh & Roisman, 2009; Pechtel, Murray, Brumariu, & Lyons-Ruth, 2013; Swain et al., 2012) as well as to their emotional and cognitive responses (Leerkes et al., 2012), all of which may influence the way in which mothers interpret and respond to their infants.

Given the propensity for mothers' sensitivity to facilitate different goals depending on whether the infant is in nondistress or distress, and the understanding of the importance of considering parenting domains, researchers recently have considered maternal sensitivity with respect to the situation in which the mother is responding to the infant and found situationally-dependent outcomes. Greater maternal sensitivity in the context of infant distress (i.e. appropriate and timely responsiveness to infants' distress), but not nondistress (i.e. appropriate and timely responsiveness to infants' social gestures, expressions, and cues), when infants were 6-months-old predicted a greater likelihood of being securely attached at 15 months (McElwain & Booth-LaForce, 2006), as well as more positive social behaviors at 24 months of age and fewer behavioral problems at 24 and 36 months (Leerkes et al., 2009). Further, Leerkes and

Zhou (2018) found that greater maternal sensitivity to 6-month-old infant distress predicted attachment security among 12-month-old infants with high, but not low, negative emotionality, while sensitivity to nondistress did not predict attachment security, alone or in interaction with negative emotionality. Thus, mothers' responses to infants' distress, compared with those to nondistress, may have more influence on infants' later social, emotional, and behavioral development.

Mothers' Affective Responses to Infants' Distress: Theory and Empirical Findings

Despite the understanding of the importance of the goal that sensitivity to distress serves in facilitating comfort and support of the infant (i.e. the role of parents in helping infants to regulate their emotional responses in the face of distress), it is not clear *how* mothers should best respond to infants' distress, in terms of the mothers' own affect expression. That is, when mothers attempt to bring their infant out of negative affect, should mothers match their infants' negative affect or turn to positive affect?

Mothers may respond to their infants' distress with gestures as well as affect, and several researchers have examined contingencies between specific maternal touch behaviors and shifts in infant affect (Egmose, Cordes, Smith-Nielsen, Væver, & Køppe, 2018; Gusella, Muir, & Tronick, 1988; Jean & Stack, 2009). Yet, there are several reasons to suggest that a specific focus on mothers' affect, relative to their actions, is important in order to understand how mothers' responses to infant distress may be experienced by the infant as sensitive or insensitive. First, affective expressions have been proposed to play a critical role in facilitating communication between infants and mothers before they develop language capabilities, thereby serving as a way in which the infant may learn about emotions and intentions (Cassidy, 1994; C. A. Nelson & Dolgin, 1985). By two months of age, infants are able to read and respond to facial displays, and by six months, infants develop social expectations based on their caretakers' facial cues and are capable of making connections between current and previous face-to-face interactions (Rochat & Striano, 1999). Second, within and around the second half of the first year of life, infants tend to seek out and use information from their mothers' facial expressions to inform what is safe or harmful in their environment (Sorce, Emde, Campos, & Klinnert, 1985), they demonstrate the ability to discriminate between different affective expressions (C. A. Nelson & Dolgin, 1985), and this ability to differentiate between and attend to affective expressions has been found to be related to specific brain systems (Leppänen & Nelson, 2009). As such, mother-infant affect responses play an essential role in infants' development of socio-emotional functioning (Izard, 2009; Malatesta & Haviland, 1982) and it is therefore important to separately examine the role that variations in maternal affect during infant distress may play in influencing infants' behavioral and physiological responses.

Mothers' Negative Affect

In terms of mothers expressing negative relative to positive affect in response to infant distress, two theories, the Mutual Regulation Model (Gianino & Tronick, 1988) and the Social Biofeedback Model of Affect-Mirroring (Gergely & Watson, 1996, 1999) propose that dyadic partners, including infants, have an expectation of being affectively matched, even when in negative affect states; the affective matching functions to communicate the partner's (mother's) understanding of the other's (infant's) "feeling state" (Beebe & Lachmann, 1988). Beebe and Lachmann (1988) assert that matching a partner's affect allows for the connection of emotional understanding between the two partners and contributes to the development of feeling "understood," "known," or "involved," and is related to empathy. Beebe et al. (2010) suggest that infants store models of interaction dynamics by noting affective cues of a partner and whether or not that affect is matching theirs; these stored models subsequently contribute to the way in which infants organize their early understanding of "procedural representation." In an effort to further clarify mother-infant interactions when infants are distressed, Gergely and Watson (1996) emphasize the importance of mothers' mirroring of the infants' negative affect being intentional, i.e. reflecting the infant's state (and not the parent's state), which they label as being "marked" affect displays. Mothers' "marked" affect displays may serve to modulate infants' negative affect as infants perceive this response to be associated with their own emotional state (Gergely, 2004). Thus, there is strong theoretical support for mothers' contingent matching of their infants' negative affect (i.e. baby negative affect followed by mother negative affect) being positively associated with infants' development of emotion regulation.

Researchers have linked matching affect to greater empathy. Beebe and Lachmann (1988) discussed that taking on the same facial expression of a partner elicits a similar physiological state in the other partner, which allows the partner to understand and take part in the other's emotional state. Wiesenfeld, Whitman, and Malatesta (1984) found that females who were categorized as being high on empathy were more likely to respond to 5-month-old crying infants with matching affect, relative to a low empathy group.

Mothers' matching of infants' negative affect may also be a validating response. Validating responses communicate to others that their responses (feelings, experience, thoughts, desires, actions, and/or sensations) make sense and are understandable (Hall & Cook, 2012; Linehan, 1993), whereas invalidating responses communicate to others that their experiences are not understandable, or wrong (Fruzzetti & Worrall, 2010). In studies of adults, validating responses tend to decrease another person's negative reactivity (i.e., negative affect, heart rate, and skin conductance), and invalidating responses tend to prolong or worsen another person's negative reactivity (Shenk & Fruzzetti, 2011). Since validation can be communicated through facial expressions (Hall & Cook, 2012), mothers responding to their distressed infant with mild negative affect may be a nonverbal signal of validation and may serve to decrease infants' negative reactivity.

We found no studies that separately assessed mothers' affect responses to their infants' distress. In one study that is related, but did not include a distress task, the authors found that when one-year old infants were presented with a pleasant toy, an ambiguous or strange toy, and an aversive toy, mothers' positive affect, versus neutral affect, in response to the ambiguous toy (but not the pleasant or aversive toy) was associated with infants' greater positive responses (Gunnar & Stone, 1984). Therefore, it may be that mothers' positive affect during aversive events is not helpful for infants' affect regulation, and perhaps mothers' mirroring the infants' negative affect is more important in these situations. These authors, however, did not include a condition in which mothers expressed negative affect in response to their infant encountering each toy, so a direct comparison of positive versus negative affect response cannot be made.

Mother's Positive Affect

In contrast to the theories that suggest that mothers should match their infants' negative affect, there is also theory that suggests that mothers' displaying mild positive affect when infants display distress may be helpful for infants. Bloom (2016, 2017a, 2017b) argues for distinguishing empathy, which he defines as matching one's feelings to those of another (also known as emotional or affective empathy), from compassion, defined as concern for others and hope that they are well and free from distress. Bloom asserts that when individuals are suffering or struggling, it is not helpful for someone to support them by taking on those same feelings and suffering/struggling with them. Instead, he claims, they need compassion – calm support and caring – and sometimes even a bit of the opposite emotion (e.g. cheer). To relate this to an example within mother-infant interactions, Bloom would likely maintain that if babies are crying because they are confined and cannot reach a desired object, mothers would be most helpful to their infant's emotion regulation effort by expressing at least mildly positive affect in a composed and caring manner, relative to using empathy and responding to the baby's distress with their own expression of frustration or sadness.

Also in terms of mothers expressing positive, relative to negative affect in response to infant distress, mothers' modeling of positive affect when infants are expressing negative affect may help to bring infants into positive affect. Based on social referencing theory and empirical work, mothers can influence infants' perceptions and responses to situations (Feinman, 1982). Feinman (1982) defined social referencing as the act of using another person's interpretation and perception of a situation to understand the event. The information about another person's perception and interpretation does not need to be explicitly stated, and young infants who do not yet have the capacity to understand verbal information mostly acquire social referencing information from nonverbal cues (Feinman, 1982).

Social referencing has typically been studied in the context of infants searching for information about how to perceive and respond to novel or ambiguous events, such as a visual cliff (Sorce et al., 1985), and mechanical toys (Gunnar & Stone, 1984; Rosen, Adamson, & Bakeman, 1992; Walden & Ogan, 1988), and findings from these studies support the idea that infants use the affect of their partners to inform their responses in novel and ambiguous situations. The process of social referencing has been described as having multiple steps: first, infants search for information about their partners' perception of situations, next the partner displays an affective response, then, infants react to the situation in a manner that is in line with their partners' expressed message (Rosen et al., 1992). Though we found no published studies that investigated social referencing during infancy following a distress-eliciting situation, it is possible that distressed infants use social referencing to understand from their parents how they should respond. Mireault et al. (2014) found that in response to an ambiguous event, 6-month-old infants were more likely to smile at their parent (but not at the ambiguous stimulus) after referencing their parent. Thus, if mothers are displaying positive affect when their distressed infants are expressing negative affect, infants may change to positive affect to be in line with their mother.

Despite these arguments in favor of responding to infants' distress with positive affect, we found no studies that examined the effect of mothers' positive affect in response to infants' distress on infant outcomes. Kiel, Gratz, Moore, Latzman, and Tull (2011) found that in response to 12- to 23-month-old infants' distress during the strange situation, mothers were more likely to respond to their infants' distress with positive affect than negative affect. Though this study did not examine subsequent infant affect or physiology based on these two responses, these authors provide information that mothers do tend to use positive affect in the face of their infants' distress. This observational finding further supports the importance of understanding the influence that this response has on modulating their infants' distress, versus mothers' responding with negative affect.

Summary: Mothers' Negative versus Positive Affect

Overall, both theory and limited empirical data support that mothers should match their infant's negative affect as a sensitive way of managing their distress. Moreover, when weighing the evidence for mothers' showing negative, relative to positive affect in response to their infants' distress, it should be noted that there is more infant-specific theoretical and empirical weight in support of mothers' negative affect response being more effective in decreasing infants' distress. In contrast, support for mothers' positive affect response being more effective comes for a theory of empathy versus compassion, from which we speculate how it may be relevant to infants, and from infant literatures that are not specific to studies of infant distress.

Nonetheless, there are several limitations to being able to draw conclusions from the empirical studies. These include the situation in which infant negative affect is assessed (i.e. most researchers observing interactions that typically elicit few infant distress signals, as discussed further below), and composite measures of maternal responses that preclude us from having a conclusive understanding of the role that mothers' negative affect may play in response to infants' distress. The current study design addressed each of these limitations.

Infants' Physiological Responses During Distress

Although observations of infants' behavior, such as their duration and intensity of observed distress, provide important information about their ability to regulate emotion, a more comprehensive understanding of infants' efforts at emotion regulation includes their physiological responses. A routinely studied physiological indicator of emotion regulation is cardiac activity, including in studies of infants. Cardiac vagal tone is a standard index of emotion regulation, which has been measured via the amplitude of respiratory sinus arrhythmia (RSA). RSA is an index of parasympathetic nervous system control of the heart. Amplitude changes are detected in response to challenging environmental sensory, cognitive, and visceral demands and reflect emotion, communication, and motion activity (Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). Vagal tone maintains homeostasis and modulates metabolic output in response to challenging environmental demand (Porges, Doussard-Roosevelt, & Maiti, 1994).

Studies with infants in environmentally challenging situations have measured vagal withdrawal, i.e., a decrease in RSA during times when regulating emotion and coping, when the vagus nerve signals to the heart to prepare to respond to the environment (Porges, 2007). That is, a decrease in RSA from baseline during distress reflects decreased vagal nerve input and increased sympathetic nervous system engagement. In nondistress situations, however, the vagus nerve increases the parasympathetic system and decreases the sympathetic system for relaxation. Researchers typically calculate RSA withdrawal as baseline RSA minus RSA that is measured during a distress task and interpret RSA withdrawal as providing an index of extent of physiological response to distress. Taking this approach, some studies have found evidence of vagal withdrawal during a distress-eliciting task, the still-face episode within the still-face paradigm (Bazhenova, Plonskaia, & Porges, 2001; Moore & Calkins, 2004; Weinberg & Tronick, 1996). Thus, vagal withdrawal may be used an index of physiological regulation for infants during distress.

Infants' vagal withdrawal may also relate to their mothers' degree of sensitivity. Perry (2015) examined vagal withdrawal during another common distress-eliciting task, the arm restraint task, and found that, after controlling for infants' vagal withdrawal at 5 months of age, greater maternal sensitivity when infants were 5 months old predicted greater vagal withdrawal at 10 months. Therefore, infants' developing physiological regulation may be associated with the way in which mothers respond to their distressed infants.

Relations between Infants' RSA and Behavior

Researchers have investigated associations between infants' observed affect and RSA during distress inducing tasks, such as the still-face. The typical infants' RSA pattern - decreasing from baseline to the still-face episode and then increasing during the reunion segment

(Moore et al., 2009) - tends to parallel infants' affect changes. That is, infants' negative affect increases from baseline to the still-face episode, then decreases during reunion (Mesman, van IJzendoorn, & Bakermans-Kranenburg, 2009; Qu & Leerkes, 2018). However, some authors have identified subgroups of infants who exhibit patterns that differ from these general findings. Moore and Calkins (2004) found that among a group of infants, all of whom exhibited elevated levels of negative affect during the still-face, infants had different physiological responses, whereby some demonstrated RSA withdrawal and others did not. Qu and Leerkes (2018), using a person-centered approach, identified four negative affect-RSA profiles across still-face episodes: 1) "highly distressed, but regulating"; 2) "over-regulated"; 3) "resilient to distress; and 4) "under-regulated", whereby profiles 1 and 4 showed significantly greater negative affect than profiles 2 and 3, and profiles 3 and 4 showed significantly greater RSA. Thus, though RSA withdrawal tends to match patterns of negative affect on average, researchers find that it does not appear to directly link with facial expressions at an individual level. Therefore, RSA withdrawal cannot be assumed by infants' affect and it is important to account for variability across infants when examining RSA withdrawal during distress tasks.

Distress Eliciting Paradigms

It is important to explore questions about mothers' affective responses to infant distress in the context of a distress task, rather than free-play, given that the typical play context of mother-infant observed interactions relies on the spontaneous occurrence of infant distress and infant negative affect typically is observed with low frequency (Beebe et al., 2010). Researchers have turned to distress-inducing tasks to increase the likelihood of observing infant negative affect. Those most commonly used for this purpose include: 1) an arm restraint procedure designed to elicit frustration, adapted from Goldsmith and Rothbart (1996), during which an experimenter (while kneeling in front of the seated infant) holds down the forearms of the infant; 2) The Face-to-Face Still-Face paradigm, designed to elicit distress due to violation of social expectation, during which, after playing with their infant for two minutes, mothers take on a still face for two minutes, followed by a two minute reengagement (Tronick, Als, Adamson, Wise, & Brazelton, 1978); 3) a novel toy procedure designed to elicit fear, during which a remote-controlled vibrating truck with flashing lights and sound approaches the infant three times, also adapted from Goldsmith and Rothbart (1996); and 4) procedures in which mothers help their infant become interested in a toy, then the toy is taken away from the infant and placed out of his/her reach (e.g., plastic barrier task, maternal prohibition task) (Calkins, Dedmon, Gill, Lomax, & Johnson, 2002). Though these designs are typically used to elicit infant distress in order to study infant responses, researchers have only recently begun to also observe maternal behaviors during these tasks, in an effort to understand predictors and outcomes of maternal sensitivity to their infant's distress (Leerkes, 2010; Leerkes et al., 2015; Norcross, Leerkes, & Zhou, 2017). Yet, to our knowledge, no study has examined maternal affect during infant distress in relation to the duration of infants' negative affect, infants' expressed affect intensity, and/or physiological response during a distress-eliciting task.

Thus, an important next step in this line of research is to compare distressed infants' affect and physiological responses when mothers respond to infants' distress with positive affect versus negative affect. Such information is important to better understand how mothers might best respond to infants' expressed negative affect (distress) in order to support infants' developing self-regulation abilities and social competencies by facilitating their sense of security and ability to self-regulate their distress, as well as teaching infants about others' emotions and intentions and what is safe or harmful in their environment. Although negative affect or distress might be defined as including fear, sadness (cry/fuss), and/or frustration, for the purposes of this study, we focused on mothers' responses to infants' frustration. We justified this selection based on three sets of findings: 1) infants experience frustrations regularly (e.g. unable to reach desired objects when they are confined) (Braungart-Rieker & Stifter, 1996), 2) the way in which infants regulate their distress during frustration is related to their level of negative affect (Buss & Goldsmith, 1998; Calkins & Johnson, 1998; Stifter & Braungart, 1995), and 3) frustration level has been linked with RSA withdrawal (Calkins et al., 2002).

Measurement of Sensitivity

With regard to measurement of sensitivity, researchers typically use global rating scales or micro-level coding of observed interactions (Bernard, Meade, & Dozier, 2013; Goodman, Bakeman, McCallum, Rouse, & Thompson, 2017; Leerkes, 2010). Following in the tradition of Ainsworth (1969), global rating scales are particularly common approaches to characterize mothers' responses to their infants during face-to-face play interactions, with observers assigning a rating reflecting the degree to which sensitive responsiveness was present during the designated interaction segment (Moore et al., 2009; NICHD, 1997). Despite the strengths of this approach, these ratings are unable to capture moment-by-moment mothers' sensitive responsiveness to their infants' nondistress and distress. Recent studies that have examined mothers' responses to infants' distress during distress-eliciting tasks typically study mothers' responses by merging affective responses with other maternal behaviors, such as touch, vocalizations and intrusiveness, thus precluding the ability to draw conclusions about mothers' affective responses per se (Crockenberg & Leerkes, 2004; Leerkes, 2011; Pratt, Singer, Kanat-Maymon, & Feldman, 2015).

Micro-level coding, on the other hand, allows for the continuous investigation of these moment-by-moment behaviors and provide ways to take infant affect into consideration. As one example of such an approach, Leerkes and colleagues continuously coded mothers' behaviors (negative, intrusive, mismatched affect, withdraw, distracted, persistent ineffective, monitor, task focused, calming, etc.) and infants' affect. From the coded data, they then rated each maternal behavior on a 3-point scale, *insensitive* (1), *moderate* (2), and *sensitive* (3), taking the infants' affect into consideration, and then computed an average of the ratings of the behaviors across the interaction (Leerkes, 2010; Norcross et al., 2017). For example, a mother who withdraws from the interaction when her infant is displaying negative affect would score a 1 (insensitive) for that withdrawal behavior. Similarly, Norcross et al. (2017) defined one type of insensitivity by creating a composite of "overtly negative maternal behavior," which consisted of the percentage of time mothers mismatched their infants' affect (e.g. mom laughing while infant distressed), or engaged in negative (e.g. mom directing negative affect toward infant), intrusive (e.g. mom forcing own agenda onto infant), or persistent ineffective behaviors (e.g. continuing to soothe infant in the same way without trying a new method when infant remained distressed).

These approaches to micro-level coding take an important step toward examining specific aspects of sensitivity, in this case, negative maternal behaviors, but they nevertheless result in a sensitivity score that reflects both mothers' affect and actions, and thus lose the distinction between them. There are limitations to interpreting findings from this approach of taking both affect and action into consideration. For example, a mother may respond to her infant with mismatched affect, but not be intrusive, while on the other hand, a mother may respond to her infant with matched affect, but be highly intrusive. Thus, it is not clear from these composite scores if one category (e.g., affect or actions) is contributing more or less than the other category to the composite sensitivity score.

For the purposes of the current study, we focus on differentiating between mothers' positive affect and their negative affect, with the goal of better understanding infants' responses to mothers' positive relative to negative affective responses when infants are distressed. Despite the strength of knowledge gained with rating scale measures of parenting qualities, only coding of affect enables answering specific questions related to infants' moment-by-moment responses to their mothers' positive or negative affect responses when their infants are expressing distress. The latter approach is particularly well suited to answer a question that is a logical next step in this line of inquiry: can parents elicit different responses from infants who are expressing negative affect by responding to them with their own negative affect versus positive affect? Thus, we examine infants' affect and physiological responses during a controlled manipulation of mothers' affect in the context of a distress task.

Current Study

This study aimed to investigate the question: How can mothers, through their affective expressions, most effectively minimize their infant's observed negative affect and RSA withdrawal during distress? We sought to do so by relying on a paradigm designed to elicit infants' distress, thereby increasing the likelihood of observing infant negative affect, relative to play contexts. This paradigm offers an opportunity to examine questions about what role mothers' affective responses might play in mitigating versus exacerbating infants' duration and intensity of negative affect and cardiac activity during distress. Examining infants' behavior and physiology during a frustration task has the potential to reveal differences in distressed infants' responses to their mothers' positive relative to negative affective responses.

Studies to date have yielded support, both empirically and theoretically, for the importance of how mothers respond to infants' distress, with implications for infants' development of self-regulation and social competence. Infants' behavior (duration and intensity of distress) and physiology (RSA withdrawal) following mothers' particular affective response to their distress have the potential to reveal important indications with regard to whether one type of affective response might do a better job of decreasing infant distress relative to the other. Yet we found no published study of maternal sensitivity that investigated specific maternal affective responses to infant distress in relation to infant behavior and physiology. Rather, researchers relied on composite measures of maternal sensitivity or negative maternal behavior that combined maternal affect and actions. Thus, studies to date have been unable to answer the important question of how different maternal affective responses to infant distress might directly predict infant behavioral and physiological recovery from distress.

The current study took this important next step in this line of research, i.e. to examine infants' behavior and physiology following their mothers' positive relative to negative affect expression in response to their distress. Specifically, we investigated how distressed infants respond behaviorally (duration of negative affect and intensity of expressed affect) and physiologically (RSA withdrawal) under two varying conditions: 1) when mothers match infants' negative affect, perhaps in an effort to show an empathic or validating response; versus 2) when their mothers respond with opposite affect and display positive affect (close to that of joy and cheer), perhaps in attempt to be compassionate or to model positive affect. To fill the several identified gaps in the literature, and to move the field beyond the predominant reliance on correlational studies, we implemented a within-subject design, experimentally manipulating mothers' affective responses to their infants' induced distress by assigning mothers to respond, separately, with positive and negative affect during an arm restraint task, designed to elicit infant frustration. The arm restraint task has been descriptively shown to elicit a moderate level of distress intensity and a relatively low latency to fuss or cry (Calkins et al., 2002).

We tested the study aims and hypotheses on infants between the ages of 4-8 months. This sampling strategy was based on knowledge that infants in this age range are capable of interacting actively with another person (Rochat, 2009) and are typically able to identify varying facial expressions (Bornstein & Arterberry, 2003; Ludemann & Nelson, 1988). Further, infants have the developed ability to control their arms by around 5 months of age, therefore the arm restraint task is effective at eliciting frustration (Camras, Oster, Campos, Miyake, & Bradshaw, 1992), as has been demonstrated in its previous use with infants this age (Kuzava & Bernard, 2018).

We also examined several factors that may influence the way in which distressed infants respond to their mothers' positive versus negative affect during frustration tasks, beyond the mothers' affect expression per se. One possible factor is infants' age. Even within the relatively narrow age range that we selected for this study, infants are rapidly developing. For example, they are increasingly becoming sensitive to caregivers' facial expressions. Second, infants' negative emotionality increases across the first year of life (Gartstein, 2003). Infants who are higher in negative emotionality may react more strongly when frustrated and may be more or less reactive to their mothers' subsequent affect; moreover, high negative emotionality infants may be accustomed to less sensitive parenting, given that researchers find infant negative emotionality to be associated with mothers' less sensitive parenting (Paulussen-Hoogeboom, Stams, Hermanns, & Peetsma, 2007). A third possible set of factors that may influence distressed infants' responses are mothers' current depressive symptom level and their trait-level positive and negative affective states. Higher depressive symptoms in mothers of infants are associated with their being less sensitive (Bernard, Nissim, Vaccaro, Harris, & Lindhiem, 2018). Despite these bases for concern about sensitive parenting in mothers with elevated depressive symptoms, in a community sample, in which depressive symptom levels are likely to be low, positive and negative affect may better capture the relevant individual differences than symptom levels. Researchers find that low positive affect and high negative affect are positively associated with depressive symptoms (Watson, Clark, & Tellegen, 1988) and, even in the absence of depressive symptoms, may explain important differences in parenting behaviors (Lovejoy, Graczyk, O'Hare, & Neuman, 2000). Fourth, the affect that mothers typically display with their infants’ during free play and when their infants are distressed (e.g., with positive versus negative affect), i.e., what response they are used to, may influence the way in which infants respond when exposed to their mothers’ experimentally manipulated positive and negative affect in the lab. We considered each of these factors as possible covariates and expected that mothers’ expressed positive and negative affect would account for additional variance beyond the effect of any of these factors.

In contrast to factors for which there is empirical evidence to support an expectation that they may influence distressed infants’ responses to their mothers’ expressed affect, there is little empirical support for infants’ biological sex playing a role in influencing the way in which distressed infants respond to their mothers’ positive versus negative affect. There exists evidence that females show more self-regulatory behaviors during distress (Calkins et al., 2002; Weinberg, Tronick, Cohn, & Olson, 1999); however, there is little evidence to support sex differences as they relate to infants’ responses to distress and mothers’ sensitivity to infant distress during the first year of life. Braungart-Rieker and Stifter (1996) did not sex find differences in infants’ affective response to frustration during distress tasks. Similarly, Gartstein (2003) and Else-Quest, Hyde, Goldsmith, and Van Hulle (2006) found that sex differences in parent reports of negative emotionality were specific to fear. Leerkes and Zhou (2018) did not find associations between sex and maternal sensitivity to distress. Further, Moore et al. (2009) did not find sex differences in RSA during the face-to-face still-face paradigm. Thus, we had inadequate bases for expecting sex differences and examined them solely for confirmation of what others had reported.

Specific Aims

Aim 1. Compare distressed infants' behavioral response (duration of negative affect and average affect intensity) when their mothers respond with positive relative to negative affect.

Hypothesis 1. Because there was more infant-specific theoretical and empirical weight in support of mothers' negative affect response being more effective in decreasing infants' distress, we predicted distressed infants' duration of negative affect would be smaller and infants' average affect intensity would less negative when mothers respond with negative affect versus positive affect. We based this hypothesis on (a) theoretical support for the Mutual Regulation Model (Gianino & Tronick, 1988), (b) the Social Biofeedback Model of Affect-Mirroring (Gergely & Watson, 1996, 1999), (c) theoretical links between mothers' affective matching and validation (Hall & Cook, 2012), and (d) theoretical and empirical connections between matching affect and empathy (Beebe & Lachmann, 1988; Wiesenfeld et al., 1984).

Aim 2. Compare distressed infants' physiological responses (RSA withdrawal) when their mothers respond with positive relative to negative affect.

Hypothesis 2. Because there was more infant-specific theoretical and empirical weight in support of mothers' negative affect response being more effective in decreasing infants' distress, we hypothesized that distressed infants' vagal withdrawal would be lower when mothers respond with negative affect versus positive affect, thus indicating a less challenging environment. We based this hypothesis on (a) theoretical support for the mutual Regulation Model (Gianino & Tronick, 1988), (b) the Social Biofeedback Model of Affect-Mirroring (Gergely & Watson, 1996, 1999), (c) theoretical links between mothers' affective matching and validation (Hall & Cook, 2012), and (d) theoretical and empirical connections between matching affect and empathy (Beebe & Lachmann, 1988; Wiesenfeld et al., 1984), and (e) taking into consideration that vagal withdrawal tends to increase in the face of environmental challenges in an effort to initiate coping behaviors and decreases when environmental demands decrease.

Approaches to Analyses

We planned preliminary analyses to identify any potential covariates and assess skew in our dependent variables. To identify possible covariates, first we planned to generate Pearson's correlations between a set of potential covariates that are continuous variables: infant age, infant negative emotionality, maternal depressive symptoms, maternal trait negative and positive affect, mothers' duration and average intensity of expressed negative and positive affect during free-play and the three dependent variables (distressed infants' duration and average intensity of expressed negative affect and RSA withdrawal). Second, we planned to conduct a series of T-tests to compare, separately, distressed infants' scores on the three dependent variables between infants whose mothers indicated that they typically respond to their infants' distress with positive affect "never" or "sometimes" versus "often" or "almost always," as well as between infants whose mothers indicated that they typically respond to their infants' distress with negative affect "never" or "sometimes" versus "often" or "almost always." If we found significant relations between any of these variables and the three dependent variables, we planned to include them as covariates in our main analyses.

We also planned preliminary analyses to examine the extent to which mothers followed the instructions of the experimental manipulation, as quantified by their observed affect, and to assess whether the extent to which we observed mothers to follow manipulation instructions influenced the three dependent variables (distressed infants' duration and average intensity of expressed negative affect and RSA withdrawal). We planned to descriptively examine the manipulation check variables (percentage of time mothers were observed in positive and negative affect and their average affect intensity during each of the frustration tasks), and to conduct Pearson's correlations between the manipulation check variables and the three dependent variables. We planned to describe these findings and take them into consideration in interpreting the results of hypothesis testing, but we did not plan to control for manipulation check variables given that each variable was specific to a condition.

We planned to assess skew in our three dependent variables by examination of skewness statistics, Shapiro-Wilk statistics, and histograms. If skew was significant for one or more variables, we planned to test log, square root, and reciprocal transformations for the impact on skew to identify the transformation that most effectively reduced skew. Then, we planned to transform skewed data using the best transformation and use this (or these) variables in mixed analyses of variance (ANCOVAs) described below.

Finally, we planned to assess residuals for normality by examining plots of regression standardized residuals for RSA withdrawal in each condition. If residuals were normally distributed, we planned to proceed with our main analyses approach and run linear mixed-effects models (described below). If residuals were non-normally distributed, we planned to test log, square root, and reciprocal transformations for the impact on skew to identify the transformation that most effectively reduced skew. Then, we planned to transform skewed data using the best transformation and use this (or these) variables in running linear mixed-effects models (described below).

We planned the main analyses to test hypotheses regarding the predicted effects of maternal affect responses on infants' expressed negative affect and RSA withdrawal as follows.

Aim 1. Compare distressed infants' behavioral response (duration and average intensity of negative affect) when their mothers respond with positive relative to negative affect.

Hypothesis 1 Analysis Approach. To examine our first hypothesis, that distressed infants' duration and average intensity of negative affect will be smaller when mothers respond with negative affect versus positive affect, we planned to analyze the data in two ways. First, we planned to run linear mixed-effects models since there is the possibility of skew in our observed behavioral dependent variables, which could contribute to an increase in type I error; moreover, infants' responses during distress tasks are not independent from each other. Using linear mixed effects models, we planned to predict distressed infants' (a) duration and (b) average intensity of expressed negative affect from condition group (when mothers respond with positive affect versus negative affect). We planned to compare the results of the linear mixed-effects models to ANCOVA results. If skew was not an issue in our duration and average intensity of expressed negative affect variables, we planned to compute two ANCOVAs with untransformed dependent variables to determine whether distressed infants' (a) duration and (b) average intensity of expressed negative affect differs when mothers respond with positive affect versus negative affect with type of condition (positive vs. negative affect) as the within-subjects variable and condition order (positive or negative first) as the between-subjects variable. If skew was an issue in these observed behavioral variables, we planned to run the mixed ANCOVAs, as described above, with transformed variables. Significant findings of the main effect for mothers' affect condition in the predicted direction would reveal support for the hypothesis. A significant main effect for condition order would reveal that there had been a condition order effect. A significant interaction between counterbalanced groups and affect condition would reveal if there had been an order effect by condition. Findings from the interaction between counterbalanced groups and affect condition would determine whether or not there was an order effect of condition. If covariates are included, pending findings from preliminary analyses, results would indicate support for the main effect or the interaction above variance accounted for by the covariate(s).

Aim 2. Compare distressed infants' physiological responses (RSA withdrawal) when their mothers respond with positive relative to negative affect.

Hypothesis 2 Analysis Approach. To examine our second hypothesis, that distressed infants' vagal withdrawal will be lower when mothers respond with negative affect versus positive affect, consistent with the idea that this would be a less challenging environment, we planned to analyze the data in two ways. First, we planned to run linear mixed-effects models since there is the possibility of skew in our physiological variables, which could contribute to an increase in type I error; moreover, infants' responses during distress tasks are not independent from each other. Using linear mixed effects models, we planned to predict distressed infants' RSA withdrawal from condition group (when mothers respond with positive affect versus negative affect). We planned to compare the results of the linear mixed-effects models to ANCOVA results. If skew was not an issue in our physiological variables, we planned to compute a mixed analysis of covariance (ANCOVA) with untransformed dependent variables to determine whether distressed infants' RSA withdrawal differs when mothers respond with positive affect versus negative affect with type of condition (positive vs. negative affect) as the within-subjects variable and condition order (positive or negative first) as the between-subjects variable. If skew was an issue in these physiological variables, we planned to run the mixed ANCOVA, as described above, with transformed variables. Significant findings of the main effect for mothers' affect condition in the predicted direction would reveal support for the hypothesis. A significant main effect for condition order would reveal that there had been a condition order effect. A significant interaction between counterbalanced groups and affect condition would reveal if there had been an order effect by condition. If covariates are included, pending findings from preliminary analyses, results would indicate support for the main effect or the interaction above variance accounted for by the covariate(s).

Method

Participants

An a priori power analysis using G*Power 3.1 indicated that a sample size of 34 mothers and their infants is sufficient to achieve 80% power and a medium effect size for a mixed within-between subject design (Faul, Erdfelder, Lang, & Buchner, 2007). The correlation among repeated measures was estimated from a sample of 12-month-old infants (n = 25) from an unpublished dataset by Sherryl Goodman et al. using a Pearson's correlation of the relative duration of negative affect during a mother distract task and a mother unavailable task (both distress-eliciting tasks), r = 0.55 (Appendix A).

We recruited participants within an urban Southeastern United States city through flyers, word of mouth, media announcements, internet postings (e.g. Facebook) and through a database of families who offered to be contacted about participating in child development related studies. A phone screen was used to determine whether mothers were willing and able to come into the lab for one 60-minute visit and whether mothers and infants met our inclusion criteria: mothers at least 18 years old and fluent in English with a 4- to 8-month-old infant. In order to eliminate potential confounds, mothers and infants were excluded from the study if mothers had a history of psychosis, were currently substance abusing, were currently suicidal, if infants had a neurodevelopmental disorder, or if infants were born prematurely (<32 weeks gestational age). If the mother had twins, we randomly selected one per family to participate. Of the mothers who passed the screen, *n* = 4 had twins (*n* = 2 were later excluded).

Of 52 mothers and infants who attended a lab visit, *n* = 5 infants did not get frustrated with the arm restraint and therefore had no behavioral and physiological data, *n* = 2 infants were too fussy and could not complete either frustration task, *n* = 6 mothers did not adhere to the affect protocol instructions ([*n* = 1] demonstrated the opposite of the instructed affect for the first frustration task and her baby did not get frustrated for the second frustration task, and [*n* = 5] mothers spent >75% of time in neutral affect during the negative affect condition), *n* = 2 mothers demonstrated a number of protocol violations (e.g., hugging infant, excessive stroking/rubbing of infant's arms and legs), and *n* = 2 mothers asked to withdraw from the study before completion of the visit. These participants were excluded from the study. We were able to retain 67% (35/52) of participants. Of the *n* = 35, a few participants had incomplete data: *n* = 2 infants were inconsolable after the first frustration task and could not participate in a second frustration task, and one of these mothers did not complete the questionnaires, and *n* = 1 mother did not adhere to the affect protocol instructions for one frustration task (demonstrated the opposite of the instructed affect), therefore data were only used for one frustration task for each of these dyads. Finally, *n* = 3 infants had electrocardiogram (ECG) data files that were not editable, and therefore had to be discarded; however, their behavioral data was included in analyses.

The final sample consisted of 35 mothers and their babies. Infants ranged from 4.83 to 7.85 months of age (*M* = 6.23, *SD* = 0.74), 19 (54%) were female. Mothers ranged from 24 to 43 years of age (*M* = 33.29, *SD* = 4.74). Of the (*n* = 34) mothers who completed the demographics questionnaire, most (74%) mothers and (65%) infants were White, some (18%) mothers and infants were Black or African American, some (6%) mothers and (12%) infants were Asian, and a few (3%) mothers and (6%) of infants identified as "other." Nearly all (88%) mothers were married, most (85%) had completed a four-year college degree or higher, and most (79%) were employed or self-employed. The median household income was between $100,000 and $149,999.

Procedure

The study protocol was approved by the Emory University Institutional Review Board and all mothers participated in an informed written consent procedure for their own and their infants' participation. See Appendix B for the study manual and Appendix C for the study script. All visits took place in a lab at Emory University. Within 24 hours prior to the visit, mothers completed an online questionnaire about their demographics, emotions, and behavior, as well as their baby's temperament for the purpose of obtaining descriptive information of the sample and determining if study variables vary in relation to these factors in order to identify possible confounding variables.

During the lab visit, an undergraduate research assistant (RA) obtained informed consent, then provided mothers with a brief overview of the lab procedures. We counterbalanced the order of conditions with which mothers were instructed to respond (positive/negative affect). We instructed a randomly chosen half of the mothers to respond with positive affect during the first frustration-eliciting task and with negative affect during the second frustration-eliciting task, and the other randomly chosen half of the mothers to respond with negative affect during the first frustration-eliciting task and with positive affect during the second frustration-eliciting task.

We video recorded all study visits. We instructed mothers to place their baby in an infant seat on a low table and seated mothers in a fixed chair facing their infant, with mothers' faces at about the same height as babies' faces. The RA placed heart rate electrodes on the infant and set up the ambulatory ECG and respiration data collector, evaluating the quality of the recording and adjusting electrodes as necessary. We collected ECG and respiration data throughout all lab visit tasks.

To establish infants' baseline RSA and mothers' baseline affect during a mother-infant interaction, mothers and infants first participated in a 5-minute baseline face-to-face play segment. The RA provided mothers with a set of age appropriate toys (e.g., rubber duck, stacking rings, cow puppet) and instructed them to play with their infant as they normally do. The RA left the room during the play segment.

Next, mothers and infants participated in the two tasks designed to elicit infant distress. Prior to the first distress task, the RA informed the mother about the arm restraint task and about how the mother was to respond, "Now we'll do the frustration task. I will gently hold (baby's name)'s forearms down until he/she is frustrated. For the first part when I am holding his/her arms, please display a neutral face and do not respond to or interact with him/her." The RA asked mothers to lightly sit on their hands (or part of their hands) for the first non-interacting part, in order to increase the likelihood that they engage in any gestures. The RA provided mothers with and instructed them to wear an earbud, through which they would hear directions from a second RA who was situated behind a one-way mirror. The RA in the room then told mothers, "[RA 2's name] will tell you to begin interacting with your infant through this earpiece.

At that point, please also place your hands on your baby's legs to help comfort him/her. Just make sure to use sustained touch, so try to just hold on to the thighs and do not use any stroking. You can try it out now." During pilot testing, we added this instruction for mothers to place their hands on their infants' legs because we found that infants were inconsolable when mothers did not engage in any touch with them. To keep the variable of touch consistent, we asked mothers to only use sustained touch (i.e., no stroking, rubbing, patting).

The RA then showed mothers two brief video demonstrations of how to respond during the first condition. For each condition, we showed two samples of different women demonstrating the instructed affect, as described below, and saying the words, "Aw, it's ok." Following the video demonstration, the RA provided the following verbal instructions for the positive condition, "Please respond with a mild happy face/positive affect and tone and do not frown or show a sad face." The instructions for the negative condition were, "Please respond with a mild sad face/negative affect and tone and do not smile or laugh." Next, the RA directed mothers to a mirror to practice the instructed affect. The RA then put away all toys and placed them out of sight.

We followed Parade and Leerkes (2008) arm restraint task directions with two modifications: 1) position/placement of the RA and 2) timing of the protocol. Whereas Parade and Leerkes had RAs kneel in front of infants, hold infants' arms down for four minutes, and instruct mothers to interact after the first minute, in our study, the RA sat behind the infants' chair (out of the infants' sight) and gently held infants' forearms down until they let out a full-blown cry. At that point, the second RA, from behind the one-way mirror, began a 3-minute timer and directed mothers (through the earbud) to begin responding with the selected affect and to place their hands on top of their baby's thighs. We made these modifications in order to standardize the start point for the recovery period, i.e. for recovery to begin immediately following infants reaching their highest intensity of distress. During piloting, we found that if we waited one minute before instructing mothers to respond, that mothers became involved when infants were at varying levels of affect.

If mothers deviated from the instructed affect response or moved their hands, the second RA, through the earbuds, reminded mothers to either keep smiling or try not to smile (depending on the condition) or to keep their hands still on their baby's legs.

Following the first frustration task, mothers and infants completed a 10-minute calming segment. The RA told mothers that they would have a break so that their infants could calm down before doing the second frustration task and so that they could hold, soothe, and/or play with their infant in any way that they would like. The RA gave mothers the same set of toys as used during the free play segment.

Once the calming segment was complete, the RA repeated the frustration task instructions and directed mothers to respond with the opposite affect (positive if they responded with negative affect during the first frustration task, and negative if they responded with positive affect during the first frustration).

Measures

Demographics

Mothers provided general demographic information by completing a questionnaire requesting information on their age, race/ethnicity (their own and their infant's), marital status, household income, educational history, and employment.

Infants' Negative Emotionality

To measure infants' negative emotionality temperament, mothers completed the Very Short Form of the Infant Behavior Questionnaire-Revised (IBQ-R-VSF) (Putnam, Helbig, Gartstein, Rothbart, & Leerkes, 2014). The IBQ-R-VSF is a 37-item factor-analytically derived measure of temperament for infants 3-12 months of age. Each item asks caregivers to report the frequency within the last week (the past seven days) that their infant has exhibited the specified behaviors, using a 7-point scale, ranging from 1 (Never) to 7 (Always). We used the 12-item broad, empirically derived Negative Emotionality composite that indexes Distress to Limitations, Sadness, and Fear. The IBQ-R-VSF Negative Emotionality Scale has acceptable convergent and predictive validity as well as interrater and retest reliability (Putnam et al., 2014). For our sample, the Cronbach's alpha for the Negative Emotionality Scale was .75.

Mothers' Depressive Symptoms

Mothers completed the Center for Epidemiologic Studies - Depression Scale (CES-D; Radloff, 1977). The CES-D is a 20-item self-report measure of depressive symptoms over the past two weeks and has been found to be a reliable and valid measure of depression severity (Radloff, 1977). Respondents rate their symptoms on a Likert scale ranging from *never* (0) to *almost always* (3) in response to items that correspond to various depression symptoms, whereby higher scores indicated more severe depression. A score of 16 or greater typically is considered clinical cut-off for depression. In the current sample, the Cronbach's alpha was .88.

Mother's Affective State

To measure mothers' affective state, mothers completed the Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988), self-reporting to what extent they felt a certain way "in general, that is, on the average." The PANAS is a 20-item self-report measure that contains 10 positive (e.g. interested, excited) and 10 negative (e.g. distressed, upset) words that describe affective states. Respondents rate each item on a Likert scale ranging from *very slightly or not at all* (1) to *extremely* (5). The PANAS yields two scores: a negative affect score, derived by adding the scores of the negative affect items, and a positive affect score, derived by adding the scores of the positive affect items. Thus, scores range from 10 to 50, with higher scores indicating more of the affect. The PANAS, with the instructions we used here, has been found to be a reliable and valid measure of trait level positive and negative affect, the primary dimensions of mood (Watson et al., 1988). The Cronbach's alpha for our sample was .74.

Mothers' Typical Response to Infants' Distress

Mothers replied to this question twice: "How often do you typically respond like this to your infant when he/she is distressed/frustrated?" and were asked to respond on a Likert scale ranging from *never* (1) to *almost always* (4). After the first time they were asked the question, they were shown an image of a mother frowning. After the second time they were asked the question, they were shown an image of a mother smiling.

Infants' Observed Affect

Using Mangold INTERACT Observational Coding Software (Mangold, 2010), trained RAs coded infants' observed affect moment-to-moment from the video recorded frustration segments using a modified version of Dawson's Global Affect Scales for behavioral coding (Dawson et al., 1999). RAs coded infants' affective behaviors on a scale ranging from two levels of negative affect, i.e. *marked distress/cry* (-2) or *mild distress/frown/pout* (-1), to *neutral* (0), to two levels of positive affect, i.e. *positive interest/engagement* (+1), or *smiles/laughter/squeal* (+2) (see Table 1 for detailed descriptions of coding categories).

Mothers' Observed Affect

We also used Mangold INTERACT and followed procedures modified from Dawson et al. (1999) for coding mothers' affect expressions 1) during the free play segment and 2) during the final 3 minutes of each distress-eliciting segments as a manipulation check to determine the extent to which mothers complied with the affect instructions. We used three intensities of negative affect, i.e. *marked distress* (-3), *brief, marked distress* (-2), or *worry/tension* (-1), *neutral* (0), and three intensities of positive affect, i.e. *interest* (+1), *smile* (+2), or *laughter* (+3) (see Table 2 for detailed descriptions of coding categories).

Coding Training. We followed procedures outlined in Bakeman and Goodman (2019) for training observers, and for achieving and maintaining inter-observer reliability. Undergraduate RAs who were unaware of conditions and hypotheses coded mother and infant affect separately. Observers underwent a training process in which they practiced coding and discussed disagreements with a graduate student (the principal investigator). To be allowed to code study segments, observers had to demonstrate inter-observer reliability by a kappa greater than .80 on four consecutive training segments. A second observer coded a randomly selected 20% of videos, with neither observer aware of which segments were selected for this process. These double coded videos enabled calculation of a kappa score to estimate inter-observer reliability. Throughout the coding phase, in an effort to maintain inter-observer reliability, coders attended weekly meetings, during which the team discussed the videos that had been coded by two observers.

Inter-observer Reliability. We calculated inter-observer reliability for mothers' affect during free play for a randomly selected 19% of free play segments. The time-unit kappa reflecting the extent of agreement for positive, negative, and neutral mothers' affect within a 2-s tolerance was .81. For infants' affect, we calculated inter-observer reliability for a randomly selected 20% of frustration task videos. The time-unit kappa reflecting the extent of agreement for positive, negative, and neutral infants' affect was .86 during the positive affect condition and .83 during the negative affect condition. For mothers' affect during the frustration tasks during a randomly selected 19% of frustration task (manipulation check) videos, the time-unit kappa reflecting the extent of agreement for positive, negative, and neutral mothers' affect was .82 during the positive affect condition and .90 during the negative affect condition.

Uncodable Data. We statistically accounted for any portions of time in each segment that were coded as "uncodable" by calculating relative duration of expressed affect, with the denominator being the duration of the segment minus any seconds that were uncodable. Mothers or infants were coded as uncodable when infants' and/or mothers' faces were off screen for more than 3 seconds, or there was a protocol violation (e.g., research assistant walked into the room to give an instruction). The total uncodable and protocol violation time was subtracted from each segment. Of the total interaction times, <1% was considered uncodable each during free play, the positive affect condition, and the negative affect condition.

Relative Duration and Intensity Calculations. From the coded affect, using Mangold INTERACT, we computed two sets of scores for infants' and mothers' affect during each segment. First, we computed the relative duration (percentage of time) spent in negative (summing across levels of intensity of negative affect), positive (summing across levels of intensity of positive affect), and neutral affect. Second, we computed an average affect intensity score for the segment (5 minutes of free play or the final 3 minutes of each distress task, when the mother is responding). We calculated an average affect intensity score by summing the number of seconds spent in each affect code and dividing by the total number of seconds in the segment. For example, (-2*100) + (-1*30) + (0*10) + (2*40) = -150/180 = -.83 reflects an infant who spent 100 seconds in affect coded as -2 (high negative affect), 30 seconds in affect coded as -1 (low negative affect), 10 seconds in affect coded as 0 (neutral), and 40 seconds in affect coded as 2 (high positive affect) and the segment was a total of 180 seconds. With this average affect intensity score, higher (positive) values reflect more positive affect intensity and lower (negative) values reflect more negative affect intensity.

Infants' RSA

Prior to editing ECG recordings from the study segments, the principal investigator underwent a training process established by the Dr. Stephen Porges lab. Training included successfully completing 20 practice files, which were then submitted to Dr. Keri Heilman in the Porges lab for feedback. We first used CardioPeak software (Brain-Body Center for Psychophysiology and Bioengineering, University of North Carolina, Chapel Hill. 2019) to identify R-wave peaks and inter-beat intervals within each infant ECG recording. Then, we edited these files for artifacts that may have been due to software R-wave misdetection, baby movement and/or physiological anomalies (e.g., arrhythmia) using CardioEdit software (Brain-Body Center, University of Illinois at Chicago. 2007). To calculate RSA, we followed procedures developed by Porges (1985) and Porges and Bohrer (1990), and used CardioBatch Plus software (Brain-Body Center for Psychophysiology and Bioengineering, University of North Carolina, Chapel Hill. 2016). An algorithm was applied to sequential heart period data that was obtained from ECG inter-beat intervals to calculate RSA estimates sequentially over 30 second periods, then these estimates were averaged across the duration of time for each of the two frustration tasks. We calculated RSA withdrawal scores by subtracting the average RSA during each frustration task from the average RSA during free play.

Results

Preliminary Analyses

All analyses were conducted using IBM SPSS Statistics Version 26. Means and standard deviations for key variables are presented in Tables 3-5.

Intercorrelations between key variables are presented in Table 6. Among the infant variables during the distress tasks, infants' greater percent of time spent in negative affect during the positive condition was significantly associated with their more negative affect intensity during the positive condition ($r = -.94$, $p < .01$). Infants' greater percent of time spent in negative affect during the negative condition was also significantly associated with infant's more negative affect intensity during the negative condition ($r = -.91$, $p < .01$). Finally, infants' greater RSA withdrawal score during the positive affect condition was significantly associated with their greater RSA withdrawal score in the negative condition ($r = .66$, $p < .01$). There were no significant associations between any of the behavioral mother variables during free play and any of the observed behavioral infant variables during the distress tasks.

Determination of potential covariates

To identify potential covariates, first we ran Pearson's correlations (see Table 6). We examined correlations between the dependent variables from each of the two distress conditions (infants' percent of time in negative affect, average intensity of expressed affect, and RSA withdrawal) and a set of infant variables: sex (which we ran as a point-biserial correlation), age, and negative emotionality temperament score. Similarly, we examined correlations between the dependent variables from each of the two distress conditions and a set of mother variables: depressive symptom severity, state positive and negative affect, and displayed affect during free play. For the latter, we examined percentage of time observed in positive affect, percentage of time in neutral or negative affect during free play - collapsed due to the small amount of time that mothers were observed to be expressing negative affect during free play – and average affect intensity during free play. Second, we ran a series of t-tests to examine if the way in which mothers reported that they typically respond to their distressed infants influenced frustrated infants' behavioral and physiological responses. We collapsed response options to provide sufficient cell sizes for the analyses, creating a dichotomized variable ("never" or "sometimes" versus "often" or "almost always").

From among the findings on the infant variables, as expected, we found that infants' sex was not significantly associated with any of the three dependent variables. For infant negative emotionality, we found that infant's greater negative emotionality was significantly associated with infants' greater percent of time spent in negative affect and infants' greater negative affect intensity, albeit exclusively in the positive affect condition (r = .44, $p < .01$ and r = -.37, $p < .05$, respectively). These associations were not significant when mothers responded with negative affect. Further, we found no significant relationship between infant negative emotionality and RSA withdrawal in either condition.

Turning next to the mother variables, we did not find significant associations between mothers' depressive symptom severity, nor their state positive and negative affect levels, and any of the three dependent variables in either condition. For mothers' observed affect displayed with infants during free play, we found some significant correlations. In both conditions, mothers' more positive average intensity of affect during free play was significantly correlated with infants' greater RSA withdrawal (r = .42, $p < .01$ for the positive condition; r = .51, $p < .01$ for the negative condition). Additionally, specific to the negative affect condition, mothers' greater percent of time spent in positive affect and lower percent of time spent in negative and neutral affect (combined) during free play were significantly associated with infants' greater RSA withdrawal ($r = .50$, $p < .01$; $r = -.47$, $p < .01$, respectively). Finally, there was no significant difference in infant observed behavioral and physiological dependent variables in either condition based on mothers' report of how often they typically respond to their infants' distress with positive affect (dichotomized) or how often they typically respond to their infants' distress with negative affect (dichotomized) (see Tables 7 and 8).

Based on the pattern of significant correlations that we detected, we included covariates in hypothesis testing as follows. First, we treated infants' negative emotionality temperament score as a covariate for Hypothesis 1 testing (i.e., with observed behavioral variables). Second, we treated mothers' average affect intensity during free play as a covariate for Hypothesis 2 testing (i.e., with physiological variables). Among the three affect variables from the free play observation, we found that mothers' more positive average affect intensity was significantly associated with mothers' greater percent of time spent in positive affect during free play, $r = .88$, $p < .01$. Mothers' more negative average intensity was also significantly associated with mothers' greater percent of time spent in negative and neutral affect combined, $r = -.81$, $p < .01$. Thus, we selected mothers' average affect intensity as the covariate since it was significantly related to infants' RSA withdrawal in both conditions, and since it was so highly correlated with the percentage of time that mothers spent in positive affect during free play and the percentage of time that mothers spent in negative and neutral affect during free play.

Manipulation check

For infants, we took two steps to ensure that the arm restraint task functioned to induce distress (see Table 4 for the ranges of negative affect during distress tasks). First, as described in the method section, we modified the arm restraint instructions so that the RA held infants' arms down until the infants let out a full-blown cry to ensure that infants expressed distress. Second, as described in the participants' section, we excluded the few (*n* = 5) infants who did not cry with the arm restraint.

To examine the extent to which mothers followed the instructions of the experimental manipulation, we descriptively examined means and standard deviations for mothers' observed affect variables during the two sets of instructions for the frustration task (see Table 5). Consistent with the manipulation, during the positive affect condition, mothers spent an average of 93% (*SD* = 8.34) of time in positive affect with an average intensity of 1.21 (*SD* = 0.36) and 4% (*SD* = 6.80) of time in neutral or "flat" affect. Also consistent with the manipulation, during the negative affect condition, mothers spent an average of 96% (*SD* = 5.28) of time in negative affect with an average intensity of -.96 (*SD* = 0.06) and 4% (*SD* = 4.97) of time in neutral or "flat" affect. Although these descriptive findings provide strong support for the effectiveness of our manipulation, these means somewhat mask the variability among mothers, as shown in the ranges in Table 5. On the basis of these descriptive findings, taking these individual differences into account, we conducted Pearson correlations between the manipulation check variables and the three dependent variables to consider in interpreting the results of hypothesis testing.

We ran Pearson's correlations between the extent to which each mother was observed to follow manipulation instructions during each of the frustration task instructions (percentage of time observed in positive and negative affect, and average affect intensity) and the three dependent variables (distressed infants' duration and average intensity of expressed negative affect and RSA withdrawal) (see Table 7). With regard to infants' observed behavioral variables, specific to the negative affect condition, 1) mothers' greater percent of time spent in negative affect predicted infants' greater percent of time spent in negative affect ($r = .63$, $p < .01$) and infants' more negative affect intensity ($r = -.48$, $p < .01$), and 2) mothers' more negative affect intensity predicted infants' greater percent of time spent in negative affect ($r = -.54$, $p < .01$) and infants' more negative affect intensity ($r = .42$, $p < .01$). None of the manipulation check variables were significantly associated with observed infant behavioral variables in the positive affect condition. With regard to infants' RSA withdrawal, specific to the positive affect condition, mothers' greater percent of time spent in positive affect and less percent of time spent in negative affect significantly predicted infants' greater infants' RSA withdrawal ($r = .40$, $p < .05$ and $r = -.55$, $p < .01$, respectively). None of the manipulation check variables were significantly associated with infant's RSA withdrawal in the negative affect condition. Because we had separate maternal affect scores for each condition, we could not include the variables that were significantly correlated with infants' duration and intensity of negative affect and RSA withdrawal as covariates in main analyses.

Tests for skew

We examined all three dependent variables for skew and found that the observed infant behavioral dependent variables (percent of time spent in negative affect and average intensity of expressed affect) were significantly skewed in both conditions. Infants' RSA withdrawal data were not significantly skewed in either condition. After testing log, square root, and reciprocal transformations for the impact on skew, a log transformation best fit the observed behavioral data and most effectively reduced skew. Skewness, kurtosis, and Shapiro-Wilk statistics for each behavioral observation variable per condition following log transformations are reported in Table 10. We used the transformed variables in all ANCOVA analyses with the behavioral observational variables.

Post Hoc Power Analyses

Our final sample sizes for the planned ANCOVA analyses were smaller than the sample size of *n* = 34, which the a priori power analysis (using G*Power 3.1) indicated would be adequate. Thus, we conducted post hoc power analyses to determine estimated power based on our final sample sizes. For our analyses using the observed behavioral dependent variables (duration and intensity of infant negative affect), with our sample of *n* = 32, the post hoc power analysis revealed that our estimated power was 78%. That is, the probability that tests of significance would pick up on an effect that is present was below 80%. For our analyses using infant RSA as a dependent variable, we had a sample of *n* = 30 and the post hoc power analysis revealed that our estimated power was 75%. That is, the probability that tests of significance would pick up on an effect that is present was below 80%.

Hypothesis Testing

Hypothesis 1

Next, we evaluated support for Hypothesis 1, that distressed infants' duration of negative affect would be smaller, and infants' average affect intensity would be less negative when mothers respond with negative affect versus positive affect. Because our observed behavioral dependent variables were skewed, we were concerned that this may contribute to an increase in type I error, and since infants' responses during distress tasks were not independent from each other, we used SPSS to fit linear mixed-effects models predicting the two infant observed behavioral dependent variables from condition group. We first assessed residuals for normality by examining plots of regression standardized residuals for each observed dependent variable in each condition. None of the distributions deviated greatly from normality. Therefore, we used untransformed variables in the models predicting observed behavioral dependent variables.

Based on tests for potential covariates, we included infants' negative emotionality temperament as a covariate for analyses with the observed behavioral dependent variables, infants' negative emotionality scores in the models predicting relative duration and intensity. Because this covariate was assessed once prior to the lab visit, we treated it as a fixed effect in the models. We also included condition order as a fixed effect covariate in all models and added a random effect for subject (infants) to account for individual differences in behavioral responses to frustration. We used a two-level hierarchical data structure in which infants' behavioral responses to the two distress tasks (level 1) are nested within participants (level 2). We opted for an unstructured covariance structure since covariances were assumed not to conform to a systematic pattern. All analyses used maximum likelihood estimation. We calculated effect size as Cohen's *d* from the equation $d = t(2/\mathrm{n})^{1/2}$ (Dunlap, Cortina, Vaslow, & Burke, 1996). We interpreted our findings based on three levels of effect size: small ($d = .20$), medium ($d = .50$), and large ($d = .80$) (Cohen, 1988).

To evaluate our hypothesis that distressed infants' duration of negative affect would be smaller and infants' average affect intensity would be less negative when mothers respond with negative affect versus positive affect, we predicted the percent of time infants spent in negative affect from condition group. Compared to a model with fixed parameters (AIC = 569.56), a model with a random intercept and random slope (AIC = 534.32) was a better fit, X^2 (2) = 39.24, $p < .01$. The model including negative emotionality as a covariate was the best fit. In this model, condition significantly predicted the percentage of time infants spent in negative affect, $F(1, 34) = 9.62$, $p < .01$, $d = .75$. Infants spent a significantly greater amount of time in negative affect during the negative affect condition. See Table 11 for parameter estimates. Condition order also significantly predicted infants' average affect intensity, $F(1, 32) = 4.18$, $p < .05$, $d = -.50$. Infants who were randomly assigned to the positive affect condition first displayed lower intensities of negative affect than those who were randomly assigned to the negative affect condition first. Infants who were randomly assigned to the positive affect condition first spent more time in negative affect than those who were randomly assigned to the negative affect condition first. The relationship between mother's condition (positive versus negative affect) and the percent of time infants spent in negative affect showed significant variance in intercepts, Var(u_{0j}) = 41.64, *SE* = 10.47, 95% CI [25.44, 68.15], $p < .01$,and slopes, Var(u_{1j}) = 542.48, SE = 133.23, 95% CI [335.23, 878.86], $p < .01$, across participants. The slopes and intercepts did not significantly covary, Cov(u_{0j}, u_{1j}) = 16.45, *SE* = 28.02, 95% CI [-38.46, 71.38], $p = .56$.

In predicting infants' affect intensity from condition group, compared to a model with fixed parameters (AIC = 126.49), a model with a random intercept and random slope (AIC = 106.42) was a better fit, X^2 (2) = 24.06, $p < .01$. The model including negative emotionality as a covariate was the best fit. In this model, again as expected since duration and intensity were so highly correlated, condition significantly predicted infants' average affect intensity, $F(1, 34)$ = 13.16, $p < .01$, $d = -.87$. Infants' affect was more negative during the negative affect condition. See Table 12 for parameter estimates. Condition order also significantly predicted infants' average affect intensity, $F(1, 34) = 5.17$, $p < .05$, $d = .54$. Infants who were randomly assigned to the positive affect condition first displayed higher intensities of negative affect than those who were randomly assigned to the negative affect condition first. The relationship between mother's condition (positive versus negative affect) and infants' average affect intensity showed significant variance in intercepts, Var(u_{0j}) = .09, *SE* = 0.02, 95% CI [.06, .15], $p <.01$, and slopes, Var(u_{1j}) = .60, *SE* = .15, 95% CI [.37, .98], $p < .01$, across participants. The slopes and intercepts did not significantly covary, Cov(u_{0j}, u_{1j}) = .05, *SE* = .04, 95% CI [-.03, .14], $p = .21$.

We also conducted two ANCOVAs with condition (mothers' positive vs. negative affect) as the within-subjects variable and condition order (positive or negative first) as the between-subjects variable to compare distressed infants' 1) percent of time spent in negative affect and 2) average intensity of expressed affect when mothers responded with positive relative to negative affect and found the same results (Appendix D).

Hypothesis 2

Next, we tested support for Hypothesis 2, that distressed infants' vagal withdrawal would be lower when mothers respond with negative affect versus positive affect. Since infants' physiological responses during distress tasks were not independent from each other, we used SPSS to fit linear mixed-effects models predicting the infant RSA withdrawal from condition group. We first assessed residuals for normality by examining plots of regression standardized residuals of RSA withdrawal in each condition. Neither of the distributions deviated greatly from normality. Therefore, we also used untransformed variables in the models predicting RSA withdrawal.

Based on tests for potential covariates, we included mothers' average affect intensity during free play as a covariate. Because this covariate was assessed once at the beginning of the lab visit, we treated it as a fixed effect in all models. We also included condition order as a fixed effect covariate in all models and added a random effect for subject (infants) to account for individual differences in physiological responses to frustration. We used a two-level hierarchical data structure in which infants' physiological responses to the two distress tasks (level 1) are nested within participants (level 2). We opted for an unstructured covariance structure since covariances were assumed not to conform to a systematic pattern. All analyses used maximum likelihood estimation. We calculated effect size as Cohen's *d* from the equation $d = t(2/n)^{1/2}$

(Dunlap et al., 1996) and interpreted our findings based on three levels of effect size: small (d = .20), medium (d = .50), and large (d = .80) (Cohen, 1988).

To test our hypothesis that distressed infants' vagal withdrawal would be lower when mothers respond with negative affect versus positive affect, we predicted infants' RSA withdrawal from condition group. Compared to a model with fixed parameters (AIC = 228.89), a model with a random intercept and random slope (AIC = 222.91) was a better fit, X^2 (2) = 9.97, $p < .01$. Condition significantly predicted RSA withdrawal, $F(1, 31) = 4.38$, $p < .05$, $d = .50$. Infants' RSA withdrawal was greater during the negative affect condition than the positive affect condition. See Table 13 for parameter estimates. Condition order did not significantly predict infants' RSA withdrawal $F(1, 34) = 4.13$, $p = .05$. The relationship between mother's condition (positive versus negative affect) and infants' RSA withdrawal showed significant variance in intercepts, Var(u_{0j}) = 1.91, SE = 0.49, 95% CI [1.16, 3.15], p <.01, and slopes, Var(u_{1j}) = 1.84, SE = 0.47, 95% CI [1.12, 3.03], $p < .01$, across participants. The slopes and intercepts significantly covaried, Cov(u_{0j}, u_{1j}) = .97, SE = 0.37, 95% CI [.25, 1.70], $p < .01$.

We also ran a mixed ANCOVA with type of condition (positive vs. negative affect) as the within-subjects variable and condition order (positive or negative first) as the between-subjects variable to compare distressed infants' RSA withdrawal when mothers responded with positive relative to negative affect and found that there was no significant main effect of mothers' affect condition on infants' RSA withdrawal (Appendix D).

Discussion

Both empirical findings and theory provide support for the idea that the affect that mothers exhibit in response to infants' distress has implications for infants' development of self-regulation and social competence. Yet, to our knowledge, no published study has reported having investigated specific maternal affective responses to infant distress in relation to infant behavior and physiology. In an effort to answer the important question of how different maternal affective responses to infant distress might directly predict infant recovery from that distress, this study experimentally induced infant distress and compared infants' observed affect and physiological responses when mothers were instructed to respond with positive affect versus negative affect. Using a within-subject design, we experimentally manipulated mothers' affective responses by instructing them to display, separately, positive and negative affect during an arm restraint task, intended to elicit infant distress.

Our results indicate that the experimental manipulation used in this study was effective. Mothers spent the vast majority of time in positive affect when instructed to, i.e., during the positive affect condition. Similarly, they spent the vast majority of time in negative affect when instructed to, i.e., during the negative affect condition. Of note, $n = 5$ mothers were excluded from analyses because they displayed neutral affect for >75% of the negative affect condition. This may indicate that some mothers include neutral/flat affect in what they consider negative affect; alternatively, they may have felt challenged to maintain negative affect for the full time period and had to lower the intensity of their negative affect to include neutral/flat affect.

Further, we looked beyond these findings based on group means to also examine individual differences within the times that mothers were directed to express the specified affect. We found that infants' expressed negative affect varied based on the extent to which mothers followed the manipulation check instructions only in the negative affect condition, relative to the positive affect condition. Mothers' greater time spent in negative affect and their greater negative affect intensity predicted both infants' greater time spent in negative affect and infants' more negative affect intensity. With regard to physiology, we found that there were significant associations between infants' RSA withdrawal and manipulation check variables only in the positive condition. Infants' greater RSA withdrawal was significantly associated with the more time that mothers spent in positive affect and the less time they spent in negative affect. Therefore, the extent to which mothers followed the manipulation check instructions was associated with infants' affect and physiological response, but only in specific conditions. These findings suggest that as long as mothers are at least displaying moderate durations and intensity levels of positive affect, any higher duration and intensity level does not seem to matter for infants' negative affect and intensity, but it does matter for their RSA withdrawal. Based on their RSA withdrawal, infants seem to find a highly positive response from their mothers more distressing then a moderately positive response. In the negative condition, beyond a moderate duration and intensity of negative affect, the greater duration of and more intense negative affect that mothers' display seems matter for infants' negative affect duration and intensity, but not for their RSA withdrawal. Thus, based on infants' observed behavioral responses, they seem to find mothers' more negative response more distressing than a moderately negative response.

We failed to support our first hypothesis, that infants' duration of negative affect would be smaller and infants' average affect intensity would be less negative when mothers respond with negative affect versus positive affect. Rather, we found, with large effect sizes, that infants' duration of negative affect was significantly smaller and average affect intensity was significantly less negative in the condition in which mothers responded with positive affect, compared to when they responded with negative affect. Our findings are in line with Bloom's (2016, 2017a, 2017b) theory that when individuals are suffering or struggling, they sometimes need support in the form of the opposite emotion, rather than taking on the same negative feelings.

There are several possible explanations for these findings that suggest that distressed infants are more soothed, in terms of their observed distress, by their mothers' positive versus negative affect. First, since typical mother-infant play interactions have few occurrences of mothers' negative affect, compared to positive affect, infants may be used to their mothers responding with positive affect. Second, even when infants are showing distress, most mothers in our study reported that they do not typically show negative affect. On our mothers' typical response to infants' distress/frustration questionnaire, 74% (n = 25) of mothers reported that they "never or sometimes" respond to their distressed infant with negative affect. These results are consistent with Kiel et al. (2011)'s findings that mothers were more likely to respond to their infants' distress during the strange situation with positive, versus negative affect. Thus, since mothers' negative affect may be unexpected and somewhat unfamiliar to infants, observing their mothers' extended time in negative affect may have contributed to infants' distress, or may not have been soothing to infants. In other words, mothers' positive affect, because it is more expected and familiar, may be more comforting. In light of this interpretation, it is important to keep in mind that our sample consisted of a non-depressed population of mothers who are less likely to demonstrate negative affect in front of their infants relative to mothers with depression. Infants of clinically depressed mothers, on the other hand, may be more used to their mothers' negative affect (Field, 2002), and therefore may exhibit different affective responses when their mothers use negative affect to soothe their distress.

Another possible explanation for our findings that distressed infants spent less time in negative affect and had lower negative affect intensity when their mothers displayed positive affect is that infants look to their mothers for cues on how to respond, i.e. social referencing. It may be that in order to ease their infants out of negative affect, their most effective strategy may be to model the affect in which they would like their infants to be. Thus, if mothers display negative affect, their distressed infants may stay in negative affect longer, whereas if mothers display positive affect, their distressed infants may follow their lead and move toward positive affect sooner.

Nevertheless, this finding was surprising given the wealth of theoretical support for infants' having an expectation of being affectively matched, even in negative affect (Gergely & Watson, 1996, 1999; Gianino & Tronick, 1988), and that such negative matching would communicate to the infant that the mother understands the infant's feelings and experience (Beebe & Lachmann, 1988). Communicating understanding of responses is consistent with the literature on validation (Fruzzetti & Worrall, 2010; Hall & Cook, 2012; Linehan, 1993), which in studies of adults has been found to decrease another person's negative reactivity relative to invalidation that tends to prolong or worsen another person's negative reactivity (Shenk & Fruzzetti, 2011). In the child/adolescent literature, validation has been theorized to contribute to children's ability to manage their emotional responses and there is evidence to support that parents' more validating responses are associated with less emotion dysregulation, externalizing behaviors, and greater parent-child relationship satisfaction (Shenk & Fruzzetti, 2014). Indeed, emotional validation is the foundation of dialectical behavior therapy (Linehan, 1993). Our data suggest that there may be better ways than negative affect matching for mothers to communicate understanding to their distressed infants. Future research is needed to investigate these possibilities.

Despite our finding that distressed infants soothed faster when their mothers responded with positive affect, versus negative affect, most of the infants still displayed a high duration of negative affect throughout the segment. Only about 25% of infants spent less than 75% of time in negative affect during the positive affect condition and less than 1% of infants spent less than 75% of time in negative affect during the negative affect condition, suggesting that mothers' verbal and visual facial expressions of affect may not be enough to bring distressed infants out of negative affect within a few minutes. It is possible that mothers' engaging in other behaviors, such as picking up their infants and holding them or attempting to distract them with a toy, may soothe their infants more quickly. Jahromi, Putnam, and Stifter (2004) found that mothers' typically respond to infants' distress in a number of ways, including affection, touching, holding/rocking, caretaking, and feeding/pacifying, all of which mothers were instructed not to do in our study. Thus, mothers' positive affect in combination with one or more of these behaviors may be necessary to more quickly decrease infants' negative affect. Future studies should assess the potential role of these factors in decreasing infants' distress.

We also failed to support our second hypothesis, that infants' vagal withdrawal would be lower when mothers respond with negative affect versus positive affect. Although our ANCOVA results were not significant, when we tested our hypothesis using a mixed effect model with a random intercept and random slope, we found opposite to our hypothesis, with a medium effect size, that infants' RSA withdrawal was significantly higher in the condition in which mothers responded with negative affect, compared to when mothers responded with positive affect. The fact that we yielded null findings from the ANCOVA and significant findings from the mixed effects model may suggest two things. First, taking into account the issue of non-independent observations when examining infants' physiology is important. Only after we accounted for within-subject variability and subject variability did we find a significant effect of condition on RSA. One explanation for our null ANCOVA finding may be that our estimate of RSA withdrawal during the second frustration task was imprecise since the time between distress tasks was standardized and some infants may not have had enough time to return to their original baseline RSA. Since we used the initial baseline RSA for each withdrawal calculation and did not take another baseline measure of RSA between distress tasks, it is possible that some infants were still physiologically distressed when we began the second distress task. Thus, the mixed effects model may have allowed us to account for this non-independence factor, as one example. 2) The power that we had to detect significant differences in RSA withdrawal using ANCOVA was estimated to be below 80%. Therefore, it is possible that by using a mixed effects model, which accounts for missing data, we had enough subjects and power to detect a significant difference in RSA withdrawal by condition.

Relatedly, Moore and Calkins (2004) compared infants who exhibited RSA withdrawal to infants who did not show a decrease in RSA during the still-face and found that they both displayed similar levels of negative affect during the still-face. However, during free-play and reunion segments, the infants who did not show RSA withdrawal during the still-face displayed significantly lower levels of RSA withdrawal and positive engagement. This suggests that there were lingering physiological and behavioral effects from the still-face segment for infants who did not decrease in RSA, whereas infants who showed RSA withdrawal during the still-face had only lingering behavioral effects. Although we were unable to find published studies that compared infants' RSA in two different conditions following a stressor, it is possible that a certain physiological profile may interact with experimental condition in our study so that some infants may show differences in RSA between conditions, but not others. Future studies that examine infants' physiology as a dependent variable should consider these possible effects.

With respect to factors that we thought may be possible covariates, only infants' negative emotionality and mothers' intensity of affect during free play were significantly associated with infant observed behavioral and physiological variables, respectively. Contrary to the literature we reviewed, which suggested that age may matter, infant age was not significantly associated with any of the three dependent variables. This suggests that although infants are rapidly developing between 4 and 8 months, the age range of infants in our study seemed to be narrow enough that we could be confident that the findings generalized across the full age range. Mothers' current depressive symptoms and trait-level positive and negative affective states also were not significantly associated with any of the three dependent variables, demonstrating that within the range of scores in a community sample, these trait and state variables did not matter. Finally, there was no significant difference in the levels of the dependent variables based on the affect that mothers reported typically displaying with their infants when their infants are distressed (i.e., what response the infants might be used to). This may suggest that infants may not be sensitized to their mothers' typical affect response to their distress.

Limitations and Strengths

The findings of this study should be interpreted in the context of several limitations. First, among our sample of mothers, most were White, married, well educated, and of relatively high socioeconomic status. Therefore, our findings may not be generalizable to more ethnically diverse and less socio-demographically advantaged women. Calkins et al. (2002) found that compared to infants who were less easily frustrated, easily frustrated infants' family Hollingshead scores were significantly lower, and there were more infants of African American mothers in the easily frustrated group. Thus, some groups of infants respond differently to distress than others, which may influence the way in which they respond to their mothers' affect when distressed. Further, J. A. Nelson, Leerkes, O'Brien, Calkins, and Marcovitch (2012) found that, compared to European American mothers, African American mothers rated their 5-year-old child's display of negative emotions as less acceptable and they reported fewer supportive responses to their negative emotions. This finding indicates that there may be ethnic group differences in how mothers respond to their infants' negative affect.

Second, as discussed previously, the power that we had to detect significant differences in our analyses was estimated to be below 80%. Therefore, it is uncertain if many of our findings that were not statistically significant, yet yielded small to medium effects, were true findings. Our non-significant results should be interpreted with caution in light of this limitation.

Next, the range of infants' negative affect intensity was restricted, which was possibly due to the nature of the coding scheme used. Our -3 category for negative affect included not only protesting, fussing, whimpering, grunting, and frustration sounds, but also crying. Separating infants' crying from these other lower-intensity behaviors may have yielded a greater range of scores. Future research might add an intensity level in order to determine if mothers' positive versus negative affect is associated with infants' duration of crying, separate from protesting, fussing, whimpering, grunting, and other frustration sounds. Also, the average intensity score that we calculated for infants and mothers was on a scale from negative to neutral, to positive. We did not separately examine infants' and mothers' negative and positive affect intensity, which may yield additional information about infants' and mothers' responses. Future research should consider assessing positive and negative affect intensity as separate variables.

Further, we observed participants in a laboratory setting with infants seated in a car seat and mothers were instructed not to pick up their infants, all of which constrain the generalizability of our findings. Further, the context in which we studied distress was specific to frustration. There may be contextual differences in distressed infants' responses to their mothers' attempts to soothe them depending on the reason for infant crying or the underlying infant emotion. For example, mothers' responses to infants' physical pain, fear, or hunger may have varying influences on infants' behavioral and physiological distress. Future studies should assess these potential contextual similarities and differences. Finally, this study only examined differences in mothers' responses to distressed infants. Further research is necessary to determine whether these findings generalize to fathers and other caregivers.

Despite these limitations, the study had several important strengths. First, we used a within-subject design, which allowed us to minimize random, uncontrollable differences between conditions, such as individual differences that would have been present had we instead used a between-subjects design. Second, we used an experimental design, which allowed us to manipulate mothers' affective responses to infants' distress by assigning mothers to respond, separately, with positive and negative affect. Rather than relying on natural occurrences of mothers' responses to infants' distress and correlational data, we were able to hold a number of variables constant (i.e., length of time mothers' soothed their infants following the distress task, mothers' touch, the lack of holding/rocking of infants, and no materials to sooth infants with, such as toys), which may otherwise be possible confounding factors. Additionally, since mother-infant interactions tend to be bidirectional, manipulating mothers' behavior allowed us to investigate only distressed infants' responses to their mothers' affective responses. Further, since typical free play interactions tend to have limited instances of infant distress, our use of a well-established, age appropriate lab task to elicit infant distress allowed us to have a large enough sample of negative affect data to better understand how duration and intensity of infants' negative affect may be influenced by how their mothers respond. Finally, we used micro-coding for maternal behavior during free-play and mothers' and infants' behavior during the distress tasks, obtained with a high degree of reliability, to get a sense of variability in affect duration and intensity that is not able to be captured using global rating scales.

Conclusion

The current findings provide evidence that the way in which mothers respond with their affect to their distressed infants can produce observable differences in infants' duration and intensity of negative affect, as well as their physiology. Specifically, although in the opposite direction to our hypotheses, we found that when mothers responded to their distressed infants with positive affect, infants spent significantly less time showing negative affect, showed significantly less intense negative affect, and had lower RSA withdrawal, compared to when mothers responded with negative affect. To our knowledge, this is the first study to experimentally manipulate mothers' affective responses to their infants' distress in an effort to understand whether one display of maternal affect may be better suited to manage infant distress. Despite study design limitations, findings from this study and the suggested future research have the potential to inform theory and practice about the ways in which mothers can help their infants to minimize their distress.

Clinical Implications

Caregivers' management of negative affect during infancy has important implications for decreasing the risk of later psychopathology. Clinical applications may include programs that target the moment-to-moment behaviors in mother-infant reciprocal interactions, focusing on mothers' positive affect response to infant negative affect, which might serve as a potential buffering factor against vulnerabilities to the development of psychopathology. At-risk populations that may benefit from related intervention include infants who are high in negative emotionality (Kostyrka-Allchorne, Wass, & Sonuga-Barke, 2020) and infants of depressed mothers since depression in mothers has been associated with higher observed negative affect and lower observed positive affect (Lovejoy et al., 2000). Thus, these findings may inform future research and intervention for both typically developing infants and those at greater risk of developing later psychopathology.

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Table 1

Summary of Coding Categories for Observed Infants' Affect

Intensity	Type of Code	Description
+2	Positive	Excitement, smile, laughter, squeal, happy gurgling.
+1	Positive	Positive interest, active engagement: Showing positive interest (e.g., raised eyebrows) and attentiveness (to people or toys) without additional facial or vocal cues.
0	Neutral	None of the above or below: May have blunt affect, no raised eyebrows or large body movements which show interest, eyes wandering ("staring into space"), indicating lack of engagement.
-1	Negative	Negative concentration. Wrinkled or furrowed brow in concentration (distress), smile with furrowed brow, withdrawal movements, pouting, pre-cry face, disgust.
-2	Negative	Marked distress in face and voice: Crying accompanied by appropriate facial expressions (scrunching up face, closed eyes, maybe tears). Protesting, fussing, whimpering, grunting, frustration sounds. Temporary cessation of breathing.

Table 2

Summary of Coding Categories for Observed Mothers' Affect

Intensity	Type of Code	Description
+3	Positive	Laughter: Vigorous smile with outward laughter or giggling.
+2	Positive	Smile: Smiles with any eye involvement or smiles with raised eyebrows. Or brief chuckles – inward, more brief and more contained than laughter.
+1	Positive	Interest: Smiles with no eye involvement. May include brief, ambiguous mouth or facial movements, or expressions of surprise.
0	Neutral	None of the above or below: May include brief (less than or equal to 1 second) frown or sobering expression.
-1	Negative	Worry/tension: Worried/frowning expression in the face and/or tension in body alone. Grimaces (smiles with furrowed brow) also included.
-2	Negative	Brief, marked distress: Marked distress that is brief (less than 5 seconds). Same as for -4, but for brief interval or lesser intensity.
-3	Negative	Marked distress: Marked distress for 5 seconds or more. May include marked sadness, disgust, fear, or anger.

Table 3

Means, Standard Deviations, Minimums, and Maximums for Pre-Frustration Tasks Infant and Mother Variables

	M	*SD*	*min*	*max*
Infants' Negative Emotionality	3.70	.87	2.10	5.50
Infants' Average RSA during free play	3.45	1.27	.61	6.84
Mothers' Depressive symptoms (CES-D score)	6.74	6.30	.00	22.00
Mothers' Positive affect (PANAS score)	37.09	7.43	24.00	50.00
Mothers' Negative affect (PANAS score)	15.97	4.34	10.00	28.00
Mothers'% time positive affect during free play	83.89	12.42	46.81	100.00
Mothers'% time negative affect during free play	.02	.03	.00	.16
Mothers'% time neutral affect during free play	14.13	12.33	.00	50.39
Mothers' Average affect intensity during free play	1.03	.26	.45	1.60

Table 4

Means, Standard Deviations, Minimums, and Maximums for Infants' Observed Behavioral and Physiological Variables During Frustration Tasks

	Positive Affect Condition				Negative Affect Condition			
	M	*SD*	*min*	*max*	*M*	*SD*	*min*	*max*
% time negative affect	85.41	24.27	8.20	100.00	97.43	7.09	64.24	100.00
% time positive affect	12.43	23.16	.00	89.83	2.24	6.69	.00	35.76
% time neutral affect	2.49	8.01	.00	36.32	.33	1.35	.00	6.65
Average affect intensity	-1.33	.80	-2.00	1.00	-1.78	.34	-2.00	-.52
Average RSA	3.83	1.27	.33	6.56	3.18	1.45	.42	5.62
RSA withdrawal	-.36	1.52	-3.65	3.35	.24	1.77	-3.50	4.15

Table 5

Means, Standard Deviations, Minimums, and Maximums for Manipulation Check: Mothers' Observed Behavioral Variables During Frustration Tasks

	Positive Affect Condition				Negative Affect Condition			
	M	*SD*	*min*	*max*	*M*	*SD*	*min*	*max*
% time positive affect	93.28	8.34	63.90	100.00	.28	1.34	.00	7.58
% time negative affect	2.64	4.45	.00	15.82	95.80	5.28	73.10	100.00
% time neutral affect	4.27	6.80	.00	38.56	3.91	4.97	.00	26.90
Average affect intensity	1.21	.36	.66	2.00	-.96	.06	-1.07	-.73

Table 6

Intercorrelations for Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Infants' sex (male = 1)	-														
2. Infants' age	.04	-													
3. Infants' negative emotionality (IBQR-VSF score)	-.27	.31	-												
4. Mothers' depressive symptoms (CES-D score)	-.04	.03	.04	-											
5. Mothers' positive affect (PANAS score)	.11	-.14	-.32	-.57**	-										
6. Mothers' negative affect (PANAS score)	-.08	.15	.24	.57**	-.38*	-									
7. % time mothers' positive affect during free play	-.28	-.24	.19	-.36*	.24	-.27	-								
8. % time mothers' negative and neutral affect during free play	.35*	.24	-.17	.24	-.17	.29	-.96**	-							
9. Mothers' average intensity of affect during free play	-.21	-.18	-.01	-.40*	.29	-.21	.88**	-.81**	-						
10. Positive affect condition: % time distressed infants' negative affect	.04	.10	.44**	-.29	-.02	-.18	.30	-.22	.15	-					
11. Negative affect condition: % time distressed infants' negative affect	-.18	.02	.20	.02	.10	.17	-.07	.14	.01	.24	-				
12. Positive affect condition: distressed infants' average affect intensity	-.07	-.12	-.37*	.24	.06	.14	-.21	.15	-.12	-.94**	-.22	-			
13. Negative affect condition: distressed infants' average affect intensity	.01	.05	-.12	.09	-.09	-.04	.07	-.17	-.05	-.29	-.91**	.29	-		
14. Positive affect condition: RSA withdrawal score	.07	.08	-.06	-.21	.19	-.02	.24	-.15	.42**	.09	.17	-.14	-.19	-	
15. Negative affect condition: RSA withdrawal score	-.15	-.13	.02	-.27	.15	-.17	.50**	-.47**	.51**	.31	.17	-.35	-.22	.66**	-

$^{*}p < .05$, $^{**}p < .01$

Table 7

Results of T-Tests Examining Differences in Dependent Variables Based on Mothers' Answers to How Often They Typically Display Negative Affect in Response to Infants' Distress

	Never or Sometimes			Often or Almost Always			*t*	Significance	*d*
Infant Variables	*n*	*M*	*SD*	*n*	*M*	*SD*			
Positive Affect Condition: % Time Negative Affect	25	84.81	23.01	9	85.44	29.79	-.07	*p* = .95	-.02
Negative Affect Condition: % Time Negative Affect	23	96.58	8.23	9	99.60	1.19	-1.09	*p* = .29	-.27
Positive Affect Condition: Average Affect Intensity	25	-1.32	.78	9	-1.27	.90	-.15	*p* = .88	-.04
Negative Affect Condition: Average Affect Intensity	23	-1.74	.39	9	-1.90	.12	1.17	*p* = .25	.29
Positive affect Condition: RSA Withdrawal Score	25	-.33	1.56	7	-.44	1.50	.16	*p* = .87	.04
Negative Affect Condition: RSA Withdrawal Score	23	.05	1.61	8	.81	2.19	-1.05	*p* = .30	-.27

Table 8

Results of T-Tests Examining Differences in Dependent Variables Based on Mothers' Answers to How Often They Typically Display Positive Affect in Response to Infants' Distress

	Never or Sometimes			Often or Almost Always			*t*	Significance	*d*
Infant Variables	*n*	*M*	*SD*	*n*	*M*	*SD*			
Positive Affect Condition: % Time Negative Affect	16	82.33	30.23	18	87.33	18.62	-.59	*p* = .56	-.14
Negative Affect Condition: % Time Negative Affect	15	94.99	9.89	17	99.58	1.22	-1.90	*p* = .07	-.48
Positive Affect Condition: Average Affect Intensity	16	-1.21	.92	18	-1.39	.70	.64	*p* = .53	.15
Negative Affect Condition: Average Affect Intensity	15	-1.67	.46	17	-1.88	.12	1.85	*p* = .08	.46
Positive affect Condition: RSA Withdrawal Score	14	-.56	1.29	18	-.19	1.70	-.67	*p* = .51	-.17
Negative Affect Condition: RSA Withdrawal Score	14	.18	1.84	17	.29	1.77	-.17	*p* = .87	-.04

Table 9

Intercorrelations for Manipulation Check Variables and Dependent Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Positive affect condition: % time mothers spent in positive affect	-											
2. Positive affect condition: % time mothers spent in negative affect	-.75**	-										
3. Positive affect condition: mothers' average affect intensity	.55**	-.53**	-									
4. Negative affect condition: % time mothers spent in positive affect	.06	-.06	.11	-								
5. Negative affect condition: % time mothers spent in negative affect	-.01	.15	.09	-.35	-							
6. Negative affect condition: mothers' average affect intensity	.04	-.16	-.06	.52*	-.96**	-						
7. Positive affect condition: % time distressed infants' negative affect	-.10	.11	-.14	.13	.08	-.05	-					
8. Negative affect condition: % time distressed infants' negative affect	-.09	-.10	.22	.03	.63**	-.54**	.24	-				
9. Positive affect condition: distressed infants' average affect intensity	.10	-.17	.21	-.16	.00	-.06	-.98**	-.22	-			
10. Negative affect condition: distressed infants' average affect intensity	.08	.07	-.21	-.06	-.48**	.42*	-.29	-.91**	.29	-		
11. Positive affect condition: RSA withdrawal score	.40*	-.55**	.17	.29	-.18	.18	.09	.17	-.14	-.19	-	
12. Negative affect condition: RSA withdrawal score	.23	-.25	-.02	.07	-.01	-.02	.31	.17	-.35	-.22	.66**	-

$^{*}p < .05$, $^{**}p < .01$

Table 10

Skewness, Kurtosis, and Shapiro-Wilk Statistics for Log Transformed Observed Behavioral Variables During Frustration Tasks

	Positive Affect Condition		Negative Affect Condition	
	% time Negative Affect	Average Affect Intensity	% time Negative Affect	Average Affect Intensity
Skewness (SE)	0.33 (0.41)	0.88 (0.41)	1.91 (0.41)	2.17 (0.41)
Kurtosis (SE)	-1.51 (0.81)	-0.07 (0.81)	2.55 (0.81)	4.52 (0.81)
Shapiro-Wilk	0.82	0.88	0.56	0.70
Shapiro-Wilk sig.	< .01	< .01	< .01	< .01

Table 11

Mixed Model Parameter Estimates for the Prediction of Percent of Time Infants Spent in Negative Affect Across Conditions

	Estimate	*SE*	*t*	Significance	95% CI Lower	95% CI Upper	*d*
Intercept[1]	83.45	6.93	12.04	$p < .001$	69.55	97.34	2.93
Condition	12.52	4.04	3.10	$p < .01$	4.32	20.72	.75
Condition Order	-4.60	2.25	-2.05	$p < .05$	-9.19	-.02	-.50
Negative Emotionality	2.24	1.28	1.74	$p = .09$	-.38	4.86	.42

Note:
[1]Intercept reflects estimated mean percent of time spent in negative affect across both conditions.

Table 12

Mixed Model Parameter Estimates for the Prediction of Infants' Intensity of Negative Affect Across Conditions

	Estimate	*SE*	*t*	Significance	95% CI Lower	95% CI Upper	*d*
Intercept[1]	-1.40	.30	-4.66	$p < .001$	-2.00	-0.79	-1.11
Condition	-.48	.13	-3.63	$p < .01$	-.75	-.21	-.87
Condition Order	.24	.11	2.27	$p < .05$	.03	.46	.54
Negative Emotionality	-.07	.06	-1.19	$p = .24$	-.20	.05	-.28

Note:
[1]Intercept reflects estimated mean intensity of negative affect across both conditions.

Table 13

Mixed Model Parameter Estimates for the Prediction of Infants' RSA Withdrawal Across Conditions

	Estimate	*SE*	*t*	Significance	95% CI Lower	95% CI Upper	*d*
Intercept[1]	-2.66	1.02	-2.62	$p < .05$	-4.73	-.59	-.63
Condition	.51	.24	2.09	$p < .05$	.01	1.00	.50
Condition Order	-.88	.43	-2.03	$p = .05$	-1.75	.00	-.49
Mothers' avg. affect intensity during FP	3.57	.89	4.01	$p < .001$	1.76	5.38	.96

Note:
[1]Intercept reflects estimated mean RSA withdrawal across both conditions.
FP = Free play

Figure 1

Duration of Frustrated Infants' Negative Affect in Positive and Negative Conditions

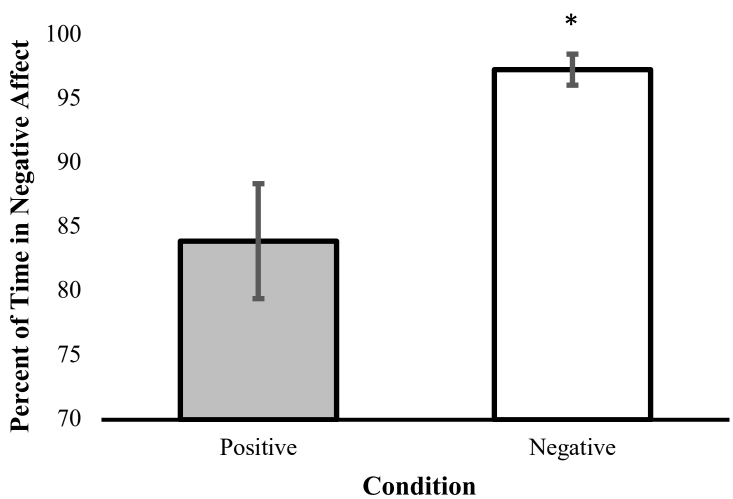


Figure 2

Intensity of Frustrated Infants' Negative Affect in Positive and Negative Conditions

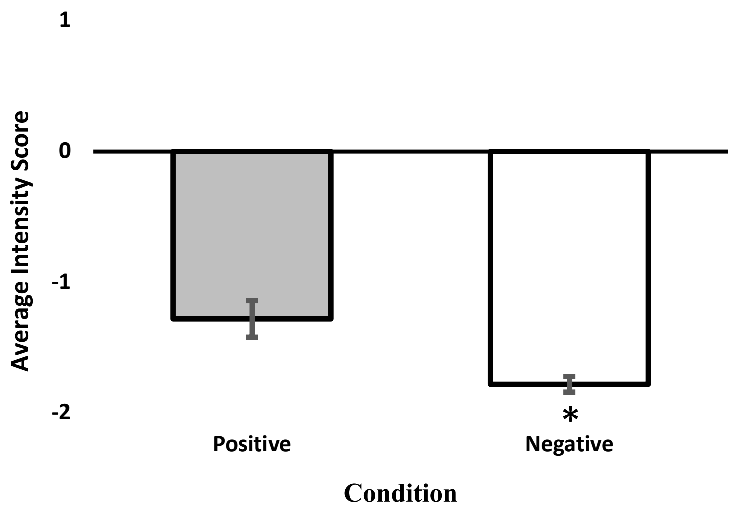
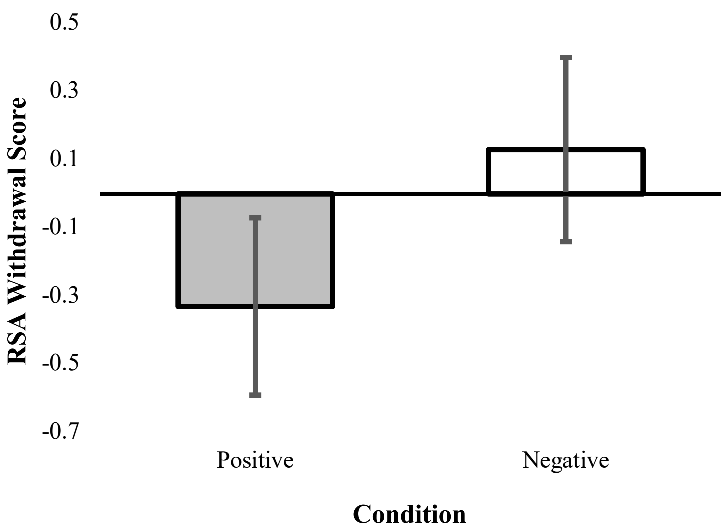


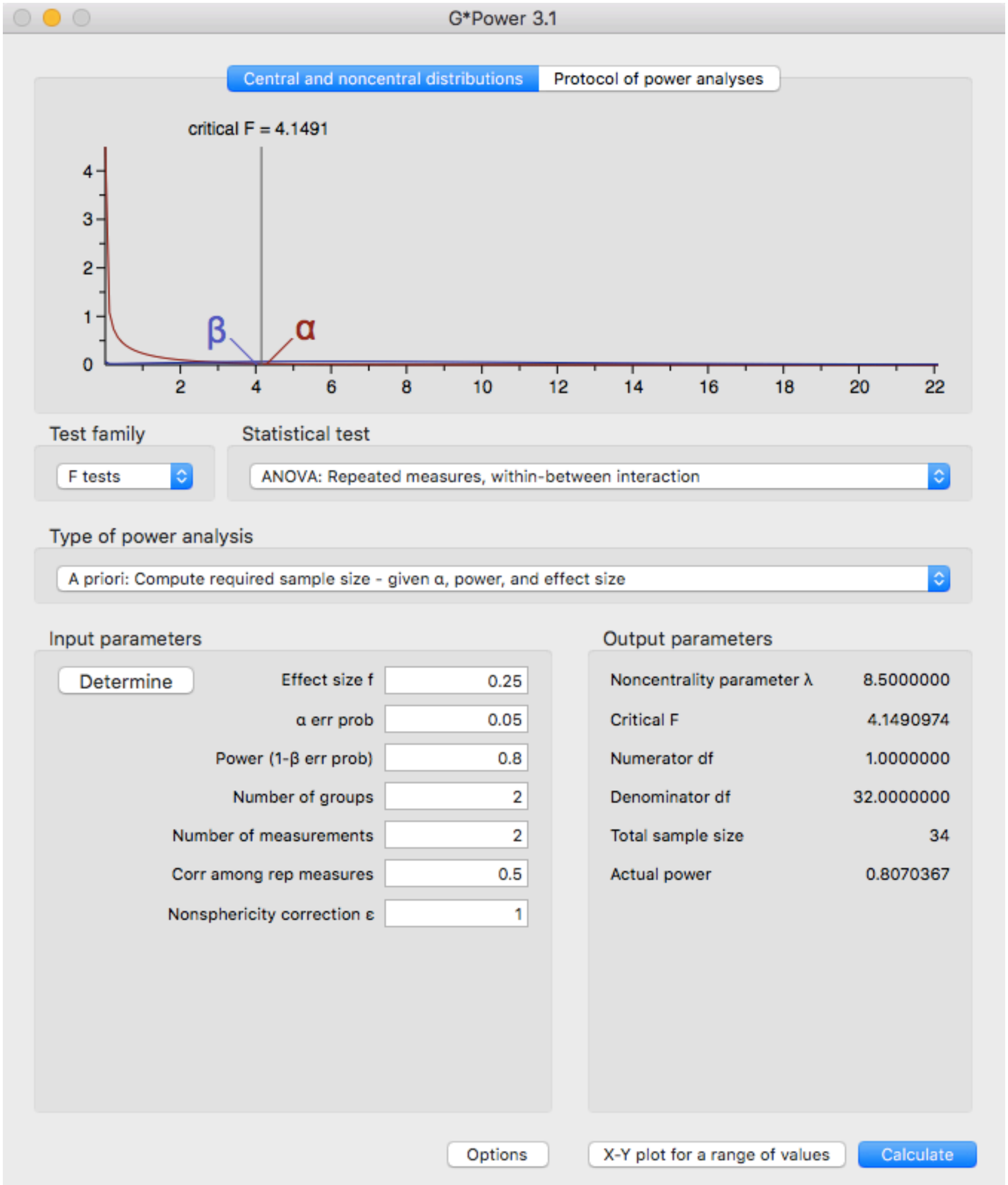
Figure 3

Frustrated Infants' RSA Withdrawal in Positive and Negative Conditions



Appendix A

Screenshot of A Priori G*Power Analysis



Appendix B

Study Manual

Participant Recruitment

Mothers and their infants, younger than 8 months old, will be recruited from around the greater Atlanta, GA area through flyers, word of mouth, media announcements, internet postings (e.g. Facebook) or through the Emory Child Study Center's database of families who offered to be contacted about participating in child development related studies.

See "Recruitment Script" and Recruitment Script Add On" documents for information on answering questions about the study – print out if you're going to recruit somewhere.

Potential Participant Tracking

Contact by email, text or call:

- One designated RA should check the Camel Lab Gmail account throughout the day, at least 1x a day
- When mothers contact the Gmail or voice account, input their information into the "Screening and Tracking - Frustration Study" document
  - Complete all other information for that mother on the spreadsheet
- Call mothers to complete the phone screening or to schedule a time to complete the phone screening within 24 hours of their initial contact
- If mothers do not respond after a contact attempt, make second attempt in 3-5 days and follow-ups should be by the same RA who made the initial contact whenever possible
- If mothers did not include their phone number in their email, reply asking for their phone number and the best time to contact them for a 10-minute-long phone screening
- Make sure that all applicable information is completed for each mother on the "Screening and Tracking - Frustration Study" document

Contact from the Child Study Center database:

- Input mothers' information into the "Screening and Tracking - Frustration Study" document
  - Complete all other information for that mother on the spreadsheet
- Call mothers to complete the phone screening or to schedule a time to complete the phone screening
- Make sure that all applicable information is completed for each mother on the "Screening and Tracking - Frustration Study" document

Participant Screening

- Print the following documents:
  1. "Phone Screener"
  2. "Verbal_Screening_Consent.doc"

- Read through the phone screener
  - Read the verbal screening consent after "do you have an infant younger than 8 months of age?"
  - If you are uncertain about whether or not a mom is eligible, say that you need to check with the PI and that you will get back to her
  - Write down the time the participant is scheduled on the last page of the phone screener
  - If she is coming on a weekday, ask how she will be getting to campus; if she is driving on a weekday—inform Meeka that she will need parking money.
- Using the e-mail template, email mothers the Verbal_Screening_Consent_PDF to withdraw their verbal consent – **this does not have to be signed
- Make sure that all applicable information is completed for each mother on the "Screening and Tracking - Frustration Study" document
- Create a folder with the family's last name on it for eligible families with the following:
  - 1) Verbal Screening Consent
  - 2) Phone Screening
- For ineligible families, staple the screening consent and phone screening documents together and place in alphabetical order in the "ineligible" folder
- Place all Verbal Screening Consent and Phone Screening documents in the locked cabinet

Data security information -
Questionnaires will be completed using Qualtrics, only using the subject ID number. No name, address, or contact information will be entered into Qualtrics.

All data will be securely saved on to an external hard drive and Emory network drive. The external hard drive will be stored within a locked cabinet in a locked room within the secure Emory Department of Psychology.

Data will be deidentified; participants' names and ID numbers will be saved in one password-protected document with access restricted to the principal investigator, faculty advisor, research coordinator, and trained research assistants.

All other data will be linked to an ID number. Only consent forms and Master ID table will contain participant's name, email, and phone number. Consent forms will be stored only in hard copy in a locked cabinet in the office of the key study personnel within a locked office.

Participant Scheduling and RA Availability

- RAs should indicate their availability on the Camel Lab Google Calendar including weekends
- Schedule families ONLY during times that there are:
  1. Two available RAs or
  2. One available RA and Meeka

- Once a family is scheduled, create a calendar event on the Camel Lab Google Calendar and email the RAs and Meeka: "I scheduled a family to come in on XXX at XXX time."

Running Lab Visits

Day before preparation:

- Call/text/e-mail the mother to confirm the appointment and send Qualtrics surveys with ID number
- Remind mom to call, text, or email once she arrives at the North entrance of the building – give your Google Voice Number again.
    - Ask mother to dress baby in two-piece clothing set or a one-piece that can be easily opened for placement of heart rate electrodes.
- Leave a VM if they do not answer the phone and send an email reminder asking that they please reply "Confirm"
- Email Meeka after confirming the appointment:
  "Tomorrow's mother confirmed her appointment at XX o'clock. She will/will not need money for parking."
- Email all lab personnel: "There is a study visit occurring tomorrow at XX o'clock. Please plan to not use the lab during this time."
- Make sure that the following are charged:
    - iPad
    - Ear bud devices
    - HR batteries

Day of preparation:

1. Get out appropriate paperwork:
    - Checklist
    - Lab visit worksheet
    - 2 copies of the consent form
2. Label lab visit worksheet with: date, participant ID
    - *Double check that it is the correct ID number!
3. Check if mother completed Qualtrics questionnaires
4. Get out "Master" and "Remote" headsets and earpiece (unopened)
5. Pull up iPad videos
6. Put do not disturb sign up outside the main lab door
7. Make sure furniture is in correct place
    - Make sure baby is facing one of the cameras and mom is facing the other camera
    - Use Clorox wipes to sanitize the chair
8. Turn on the video equipment by pushing two buttons: the power button on the VCR and the monitor power button on the TV. [If video is not working, check the top red wire].
    - Video settings should be set so that the screen splits evenly and there is a good view of both mom and baby
9. Turn on Dazzle Computer
   Video Capture Instructions:

- Open Pinnacle Studio from desktop
- Click 'Import' Tab (top left)
- Click "Dazzle DVC170" on the left and the cameras will turn on
- Choose file name (on the middle right of screen) use participant name and visit number
- Under "import to" click on participant folder on the server. Click 'ok'
- Click 'start capture' to begin recording video
- When finished click 'stop capture'
- Make sure video saved to folder.

10. Ensure that the toy box used for the free play segment includes the following: spider & cow & dinosaur puppet, firetruck, police car, oil truck, rubber duck, rhino, helicopter, and 2 dolls.
11. Place the white mat in the main lab area with toy rings. [Rings can be brought into the smaller room for play segments].
12. Heart Rate equipment set-up.
    - Make sure you have a Biolog box, the Respiration belt, and the wires with three electrodes attached. [Biolog 3 is preferred]. Use a binder clip to hold excess Respiration belt.
    - Fill a cup with a little water and use a syringe to place a half-drop of water on each of the electrodes to moisten.
    - Only use an alcohol prep pad if baby has oils or lotion on the chest area, as the leads generally stick to the baby's chest more securely if a prep pad is not used.
13. Prepare the receipt for payment and cash for parking.
    - Mom receives $40 and parking money if applicable.
    - (Parking **15min-1hr** = $4, **1hr-2hr** = $6)
    - Mother signs receipt and leaves it with the lab.

Procedure for the Visit

1. Day of dress code = business casual (no shorts)
2. RA1 waits for call, text, or email from mom saying they have arrived.
3. RA1 greets the mom and infant outside of the north entrance of the building (closest to the parking lot) and helps them to feel comfortable.
4. RA1 introduces the participant to RA2 and explains their functions. The number of researchers in the lab should be kept to a minimum.
5. RA1 brings mom to the big table in the middle of the lab for consent.
6. RA2 plays with the baby while RA1 does consent process
    - RA1 explains consent form to mom and answers any questions
    - Ask mom to sign both copies
    - Give mom one copy and keep one copy of the consent form
7. RA1 asks mom to turn off her cell phone or leave it in the main area. Also ensure that she is not chewing gum or wearing a hat.
8. RAs walk mom and baby into the research room.
    - RA1 asks mom to place baby in the chair.
    - Baby and mom play while RA 1 and RA2 set up the Biolog, evaluating the quality of the recording and adjusting electrodes as necessary.

- The reference electrode is green, and it is placed on the baby's right side of chest. It is placed one inch down and one inch out from the baby's nipple.
- The black electrode is placed on the middle of the baby's chest, directly between the baby's nipples.
- The red electrode is placed on the baby's left side of chest. It is placed one inch down and one inch out from the baby's nipple.
- The recording should not be jumpy, and it should be holding steady in the 300-400-500 range. If the reading is jumpy, smooth down the stickers until a steady recording is achieved. If the box reads 1999, that means there is no recording registering.
- Replace the electrodes as needed to get a steady recording.
- The left black button operates as the "tab" and the right black button changes the time and date.
- Place the heart rate box on the table next to the car seat.

9. RA1 goes to start the video recording
10. RA 1 follows the script to begin the 5-minute free-play segment [mother can use toys].
    - RA2 then marks the beginning of the condition by pressing the left event marker button on the Biolog box and recording the Biolog time on the Heart Rate Record Form.
    - RA 1 and RA 2 exit the room
        - When the door closes, RA 2 uses a stopwatch or phone timer to time minutes.
        - When the condition is complete, RA 2 ends the Event Mark is immediately pressed (right button) and recorded on the lab worksheet.

11. RA1 follows the script to begin the frustration task.
    - Ask mom to take the toy away. RA1 places toys out of sight.
    - RA1 shows a brief video demonstration of first condition
        - Odd ID numbers = positive affect first
        - Even ID numbers = negative affect first
    - RA 2 gives mom head set and leaves room to test that sound is working [RA 2 must hold down the "talk" button to prevent static]
12. RA 1 notes the beginning and ending of the frustration task recording by pressing response box button once at the beginning and once at the end of the condition and records the number of the event marker and approximate time of the button press on the Event Mark Record Form.
    - RA 1 cannot be wearing any jewelry or watches
    - RA 1 should hold down baby's forearms [not the wrist]
    - Once RA 2 decides that the baby has produced a full-cry, RA 2 knocks on the window and RA 1 releases forearms.
    - RA 2 tells the mother to start reacting through the headset and starts timer for 3 minutes.
        - RA 1 looks into the mirror's reflection to ensure that baby is not self-soothing with wires or respiration belt.
13. When the condition is complete, RA 2 re-enters the testing room. RA 1 stops the biolog and writes down the time.

- RA1 tells the mother "We are going to take a brief break so that [baby's name] can calm down, then we will do that one more time and ask you to respond differently."
  - Aim to keep baby in the chair but if baby is very upset, take them out of the chair.

14. RA2 starts timer - Allow mom sufficient time to calm baby (10 minutes). Make sure the Biolog is secure if mom takes baby on her lap.
15. To begin second frustration task, re-enter the testing room and follow the script.
    - RA1 shows a brief video demonstration of 2nd condition then asks mom if she would like to practice using the mirror.
    - RA1 asks mom if she is ready then says, "Ok, when you're ready to start, please sit on your hands."
16. RA 1 notes the beginning and ending of the frustration task recording by pressing response box button once at the beginning and once at the end of the condition and records the number of the event marker and approximate time of the button press on the Event Mark Record Form.
17. When the condition is complete, RA1 lets the mother know that the lab visit is complete and that she and [baby's name] did a wonderful job.
18. RA2 turns off studio 10 and disconnects baby from the ECG electrodes and respiratory belt
19. If mother has not completed Qualtrics, she may now complete the form.
20. RA1 thanks the mother, has her sign a receipt acknowledging payment, and gives her the payment and her parking money (if applicable).
    ***(Parking **15min-1hr** = $4, **1hr-2hr** = $6).
    - Give mother a flyer to take with her as well as Child Study Center interest form

After lab visit:

- Place the consent form and receipt (attached together) into the family's folder in the locked file cabinet.
- Put the lab visit worksheet in the large file cabinet.
- Download the heart rate data, prepare the file for editing, & erase the data from box.
- Save video data to folder on GoodmanLab Server.
- Clean the toys.
- Charge ear piece monitors.
- Charge iPad.

1. Find video data under My Documents -> My Videos. Cut and paste the two video files (one is the .scn file) from this folder to the participant's ID folder under Panda Jr. called Digital Files-Lab Visits on the GoodmanLab Server.
2. Download the EKG data from the Biolog box, review the file, and create list files. There are four files created (.xbd, .lbi, .lsp, and .lcg) under Goodman Lab server - > Panda JR - > Heart Rate Data - > Lab Visit xbds. Move the .lbi, .lsp, and .lcg files into the HR List

Files folder, leaving the .xbd file where it is.

For separating the .lbi file for editing:

- "10" marks the beginning of the participant (green line)
- "1" marks the start of a segment (left button press)
- "2" marks the end of a segment (right button press)
- Highlight each segment from "1" - > "2" and cut and paste into new document
- Save each segment under the participant ID in the Heart Rate Data folder (e.g. 3000m_baselinelbi).
- Do not save the changes to the original document.

For deleting the data from the EKG box:

- Turn the Interface box slowly to "Link"
- Once "Firmware" appears on the screen, hold down both buttons
- Select "Find Biolog" on the computer's UFI Biolog program
- Select "Erase Data Array"; it is done when the EKG box reads "PC Link Ready"

Preparing the data:

- Students enter the start- and end- times for each segment into the Coding Entry form

Appendix C

Study Visit Script

1. **Consent forms**
   a. "This is our consent form to participate in the study. Please take a few minutes to read through it and let me know if you have any questions."
   b. "I'll give you a quick run through of what will happen today. First we will get [baby's name] connected to the heart rate monitor. Then we will then ask you to play with him/her as you normally do. Then we will do the two frustration tasks and give you some time to play/calm him/her in between. I'll walk you through each step in detail as we proceed. [*if mom has not completed the questionnaires, say, "then I'll have you complete the questionnaire"]
   Do you have any questions?"
   c. Ask mom, "Do you need some time to feed him/her before we start?"

   RA1 START CAMERA

2. **Free Play**
   a. "Now we have a 5-minute free play time with your baby. Just interact as you normally would if playing during free time on a typical day."

3. **Frustration #1**
   a. "Now we'll do the frustration task. I will gently hold [baby's name]'s forearms down until he/she is frustrated. For the first part when I am holding his/her arms, please display a neutral face and do not respond to or interact with him/her.
   b. After one minute, [RA2's name] will tell you to begin interacting with your infant through this earpiece. At that point, please also place your hands on your baby's legs to help comfort him/her. Just make sure to use sustained touch, so try to just hold on to the legs and not use any stroking. You can try it out now [tell mom if ok or how to improve] [****GIVE EARPIECE**].** Let's do a quick test [*hold thumb up*].
   c. Great, so after the first minute of you responding with a neutral face, you'll hear [RA2's name] instruct you to respond with a happy face/positive affect and tone and do not frown or show a sad face for the next 3 minutes. Here are two video examples of what we're looking for. Here is a reminder of what to do [give mom instruction card]. Do you have any questions? You can use the mirror to your right to practice – let me know when you're done. We will ask you to sit lightly on your hands (or part of your hands) for the first non-interacting part so that you do not engage in any gestures.

[have mom take toys away and then place them outside of baby's eyesight]

   d. When you're ready to start, please sit on your hands."

4. **Calming**
   a. "We are going to take a break for a few minutes so that [baby's name] can calm down, then we will do that one more time and ask you to respond differently. You

can hold and soothe [baby's name] and play with him/her in any way you would like."
[give toys back]*

Take off mom's earpiece

5. **Frustration #2**
    a. "Now we'll do the second frustration task. I will gently hold [baby's name]'s forearms down until he/she is frustrated. For the first part when I am holding his/her arms, please display a neutral face and do not respond to or interact with him/her.
    b. After one minute, [RA2's name] will tell you to begin interacting with your infant through the earpiece. At that point, please also place your hands on your baby's legs to help comfort him/her. Just make sure to use sustained touch, so try to just hold on to the legs and not use any stroking. [****GIVE EARPIECE**]**. Let's do another quick test [*hold thumb up*].
    c. Great, so after the first minute of you responding with a neutral face, you'll hear [RA2's name] instruct you to respond a sad face/negative affect and tone and do not smile or show a happy face for the next 3 minutes. Here are two video examples of what we're looking for. And here is a reminder of what to do [give mom instruction card]. Do you have any questions? You can use the mirror to your right to practice – let me know when you're done. We will ask you to sit lightly on your hands (or part of your hands) for the first non-interacting part so that you do not engage in any gestures.

[have mom take toys away and then place them outside of baby's eyesight]

    d. When you're ready to start, please sit on your hands."

6. **Qualtrics (if mom did not complete beforehand)**
    a. "Please let me know if you have any questions while going through this."

7. **End**
    a. "That completes the lab visit. You and [baby's name] did a wonderful job!
    b. Do you have any friends or family who might be interested in our study as well? [if so, give them our flyer]
    c. Are you interested in being contacted about participating in other studies in other child labs here at Emory? [if so, give them the form to complete]
    d. Thank you for your participation!"

Appendix D

ANCOVA results

Hypothesis Testing

Hypothesis 1

First, we evaluated support for Hypothesis 1, that distressed infants' duration of negative affect would be smaller, and infants' average affect intensity would be less negative when mothers respond with negative affect versus positive affect. Since skew was an issue in our observed behavioral variables, we used the log transformed observed behavioral dependent variables to compare distressed infants' 1) percent of time spent in negative affect and 2) average intensity of expressed affect when mothers responded with positive relative to negative affect. We conducted two ANCOVAs with condition (mothers' positive vs. negative affect) as the within-subjects variable and condition order (positive or negative first) as the between-subjects variable. Based on tests for potential covariates, we included infants' negative emotionality temperament as a covariate. We interpreted our findings based on three levels of effect size: small (η_p^2 = .01), medium (η_p^2 = .06), and large (η_p^2 = .14) (Cohen, 1988).

Findings were opposite of our first hypothesis for the first of the dependent variables, percent of time infants spent in negative affect. The results of the two-way mixed ANCOVA showed that there was a significant main effect of mothers' affect condition on the percent of time infants spent in negative affect, even while controlling for infants' negative emotionality temperament, $F(1, 29) = 7.53$, $p = .01$, $\eta_p^2 = .21$. Infants spent a significantly greater percentage of time in negative affect during the condition in which mothers displayed negative affect (untransformed values: *Madj* = 97.29, *SE* = 1.20), versus the condition in which mothers displayed positive affect (untransformed values: *Madj* = 83.89, *SE* = 4.10) (Figure 1). Consistent with the idea that the randomly assigned order in which mothers showed the two affects would not matter, there was no significant effect of condition order on infants' relative duration of time spent in negative affect, $F(1, 29) = 0.69$, $p = .41$, $\eta_p^2 = .02$, and there was no significant interaction effect between condition and condition order, $F(1, 29) = 1.41$ $p = .25$, $\eta_p^2 = .05$. The main effect of negative emotionality was not statistically significant, $F(1, 29) = 3.32$ $p = .08$, $\eta_p^2 = .10$; similarly, there was no statistically significant interaction effect (between negative emotionality and condition), $F(1, 29) = 3.56$ $p = .07$, $\eta_p^2 = .11$. Because there was no statistically significant main effect of the covariate, negative emotionality, we also ran this analysis without including negative emotionality.

The results of the two-way mixed ANCOVA without including negative emotionality as a covariate also showed that there was a significant main effect of mothers' affect condition on the percent of time infants spent in negative affect, $F(1, 30) = 14.24$, $p < .01$, $\eta_p^2 = .32$. Infants spent a significantly greater percentage of time in negative affect during the condition in which mothers displayed negative affect (untransformed values: $M = 97.29$, $SE = 1.21$), versus the condition in which mothers displayed positive affect (untransformed values: $M = 83.92$, $SE = 4.48$). There was no significant effect of condition order on infants' relative duration of time spent in negative affect, $F(1, 30) = 0.52$, $p = .48$, $\eta_p^2 = .02$, and there was no significant interaction effect between condition and condition order, $F(1, 30) = 1.51$ $p = .23$, $\eta_p^2 = .05$.

As expected, since duration and intensity were so highly correlated, findings were also in the opposite direction of Hypothesis 1 for the second dependent variable, average intensity of infants' expressed affect. There was a significant main effect of mothers' affect condition on the average intensity of infants' expressed affect, even while controlling for infants' negative emotionality, $F(1, 29) = 6.80$, $p < .05$, $\eta_p^2 = .19$. Infants' average intensity of expressed affect was significantly more negative during the condition in which mothers displayed negative affect (untransformed values: *Madj* = -1.78, *SE* = 0.06), versus the condition in which mothers displayed positive affect (untransformed values: *Madj* = -1.28, *SE* = 0.14) (Figure 2). Consistent with the idea that the randomly assigned order in which mothers showed the two affects would not matter, there was no main effect of condition order on infants' average intensity of expressed affect, $F(1, 29) = 1.25$, $p = .27$, $\eta_p^2 = .04$, and there was no significant interaction effect between condition and condition order, $F(1, 29) = .81$, $p = .38$, $\eta_p^2 = .03$. The main effect of negative emotionality was not statistically significant, $F(1, 29) = 3.61$ $p = .07$, $\eta_p^2 = .11$, and there was no significant interaction between negative emotionality and condition, $F(1, 29) = 3.10$ $p = .09$, $\eta_p^2 = .10$. Because there was no statistically significant main effect of the covariate, negative emotionality, we also ran this analysis without including negative emotionality.

The results of the two-way mixed ANCOVA without including negative emotionality as a covariate also showed that there was a significant main effect of mothers' affect condition on average intensity of infants' expressed affect, $F(1, 30) = 13.96$, $p < .01$, $\eta_p^2 = .32$. Infants' average intensity of expressed affect was significantly more negative during the condition in which mothers displayed negative affect (untransformed values: *M* = -1.78, *SE* = 0.06), versus the condition in which mothers displayed positive affect (untransformed values: *M* = -1.28, *SE* = 0.15). There was no significant main effect of condition order on infants' average intensity of expressed affect, $F(1, 30) = .98$, $p = .33$, $\eta_p^2 = .03$, and there was no significant interaction effect between condition and condition order, $F(1, 30) = .90$, $p = .35$, $\eta_p^2 = .03$.

Hypothesis 2

Next, we tested support for Hypothesis 2, that distressed infants' vagal withdrawal would be lower when mothers respond with negative affect versus positive affect. Since skew was not an issue for our RSA withdrawal variables, we used untransformed physiological variables to compare distressed infants' RSA withdrawal when their mothers responded with positive relative to negative affect. We ran a mixed ANCOVA with type of condition (positive vs. negative affect) as the within-subjects variable and condition order (positive or negative first) as the between-subjects variable. Based on tests for potential covariates, we included mothers' average affect intensity during free play as a covariate. We interpreted our findings based on three levels of effect size: small (η_p^2 = .01), medium (η_p^2 = .06), and large (η_p^2 = .14) (Cohen, 1988).

Contrary to Hypothesis 2, results of the two-way mixed ANCOVA revealed that there was no significant main effect of mothers' affect condition on infants' RSA withdrawal while controlling for mothers' average affect intensity during free play, $F(1, 27) = .57$, $p = .46$, η_p^2 = .02 (negative affect condition, *Madj* = 0.13, *SE* = 0.27; positive affect condition, *Madj* = -0.34, *SE* = 0.26) (Figure 3). Findings were consistent with the idea that the randomly assigned order in which mothers showed the two affects would not matter. There was no statistically significant effect of condition order on infants' RSA withdrawal, $F(1, 27) = 2.39$, $p = .13$, $\eta_p^2 = .08$, and there was no statistically significant interaction effect between condition and condition order, $F(1, 27) = 2.38$, $p = .14$, $\eta_p^2 = .08$. There was a significant main effect of the covariate mothers' average affect intensity during free play, $F(1, 27) = 11.60$, $p < .01$, $\eta_p^2 = .30$. There was no significant interaction between mothers' average affect intensity during free play and condition $F(1, 27) = 1.48$, $p = .23$, $\eta_p^2 = .05$.