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**THE BIDIRECTIONAL RELATIONSHIP BETWEEN MOTHERS AND THEIR
INFANTS: A STUDY OF DYADS USING THE STILL FACE PARADIGM**

by

JORDAN L. BOEVE

Submitted to the Graduate School

of Wayne State University,

Detroit, Michigan

in partial fulfillment of the requirements

for the degree of

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2016

MAJOR: PSYCHOLOGY (Cognitive,
Developmental, Social)

Approved By:

Advisor

Date

DEDICATION

This work is dedicated to the most important people in my life: Abhi, my mother, and my father. Thank you for always supporting and believing in me. Also, to Hammy, Harlow, Lincoln, and Tigger for being my best friends and sources of stress relief.

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CHAPTER 1 “Introduction”

The central goal of this study was to evaluate maternal, infant, and dyadic contributions to mother-infant social interactions at 7 months postpartum in an understudied, mostly low-income African American sample. Dyads were videotaped during the Still-Face-Paradigm (SFP, Tronick, Als, Adamson, Wise, & Brazelton, 1978), a widely used procedure designed to evaluate how exposure to a social stressor (maternal still-face) affects infant reactivity and mother-infant social interaction processes. Other goals were to replicate the classic “still-face” effect and better understand the nature of dyadic relationships at this age.

The Nature of Parent-Child Relationships

The bidirectionality of parent-child relationships is a concept that has only come into the spotlight in the past 40 years (Grusec & Hastings, 2007). Before this shift in thought, scientists assumed that the direction of influence in parenting passed solely from parent to child (Bell, 1968; Kuczynski, 2003). Today, experts in child development and parenting no longer endorse a unidimensional view of parent-child relationships. Instead, many psychologists contend that an ongoing dynamic transaction occurs between parent and child throughout development that mutually influences both members of the dyad (Kuczynski, 2003; Sameroff & Chandler, 1975; Sameroff, 2010). For example, a child who is born with a feisty temperament may challenge parents’ ability to engage in sensitive caregiving more than a child born with a more easygoing temperament. In this same vein, according to the Differential Susceptibility Model, a feistier child is more affected by parenting quality, whether positive or negative, than an easygoing child (Belsky, 1984). In this way, both child and parent are affected by the actions of the other.

Consistent with the transactional model, the Mutual Regulation Model describes the parent-infant relationship as a dynamic communication system comprised of both members of

the dyad and their interchanges (Tronick, 1989; Tronick & Beeghly, 2011; Beeghly & Tronick, 2011). The responses of each member of the dyad to the other are crucial in building successful social interactions as experienced by both members of the dyad. The Mutual Regulation Model stresses that relationships are developed and co-regulated by both parent and infant (Beeghly & Tronick, 2011). However, not every moment in an interaction is perfectly reciprocal and synchronous. It is quite common for there to be mismatches in engagement or level of excitement, anger, or attention during interaction (Feldman, 2007). Through mutual participation of both members of the dyad, these mismatches are commonly repaired and the interaction becomes more regulated and synchronous (Tronick, 2007). Over time, if both the infant and parent are able to engage in mostly positive interchanges and quickly repair mismatches, the infant gains self-regulatory skills that contribute to successful interactions with not only the parent but also other adults and peers.

The co-occurrence of maternal and infant behavior and the experience of social contingencies can be observed in the first hours post-birth, indicating that synchrony may be innate in nature (Feldman, 2007). However, it is not until around 3 months that the infant is able to respond to the mother's overtures with facial expressions or vocalizations in an organized manner (Feldman, 2007). Constant shifts in behavior between mother and infant over time make different configurations of affect. For example, there may be a match between mother and infant while both are looking at each other and displaying positive affect. However, given the infant's immaturity, the infant may become dysregulated and gaze away. At this point, if the mother is still exhibiting positive affect, the dyad is experiencing a mismatch. A common maternal response to this situation would be to pause and wait for the infant to recover. When the infant begins to exhibit engagement cues again (e.g., looking or orienting toward the mother), the

mother then attempts to re-engage the infant in the activity. These match/mis-match patterns occur routinely throughout interactions. However, having more mis-matches than matches can lead to having a less synchronous relationship over time. In turn, being less synchronous is associated with having poorer child outcomes, specifically poorer social-emotional adjustment, compared to children who have experienced higher levels of synchrony with their mothers (Feldman, 2007; Feldman & Eidelman, 2004).

Still-Face Paradigm (SFP)

The SFP is a widely used social interaction task designed to evaluate mother-infant interactive processes before and after a social stressor: a maternal still-face. The traditional SFP comprises three successive 2-minute episodes: a baseline (“normal”) mother-infant social play episode during which the dyad interacts as they normally would, followed by a maternal still-face perturbation, during which the mother assumes a still (poker) face and continues to look at the infant while refraining from talking to or touching the infant, followed by a reunion play episode, during which the dyad resumes their normal social interaction. Although the SFP (particularly the still-face and reunion episodes) is emotionally and physiologically stressful for the infant and parent (Tronick et al., 1978), individual differences in infants’ and parents’ responses have also been observed (Braungart-Rieker, Garwood, Powers, & Notaro, 1998).

The maternal still-face results in an extended version of the interruptions and mis-matches that occur naturally during daily interactions between mother and infant (Tronick et al., 1978). Infants characteristically react to the maternal still-face with what has come to be known as the “still-face effect”. This effect has been replicated many times and for many purposes across many studies (Adamson & Frick, 2003). During the still-face episode of the SFP, the infant initially responds to the neutral face of the parent with attempts to re-engage the parent

followed by negative affect and eventual withdrawal and dysregulation. The still-face effect can be observed across a wide variety of infant ages and is robust across a variety of different methodologies, such as length of the still-face episode, and the directions given to the adult for their behavior between segments (Adamson & Frick, 2003; Mesman, van IJzendoorn, & Bakersmans-Kranenburg, 2009).

In their meta-analytic review of studies using the SFP, Mesman et al. (2009) found that infants in diverse samples typically react to the maternal still-face with diminished positive affect, increased negative affect, increased disengagement, and increased heart rate (called the “still-face effect”). This suggests that the maternal still-face is stressful to infants. Moreover, during the reunion episode, infants exhibit a carryover of negative affect but also a rebound of positive affect and social engagement, which suggests that “making up” during the reunion episode is also stressful for infants and caregivers (Weinberg & Tronick, 1996).

Current research shows that the quality of maternal behavior during the first play episode of the SFP is associated with the level of the infants’ positive and negative arousal during the still-face perturbation and the subsequent reunion episode (Conradt & Ablow, 2010; Mastergeorge, Paschall, Loeb, & Dixon, 2014; Mesman et al., 2009). For example, maternal sensitivity predicts a lower display of infant negative affect during the still-face episode (Tarabulsky, Provost, Deslandes, St-Laurent, Moss, Lemelin, Bernier, & Dassylva, 2003), more attempts to re-engage the mother (Carter, Mayes, & Pajer, 1990), and faster re-engagement with less negative affect during the reunion episode (Haley & Stansbury, 2003). Maternal positive parenting behaviors, such as sensitivity, warmth, and positive affect, are related to a higher level of infant positive and negative affect during the reunion episodes (Weinberg & Tronick, 2006); however, findings for the carry-over of negative affect are mixed (Mesman et al., 2009).

Although less well studied, the infant's characteristics and behavior also play a role in the mother's interactive behavior during the SFP. Infants may react differently to the SFP based on their temperament or their sex. Very few studies have investigated infant temperament characteristics in relation to the SFP. Braungart-Rieker and colleagues (1998) found that infants with higher levels of negativity reactivity (temperament) exhibited fewer self-comforting behaviors during the still-face episode of the SFP.

Results have been mixed regarding whether infant sex is associated with infants' reactions to the still-face or maternal or infant behavior during the baseline play or reunion episodes of the SFP. Many studies have found no main effects of sex on infant behavior in the SFP (Abelkop & Frick, 2003; Cossette et al., 1996; Forbes et al., 2004; Garritty-Rokous, 1999; Haley & Stansbury, 2003; Hart, Carrington, Tronick, & Carroll, 2004; Lowe, Handmaker, & Aragon, 2006; Stack & Muir, 1990; Toda & Fogel, 1993; Weinberg, Olson, Beeghly, & Tronick, 2006; Yirmiya et al., 2006). However, Weinberg and colleagues found that male infants have greater difficulty than female infants in regulating their negative emotions during each episode of the SFP (Weinberg, Tronick, Cohn, & Olson, 1999). Conversely, Mayes and Carter (1990) found stronger negative reactions to the SFP among infant girls. Thus, instead of a uni-directional influence from mother to infant, there appears to be a bidirectional influence continuously passing from mother to infant and from infant to mother, which affects the behavior of both members of the dyad over time (Mastergeorge et al., 2014).

Maternal Positive Parenting

Maternal "positive parenting" reflects multiple dimensions of maternal interactive behavior with her infant, including behavioral sensitivity, affective sensitivity, engagement, flexibility, warmth, and positive affect. These dimensions of parenting often co-occur and work

together to support infants' focus of attention, goals, and social emotional well-being during parent-infant interactions. Sensitivity reflects both behavioral and affective dimensions of maternal behavior. It is typically conceptualized as the caregiver's degree of attunement to the infant's behavioral and affective engagement and disengagement cues during caregiver-infant interaction, including mothers' level of cooperation with the infant's focus of attention and interactive goals, and level of emotional availability (supportive presence) to the infant (Paulussen-Hoogeboom et al., 2008). Sensitivity also reflects the amount of enjoyment that a parent displays while interacting with the infant and a conscious decision to act in a manner supporting the best interests of the infant (Corwyn & Bradley, 1999). Mothers who display sensitivity with their infants during social interactions are also likely to be actively engaged with them, and flexibly attuned and responsive to their infant's changing states and goals. Caregiver warmth is conceptualized as the degree to which a caregiver demonstrates affection and positive regard for her infant during social interaction, as displayed by positive facial expressions, physical affection for the infant such as hugging, kissing, or patting, positive vocal tone, and specific words directed toward the infant that express positive regard (Kawabata, Alink, Tseng, van IJzendoorn, & Crick, 2011). Mothers who display these positive parenting qualities are also likely to display higher levels of positive affect and low levels of negative affect.

A growing body of studies shows that positive parenting defined this way is linked to positive infant outcomes in a multitude of differing domains such as attachment security, greater self-regulation skills and internalized controls, as well as prosocial behavior (Belsky, 1984; Chen, Dong, & Zhou, 1997). Infants who experience more positive parenting during the first year of life also exhibit less physiological stress, as indexed by lower cortisol levels in toddlerhood (Blair et al., 2008).

Maternal positive parenting during the baseline play episode of the SFP is associated with lower levels of infant dysregulation during and after the maternal still-face, as well as in other stressful contexts (Beebe & Lachmann, 1998; Cohn & Tronick, 1987; Lowe, MacLean, Duncan, Aragon, Schrader, & Caprihan, 2012; Gunning, Halligan, & Murray, 2013; Martinez-Torteya et al., 2014). In addition, both parental sensitivity during the SFP and infants' responses to the maternal still-face predict attachment security in later infancy (Braungart-Rieker, Zentall, Lickenbrock, Ekas, Oshio, Planalp, 2014; De Wolff & van IJzendoorn, 1997). Although most studies have investigated maternal parenting behavior during the SFP (Mesman et al., 2006), at least one study has shown that maternal parenting behavior in other contexts is also related to infant positive and negative reactivity during the SFP (Tarabulsky, Provost, Deslandes, St-Laurent, Moss, Lemelin, Bernier, & Dassylva, 2003).

Infant Temperament

Because both members of the dyad determine interaction quality, infant temperament is theoretically just as important to evaluate as maternal parenting behaviors, in order to understand individual differences in the quality of the mother-infant interaction. As a general definition, temperament refers to individuals' early-emerging automatic emotional responses to different stimuli (Hiramura, Uji, Skikai, Chen, Matsuoka, & Kitamura, 2010), such as new situations, establishing routines, distractibility, and quality of mood. Of particular importance are the infant's reactivity and self-regulation (Rothbart & Bates, 2006).

Individual differences in temperament emerge early in life and are thought to be influenced by biological as well as environmental factors (Ganiban, Ulbricht, Saudino, Reiss, & Neiderhiser, 2010). Stella Chess and Alexander Thomas were among the first to describe individual differences in infant temperament during home observations in their New York

Longitudinal Study (Thomas & Chess, 1977). Chess and Thomas report that infants vary along nine behavioral dimensions (e.g., mood, approach, and distractibility), which can be combined into three temperament categories: “easy”, “slow-to-warm-up” and “difficult” (Thomas & Chess, 1977; Szabo, Dekovic, C. van Aken, Verhoeven, M.A.G van Aken, & Junger, 2008).

Easy children are typically carefree and easygoing, able to establish routines, flexibly adjust to new situations, and are cheerful most of the time. Slow-to-warm up children may be fearful and have a difficult time adjusting to new people or unknown situations. However, once given the opportunity to get acclimated, these children display similar behavior to easy children. Difficult children are more likely than other children to exhibit negative and irritable moods, often have a difficult time adjusting to new situations, have irregular schedules for eating, sleeping, and elimination, are high in activity level, and have intense reactions to stimuli (Bradley & Corwyn, 2008).

Early research on temperament has contributed to changing conceptions of infant development that characterized research in the 1970’s and 1980’s. This research demonstrates that infants vary on different aspects of their behavior that affect parenting quality and efficacy, and are linked to children’s outcomes. This research has also been instrumental in sparking the emergence of transactional models of parenting and infant development (Sameroff & Chandler, 1975; Sameroff, 2010).

Later work on temperament refined and elaborated Chess and Thomas’ temperament dimensions. In their theory of the structure and development of temperament, Mary Rothbart and colleagues identified multiple basic dimensions of infant temperament: fearful distress, irritable distress, attention span and persistence, activity level, positive affect, and rhythmicity. Notably, Rothbart et al.’s methods for assessment temperament are more time-limited and context-based

than those of Chess and Thomas, an approach that minimizes self-report bias. Moreover, because the parental questionnaires used to assess these dimensions are lengthy and often burdensome for parents, Rothbart and colleagues have developed several short-forms of their temperament questionnaires for different child age groups. For instance, scoring of their very short form of the Infant Behavior Questionnaire-Revised (IBQ-R) yields three temperament categories: surgency, negative affect, and effortful control (Rothbart, Ahadi, Hershey, & Fisher, 2001; Gartstein & Rothbart, 2003; Rothbart & Ahadi, 1994).

Surgency. Surgency refers to the infant's positive affectivity and activity level, and is often compared to "extraversion", one of the Big Five personality traits (Costa & McCrae, 1985). In young children, surgency typically manifests as smiling, laughter, exploration of the environment, and interest in novel items and experiences (Oddi, Murdock, Vadnais, Bridgett, & Gartstein, 2013). Very few studies have investigated how infant surgency and parenting are related to one another. In one exception, Pesonen and colleagues (Pesonen, Raikkonen, Heinonen, Komsu, Jarvenpaa, & Strandberg, 2008) evaluated the cross-sectional association between infant surgency and parenting stress. They report that higher infant surgency is related to lower concurrent parenting stress, although the longitudinal associations between these variables are still unknown.

Negative affect. Negative affect refers to infants' negative emotional expressivity and reactivity, such as distress to a novel person or object, or to frustrating events such as being restrained from obtaining a goal (Paulussen-Hoogeboom et al., 2008). Among infants and young children, negative affect manifests as crying, whimpering, fussing, irritability, whining, and/or negative facial expressions (e.g., anger and sadness). Paulussen-Hoogeboom et al. (2008) report that infants who exhibit greater levels of negative affect evoke different responses from their

caregivers than infants who exhibit lower levels of negative affect, regardless of their caregivers' personalities (Paulussen-Hoogeboom et al., 2008).

Effortful control. Effortful control involves the ability to regulate attention, plan, and inhibit a dominant response (Rothbart & Bates, 2006), and it embodies many of the same qualities as the broader construct of executive functioning. Critically, effortful control is not present at birth and emerges slowly during early childhood, corresponding to the prolonged maturation, synaptogenesis, pruning, and myelination of the frontal cortex. Individual differences in effortful control during early childhood are marked, and are linked with greater resilience during challenging situations in later childhood and adolescence (Eisenberg, Smith, Sadovsky, & Spinrad, 2004).

Dyadic Relationship between Mother and Infant

Although it is important to evaluate maternal and infant behaviors separately during mother-infant interaction paradigms, it is also important to study interaction processes at the dyadic-level. Early relationships between infants and their mothers emerge gradually over time and are influenced by both caregiver and infant behaviors and characteristics. Because infants are immature, early social interactions between infants and their mothers are not smooth and well-coordinated. Rather, their interactions are characterized by periods of mutual positive engagement (“matches”) that are followed by periods of disengagement and miscoordination (“mismatches”) (Tronick et al., 1978; Tronick, 1989). Periods of dyadic engagement are associated with the infant’s display of positive or neutral affect, whereas periods of dyadic disengagement are associated with the infant’s expression of negative affect.

Caregiver regulatory support is critical in supporting infants’ ability to engage the world of people and objects in a positive manner (Calkins & Hill, 2007; Tronick, 1989). When mothers

are responsive to their infants' disengagement cues and allow their infants time to recover from their disengagement and distress, these moments of mismatch are typically brief and quickly repaired (Beebe & Lachmann, 1998; Cohn & Tronick, 1987; Weinberg et al., 1999). Over time, the dyad's ability to repair mismatches quickly is thought to contribute to the infant's capacity to self-regulate (Calkins & Hill, 2007; Kopp, 1982; Tronick & Beeghly, 2011; Tronick & Gianino, 1986). Conversely, if mothers are less responsive and sensitive to their infant's disengagement cues, the frequency and duration of dyadic mismatches may increase (Murray, Fiori-Cowley, Hooper, & Cooper, 1996; Murray, Stanley, Hooper, King, & Fiori-Cowley, 1996). If these mismatches become prolonged and chronic, they may lead to behavioral and developmental problems (Tronick & Beeghly, 2011).

Infant characteristics are also important to consider. Infant difficult temperament or negative behavior may make dyadic repairs more effortful. When caregivers are low in sensitivity to their infants, the combination of child irritability and maternal insensitivity are linked to poorer infant recovery after exposure to stress (Gunning et al., 2013). This evidence is consistent with a transactional model of infant development, and shows that both maternal and infant characteristics contribute to dyadic relationship quality. Perhaps infants who have mothers who display higher levels of positive affect before a stressful situation, like the SFP, are more likely to mimic those positive behaviors after a stressful situation. This could be the same for infants of mothers who display higher levels of negative affect.

The Current Study

The current study sought to evaluate mother-infant interactive processes during the SFP in an understudied, mostly low-income African American sample at 7 months postpartum. The following aims and hypotheses were addressed:

Aim 1: The first aim was to evaluate whether the traditional still-face and reunion effects identified in prior research could be identified in the present sample. We specifically looked for change and stability in infant and maternal behavior before, during, and after a stressor (the still-face).

Based on the meta-analytic review by Mesman et al. (2009), we expected to see a relatively low amount of object engagement during the baseline, a high amount during the still-face, and a low amount during the reunion as objects can be used as a coping method during the stressor. We also expected to see a high level of social engagement during the baseline, a low level during the still-face, and a rebound of social engagement during the reunion (i.e., one that is not as high as baseline but not as low as during the still-face). We further anticipated that infants would exhibit a high level of infant positive affect during baseline, a large decline in positive affect during the still-face, and a recovery of positive affect in the reunion, which was larger than during the still-face but not quite as large as at baseline. Conversely, we expected to see a low level of infant negative affect during the baseline, a high level during the still-face, and a carryover of negative affect during the reunion with partial abatement.

Among mothers, we hypothesized that mothers would exhibit an increase in positive parenting from the baseline to the reunion. We anticipated this change in maternal behavior because mothers might be likely to soothe and comfort their stressed infant in the latter episode.

We also expected that mothers and infants would exhibit relative stability in their behavior and affect across the episodes of the SFP. Specifically, we hypothesized that mothers would retain their relative rank-ordering in positive and negative parenting scores from baseline to reunion.

In addition, we explored whether infant sex was associated with maternal ratings of infant temperament, or observed maternal, infant, and dyadic behavior during the SFP. We also evaluated whether infant sex moderated the association between infant temperament and the observed interaction variables. We hypothesized that there would be no difference between infant sex and temperament and behavior during the SFP, based on the null findings of previous studies (Abelkop & Frick, 2003; Cossette et al., 1996; Forbes et al., 2004; Garritty-Rokous, 1999; Haley & Stansbury, 2003; Hart, Carrington, Tronick, & Carroll, 2004; Lowe, Handmaker, & Aragon, 2006; Stack & Muir, 1990; Toda & Fogel, 1993; Weinberg et al., 2006; Yirmiya et al., 2006).

Aim 2: The second aim was to assess whether the three dimensions of infant temperament described above (surgency, infant negative affect, and effortful control) were associated with maternal positive and negative parenting assessed during the baseline play and reunion episodes of the SFP. Maternal positive parenting was evaluated using a composite variable reflecting sensitivity, engagement, warmth, flexibility, and positive affect. Maternal negative parenting was evaluated using a single rating: hostile/rejecting/discrepant parenting.

It was hypothesized that infants with higher levels of surgency or effortful control would have mothers who exhibited higher levels of positive parenting during mother-infant interaction. Conversely, it was expected that infants with higher levels of higher negative affect would have mothers who displayed lower levels of warmth and sensitivity during mother-infant interaction. In addition, it was hypothesized that infants with higher levels of negative affect would have mothers who engaged in higher levels of negative parenting during the SFP.

Aim 3: The third aim was to assess whether maternal report of infant temperament predicted observed infant behavior during each episode of the SFP.

It was hypothesized that infants with higher levels of surgency would exhibit less negative emotionality, more positive affect, and more social engagement during the still-face episode of the SFP, compared to infants with lower levels of surgency. Conversely, it was expected that infants with higher levels of negative affect would exhibit more negative emotionality and less social and object engagement during the still-face episode of the SFP, compared to infants with lower levels of negative affect. Finally, it was anticipated that infants with higher levels of effortful control would exhibit more social and object engagement during the Still-Face episode of the SFP than infants with lower levels of effortful control.

Aim 4: The fourth aim was to assess whether mothers' levels of positive and negative parenting during the baseline play episode of the SFP were associated with infants' observed behavior and affect during the still-face and reunion episodes of the SFP.

It was hypothesized that infants of mothers with higher levels of positive parenting would exhibit lower levels of negative emotionality when exposed to the social stress of a maternal still-face and better recovery during the reunion. This was expected because infants of sensitive mothers may be more accustomed to having their cues responded to in a timely fashion by their mothers and may therefore have better self-regulatory skills (Mesman et al., 2009).

Aim 5: The fifth aim was to assess correspondences between maternal and infant affect during the SFP at the dyadic level. This was accomplished using the Actor-Partner Interdependence Model (APIM). This model was analyzed using structural equation modeling. First, we examined the effects that maternal and infant positive affect during the baseline play episode have on their own and each other's positive affect during the reunion, controlling for infant sex and maternal education (see Figure 1). Secondly, we examined the effects that maternal and infant negative affect during the baseline have on their own and each other's

negative affect during the reunion, controlling for infant sex and maternal education (see Figure 2).

We expected that the positive and negative affect displays of mothers and infants during the baseline and reunion episodes of the SFP would equally influence one another (partner effects). We also anticipated that maternal and infant behavior during the baseline episode will affect their own respective behavior during the reunion episode (actor effects).

Figure 1.
The basic Actor-Partner Interdependence Model investigating the bidirectional effects of positive affect, controlling for infant sex and maternal education

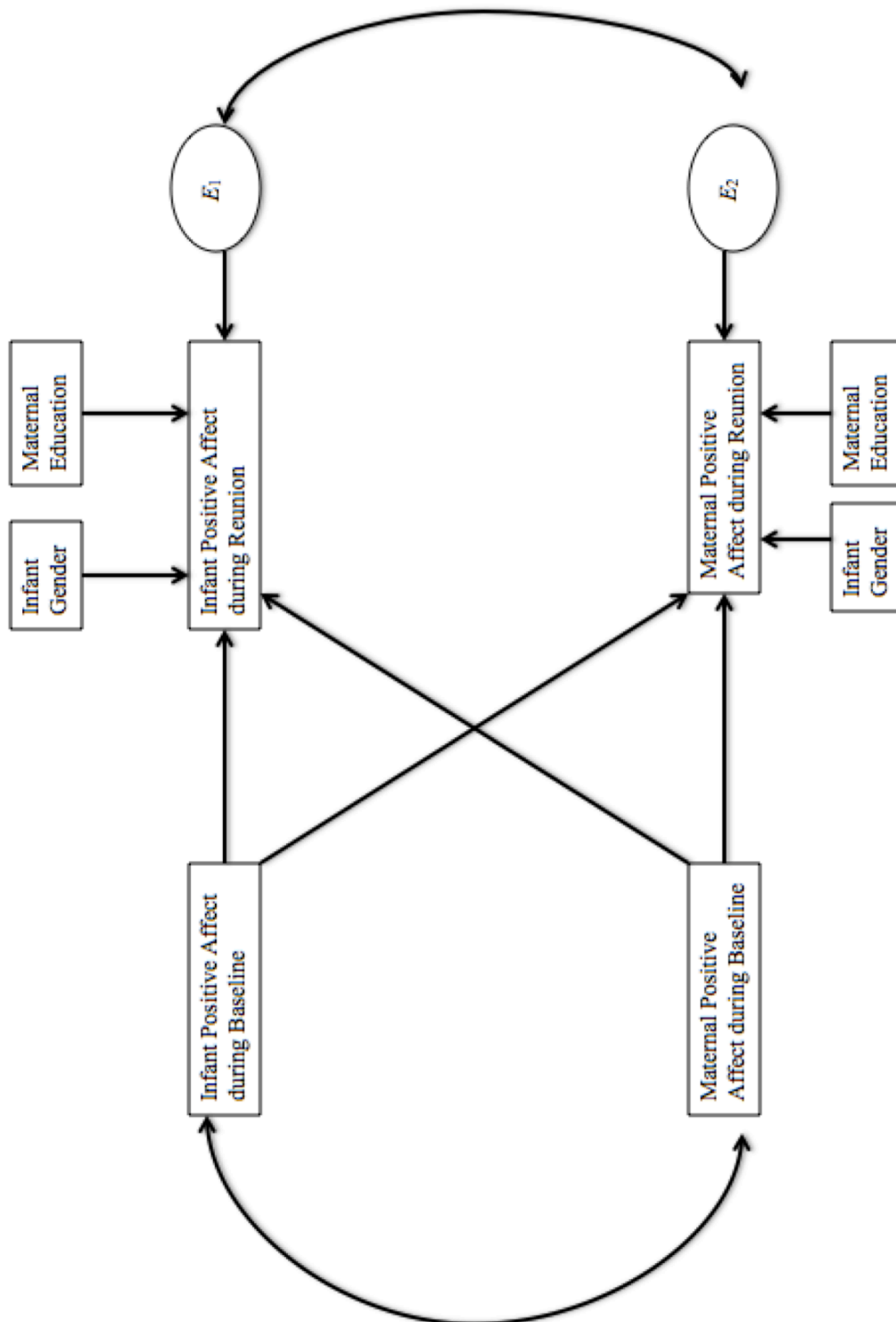
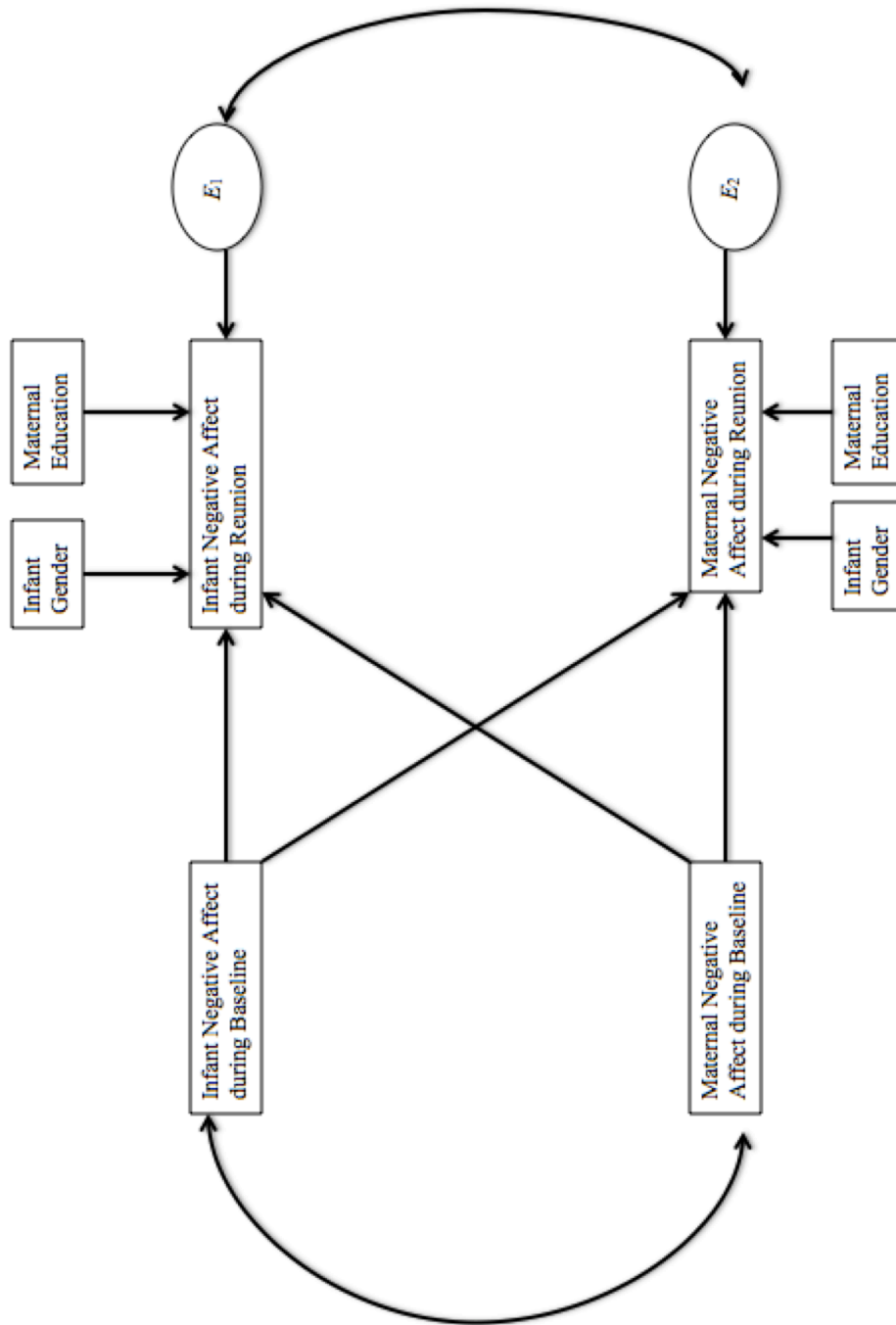


Figure 2

The basic Actor-Partner Interdependence Model investigating the bidirectional effects of negative affect, controlling for infant sex and maternal education



CHAPTER 2 “Methods”

Participants

Analyses in the present study were based on data collected for 85 mother-infant dyads who were videotaped during the SFP at 7 months postpartum. Dyads were participants in a larger longitudinal study investigating the association of fetal brain connectivity to postpartum maternal and child outcomes (Perinatal Imaging of Neural Connectivity Project/PURPLE/ELBO, Moriah Thomason, PI). Mothers were recruited during the last trimester of their pregnancy and participated in fMRI studies of fetal brain connectivity. After the delivery of the infant, the infant’s newborn neurobehavior was evaluated during a home visit. At 4 and 12 months postpartum, mothers participated in telephone interviews regarding their infants’ behavior and development. At 7- and 32-months infant age, mother-infant dyads participated in a lab visit during which their interactive behavior was videotaped and infants’ developmental skills were assessed. Analyses in the current study utilized demographic, temperament, and interaction data collected during pregnancy and at the 7-month visit.

Descriptive statistics for the sample are provided in Table 1 (maternal/familial characteristics) and Table 2 (infant characteristics). Most of the 85 dyads participating in the present study lived in the greater Detroit metropolitan area, had low-income status, and were African American in race/ethnicity. However, mothers varied in level of education and whether they were single parents or partnered. 65.9% of the infants were male.

Table 1
Demographic Information Regarding Mothers (N=85)

Maternal Education	
	<i>n</i> (%)
No GED/High School Diploma	5 (5.9%)
GED/High School Diploma	26 (30.6%)
Some College	38 (44.7%)
2 year College Degree	3 (3.5%)
4 year College Degree	5 (5.9%)
Master's Degree	2 (2.4%)
Doctorate	2 (2.4%)
Chose Not to Respond	4 (4.7%)
Maternal Race	
African American	69 (81.1%)
Caucasian	8 (9.4%)
Other	4 (4.7%)
Chose Not to Respond	4 (4.7%)
Marital Status	
Single	44 (51.8%)
Married/Partnered	39 (45.9%)
Widowed	1 (1.2%)
Chose Not to Respond	1 (1.2%)
Household Annual Income	
Less than \$5,000	13 (15.3%)
\$5,000 to \$10,000	12 (14.1%)
\$10,000 to \$15,000	12 (14.1%)
\$15,000 to \$20,000	3 (3.5%)
\$20,000 to \$25,000	7 (8.2%)
\$25,000 to \$30,000	9 (10.6%)
\$35,000 to \$40,000	4 (4.7%)
\$45,000 to \$50,000	4 (4.7%)
\$50,000 to \$55,000	2 (2.4%)
\$55,000+	7 (8.2%)
Chose Not to Respond	12 (14.1%)
Age	
	<i>M</i> (SD) Min-Max
Maternal Age at Child's Birth	26.17 (4.58), 19.22-40.36

Table 2
Demographic Information Regarding Infants (N=85)

	<i>n</i> (%)
Infant Sex	
Male	56 (65.9%)
Female	29 (34.1%)
Infant Age	<i>M</i> (<i>SD</i>)
Infant Age at 7 month visit (months)	7.56 (.72)

Procedures at the 7-Month Laboratory Visit

All procedures took place in a carpeted laboratory playroom with a one-way mirror. Prior to the onset of the study procedures, a trained research assistant described the study procedures to the mother and administered informed consent. All mothers signed a consent form and received a copy to take home.

Still-Face Paradigm (SFP). The SFP was then administered. In the larger PINC/PURPLE/ELBO study, a double SFP was used to maximize the infants' physiological (cortisol) reaction to the maternal still-face, following Haley and Stansbury (2003). The double SFP consisted of five successive 2-minute episodes, rather than the traditional three-episode SFP. During the SFP, the infant was placed into a feeding seat, and the mother sat in a chair directly facing the infant. During the first (baseline) play episode, mothers were asked to play with their infant in a normal manner for two minutes without using toys or pacifiers. Immediately following the baseline play episode, a 2-minute still-face episode took place. During the Still-Face episode, the mother was asked to look down briefly, and then look at the infant while holding a still or poker face (a face that is completely neutral) and to refrain from smiling, vocalizing, or touching the infant. If mothers felt they were going to break the still-face (i.e., smile or laugh), they were asked to look at the infant's forehead or just above the infant's head. After the still-face episode, the research assistant asked the mother to look down briefly, then to resume normal play with their infant for two minutes. This was the first reunion episode. A second still-face followed by a second reunion episode then took place.

Mother-infant interactive behavior during the SFP was videotaped using two digital cameras (one focused on the mother, one focused on the infant). The two images were combined into a single video record for scoring purposes.

In the present study, only the first three episodes of the SFP were evaluated, because seven infants were unable to tolerate the second Still-Face and final Reunion episodes. The three-episode SFP is consistent with the traditional SFP developed by Tronick and colleagues (Tronick et al., 1978) and is used widely in the SFP literature (Mesman et al., 2009).

Following the SFP, the mother filled out questionnaires while a trained research assistant evaluated the infant's developmental skills using the Bayley Scales of Infant Development-Third Edition (Bayley-III, Bayley, 2006).

Ethics. All mothers in this longitudinal study signed a consent form at the beginning of each visit. Mothers were informed that their participation was completely voluntary and that if at any time and for any reason that they wanted to stop, they could do so. This is important in all human research, and especially so in research with infants, who cannot communicate using words their potential desire to terminate study procedures. Very few mothers chose to terminate the SFP. However, in seven cases, the researchers made the decision to shorten or terminate the SFP when the infant became highly distressed (this usually happened during the second Still-Face or Reunion episodes).

During the administration of informed consent, the mothers were told that all information collected in the study was strictly confidential, labeled with a number rather than their name, and stored in a locked place accessible only to approved study staff. The mothers were also told that there were only minimal risks associated with their or their infants' participation in the study, and no direct benefits. However, mothers were told that the study staff hoped to gain important information about infant development from their and other families' participation in the study.

Mothers were given a gift card to a local department store to thank them for their time. In addition, mothers and their infants were provided with free round-trip transportation to the

laboratory at the university or were reimbursed for gas expenses if they chose to drive themselves.

Measures

Demographics. Mothers provided demographic information during the prenatal, the 7-month, and the 32-month visits. Specifically, mothers reported on their age, their years of completed education, their marital status and living arrangements, their and their infant's race/ethnicity, their infant's sex, and their household's total annual income. The current study evaluated infant sex, maternal education and total income as potential covariates.

Infant Temperament. Mothers reported on their perceptions of their infant's temperament at the 7-month visit using the very short form of Rothbart's Infant Behavior Questionnaire – Revised (IBQ-R) (Rothbart & Gartstein, 2000). The very short form includes 37 items describing infant behavioral and affective reactions to different experiences in everyday contexts. Mothers were asked to rate each item using a 7-point Likert scale, with 1 being “never” and 7 being “always” true for her infant. Scoring of the IBQ-R provides summary scores for three dimensions of infant temperament: *surgency* (13 items), *negative affect* (12 items), and *effortful control* (12 items).

Examples of questions from the surgency scale include: “When tossed around playfully, how often did the baby laugh?” “When being dressed or undressed during the last week, how often did the baby squirm and/or try to roll away?” Examples of questions from the negative affect scale include: “When tired, how often did your baby show distress?” “At the end of an exciting day, how often did your baby become tearful?” Examples of questions from the effortful control category include: “How often during the last week did the baby look at pictures in books and/or magazines for 5 minutes or longer at a time?” “When patting or gently rubbing

some part of the baby's body, how often did s/he soothe immediately?" The IBQ-R Short Form is a reliable and valid scale, with reliability about .65 for all sets.

Mother-Infant Interactive Behavior. Mother-infant interactive behavior was videotaped during the SFP at the 7-month visit. The SFP is a widely used, empirically validated procedure designed for 2 to 12-month-old infants and their caregivers, which evaluates individual differences in infant, maternal, and dyadic behavior before and after a social stressor (maternal still-face) (Adamson & Frick, 2003; Tronick et al., 1978). The traditional SFP comprises three successive 2-minute episodes: normal (baseline) play during which dyads engage in normal play, without using toys or pacifiers; followed by a maternal still-face perturbation, during which the mother is asked to hold a still (poker, or neutral) face while looking at her infant, and refraining from talking, smiling, or touching her infant; followed by a resumption of normal play (reunion). The maternal still-face allows investigators to evaluate what happens when a prolonged dyadic mismatch occurs during mother-infant social interaction (Tronick et al., 1978).

Coding of Mother-Infant Interaction during the SFP.

Infant, maternal, and dyadic behavior during the SFP was coded using a reliable scoring system developed for the Maternal Anxiety during the Childbearing Years (MACY) study (MACY Infant-Parent Coding System, MIPCS; Earls, Muzik, & Beeghly, 2009). This coding scheme includes 14 maternal, 10 infant, and 4 dyadic rating scales. Evidence for the validity and reliability of the MIPCS has been reported elsewhere (e.g., Martinez-Torteya et al., 2014).

Maternal Interaction Behavior Scales

In the present study, multiple dimensions of maternal behavior and affect were scored during the baseline and reunion episodes of the SFP. Indicators of positive parenting included

maternal behavioral sensitivity, affective sensitivity, engagement, flexibility, warmth, and positive affect. The indicator of negative parenting was mothers' hostile/rejecting/discrepant behavior toward their infant. Parental negative affect was also used in the dyadic analysis.

Maternal behavioral sensitivity was coded on a 5-point Likert scale, with 1 being "no or very little sensitivity and 5 being "very high sensitivity." Behavioral sensitivity and supportive presence include how the mother is aware of her child's feelings based on their outward responses. For example, mothers that are highly behaviorally sensitive will observe their child and change their own behavior based on the cues that their child provides. A mother who receives a 5 on behavioral sensitivity is completely guided by her correct interpretations of her infant's wishes, needs, and moods based on their physical cues. A mother who is low on behavioral sensitivity is primarily guided by her own wishes and does not take into account the feelings of the child. This mother may appear disengaged and does not show appropriate responses to her child's needs.

Maternal affective sensitivity was coded on a 5-point Likert scale, with 1 being "no or very little sensitivity" and 5 being "very high affective sensitivity." Affective sensitivity is the ability of the mother to understand and empathize with her infant's experience, intentions, and wishes. A mother who is low on affective sensitivity does not understand her infant's individual feelings or desires and therefore does not behave in a manner that is conducive to her infant's subjective experience. A mother with high levels of affective sensitivity is completely attuned to her child's experience and demonstrates understanding during the entire interaction with the child.

Maternal engagement was coded on a 5-point Likert scale, with 1 being "no or very little engagement" and 5 being "very high engagement." Coders specifically looked for adequate

spacing and turn-taking, a comfortable body position toward the infant, positive vocalizations about the interaction, as well as the facilitation of and active involvement in activities with the child. Being engaged appropriately was also taken into account. For example, if the mother was involved with her child for the entire episode, but speaking in a negative or intrusive way, full points were not given for engagement.

Maternal flexibility was coded on a 5-point Likert scale, with 1 being “no or very little flexibility” and 5 being “very high flexibility.” Flexibility encompasses the mother’s ability to be creative to direct her infant to new activities throughout the interaction. The opposite of flexibility is helplessness or rigidity. This can be characterized as an inability to think of any other ways to comfort or distract their infant or can be seen in mothers who briefly attempt to redirect her infant but quickly give up.

Maternal warmth was coded on a 5-point Likert scale, with 1 being “no or very little warmth” and 5 being “very high warmth.” The extent of warmth was coded on both frequency and intensity of displays of warmth. Maternal warmth is the degree to which the mother displays affection toward her child and displays joy when interacting. This could be verbally, with tone of voice and kind words, or non-verbally, with body language, facial expressions, and physical touch. Mothers scoring low on warmth consistently do not display maternal affection. It may seem that the mother is not enjoying the interaction with her child. Mothers scoring high on warmth display affection all of the time. The mother obviously displays the fact that she is enjoying the interaction with her child.

Maternal positive affect was coded on a 5-point Likert scale, with 1 being “no positive affect” and 5 being “much enthusiasm/joy.” This scale was coded on a spectrum from positive affect to enthusiasm to joy. Positive affect was defined as a mother exhibiting positive facial

expressions, like smiles, vocal tones and remarks. Enthusiasm was defined as a mother exhibiting the positive affect criteria plus vocal enthusiasm and laughter. Joy was defined as a mother exhibiting both the positive affect and enthusiasm criteria in addition to playfulness, glee, wonder, and amazement regarding her infant.

Because the indicators of positive parenting were highly correlated with one another, a positive parenting composite was created for both baseline and reunion maternal behaviors. This was accomplished by averaging ratings for behavioral sensitivity, affective sensitivity, engagement, flexibility, warmth and positive affect separately for each episode (baseline $\alpha = .80$, reunion $\alpha = .79$).

Maternal negative affect was coded on a 5-point Likert scale with 1 being “neither flat or negative affect” and 5 being “much negative affect.” Negative affect here includes flat or sad affect, rather than anger. A 3 on the Likert scale was a mother who displays both sad and flat affect. Flatness was denoted by expressionless gazing and limited smiles and speech. Negative affect was further described as the mother exhibiting despondent behaviors such as sad gazing, monotone or slowed speech, and possible crying.

Maternal hostile/rejecting/discrepant behavior was coded on a 5-point Likert scale with 1 being “no instances of hostile/rejecting/discrepant communication” and 5 being “many instances, all associated with angry/intense affect, or several prolonged instances of hostile/rejecting/discrepant communication.” Maternal hostile behavior can include angry, bitter, or hostile vocal expressions, such as negative remarks, teasing, disgust, prohibitions, such as the word “no,” negative facial expressions (anger, contempt), physical restrictions, or pseudo-expressions of affection. This rating was used as an indicator of maternal negative parenting.

Infant Interaction Behavior Scales

Four dimensions of infant behavior and affect were scored during each episode of the SFP. These included infant object engagement, social engagement, positive affect, and negative affect.

Infant object engagement refers to the degree to which the child gives attention and interest to objects. In the SFP, an object could be the feeding seat or strap, the infant's or mother's clothing or body parts. For an infant to be coded as actively object engaged, there must have been evidence of this focused attention such as mouthing objects, banging them, manipulating them, or looking intensely at the object. Infant object engagement was coded using a 5-point Likert scale, which considered both duration and frequency of times the infant was engaged with objects. For an infant to receive a 5 on this scale, the infant must have been actively engaged with objects for almost all or all of the time and the instances must be prolonged. Conversely, for an infant to receive a 1, there had to be no instances of object engagement.

Infant social engagement refers to the extent to which the infant looks at the mother's face or participates with the mother in joint attention, social games, or other shared-focus interactions. Nonverbal cues such as body orientation are also taken into account to measure the amount of social engagement that the infant displayed. Infant social engagement was coded on a 5-point Likert scale, with a 5 being "very high instances of infant social engagement" and a 1 being "no instances of infant social engagement." For an infant to receive a 5 on this scale, the infant must have been socially engaged with his/her mother for almost all of the interaction time. For an infant to receive a 1 on this scale, the infant must have displayed no social engagement with the mother. A low-scoring infant might be engaged in solitary activity or might be negatively engaged with the mother.

Infant positive affect refers to the infants' tendency to display pleasure and enjoyment. Signs of positive affect can range from subtle to explicit, mild to very intense. Subtle positive affect includes brief smiles, positive tones, and face-brightening. Enthusiastic positive affect includes laughter, interest, and clear excitement. Very high (joyful) positive affect includes squeals of pleasure and clapping. Infant positive affect was coded on a 5-point Likert scale, with 5 being "very high positive affect" and 1 being "no positive affect." For an infant to get a 5, he or she must exhibit intense positive affect for all or most all of the time. For an infant to get a 1, he or she must exhibit no positive affect for the entire time or show negative or neutral affect for the entire time.

Infant negative affect refers to the infants' tendency to display negative reactivity and displeasure. Indicators of infant negative affect can range from subtle to clear-cut, and from mild to intense. Subtle indicators of negative affect include brief facial expressions of anger or sadness (e.g., pouts) and/or brief, mild negative vocalizations such as fussing or whining. Clear-cut indices of negative affect include more prolonged facial expressions of anger or sadness, full-blown crying, screaming, or angry behaviors such as hitting or kicking the parent or chair. The frequency, duration, and intensity of negative affect are also considered. An infant scoring a "1" on negative affect displays no negative affect whatsoever during the SFP. An infant scoring a "5" is one who displays intense negative affect for all or most all of the time. In the present study, the infant's negative affect was scored during each episode of the SFP.

Table 3 displays descriptive statistics (means and standard deviations, as well as minimum and maximum scores) for all key study variables.

Table 3

Descriptive Statistics for Key Study Variables

	<i>M</i>	<i>SD</i>	<i>Min-Max</i>
Infant Temperament (IBQ-R)			
Surgency	5.62	.73	3.33-6.92
Negative Affect	4.60	1.04	2.00-6.64
Effortful Control	5.65	.63	3.92-7.17
Maternal Interactive Behavior			
Positive Parenting: Baseline	3.03	.55	1.92-4.25
Negative Parenting: Baseline	2.05	1.15	1.00-5.00
Negative Affect: Baseline	1.21	.49	1.00-4.00
Positive Parenting: Reunion	3.00	.52	1.92-4.08
Negative Parenting: Reunion	1.94	.93	1.00-4.50
Negative Affect: Reunion	1.22	.50	1.00-4.00
Infant Interactive Behavior			
Object Engagement: Baseline	2.31	.81	1.00-4.50
Social Engagement: Baseline	2.62	.94	1.00-5.00
Positive Affect: Baseline	2.49	.88	1.00-5.00
Negative Affect: Baseline	1.68	.99	1.00-5.00
Object Engagement: Still-face	3.02	.84	1.00-5.00
Social Engagement: Still-face	2.61	.87	1.00-5.00
Positive Affect: Still-face	1.38	.52	1.00-3.00
Negative Affect: Still-face	2.18	1.38	1.00-5.00
Object Engagement: Reunion	2.14	.77	1.00-4.00
Social Engagement: Reunion	2.57	.95	1.00-4.50
Positive Affect: Reunion	2.22	.91	1.00-4.50
Negative Affect: Reunion	2.29	1.38	1.00-5.00

Note. IBQ-R= Infant Behavior Questionnaire, Very Short form.

Inter-rater Reliability. A team of coders was trained to evaluate these qualitative dimensions of the mother-child interaction using a set of 5 videotapes that were previously coded by a senior “gold standard” coder. Coders were required to achieve an initial reliability of .8 or higher prior to being allowed to code for the project. Once this level of reliability was achieved, coding for the project began. Intercoder reliability was assessed on an ongoing basis on every fifth videotape (20%) to ensure fidelity to scoring rules and to minimize coder drift. In addition, meetings were held to discuss difficult cases between coders and resolve disagreements. Intercoder reliability was assessed using intraclass correlation coefficients (ICC).

ICCs for maternal behavior during baseline play were: .76 for positive parenting, .95 for negative parenting, .82 for positive affect, and .98 for maternal negative affect. ICCs for infant behavior during baseline play were; .75 for object engagement, .87 for social engagement, .87 for positive affect, and .85 for negative affect.

ICCs for infant behavior during the still-face episode were: .70 for object engagement, .70 for social engagement, .89 for positive affect, and .89 for negative affect.

ICCs for maternal behavior during the reunion were: .93 for positive parenting, .65 for negative parenting, .83 for positive affect, and .85 for negative affect. ICCs for infant behavior during the reunion were: .70 for object engagement, .79 for social engagement, .95 for positive affect, and .95 for negative affect.

Plan for Statistical Analysis

Preliminary analyses were carried out to evaluate the distributional properties of the study variables. Skewed or kurtotic variables were transformed prior to analysis.

Power Analysis. The G*Power 3 computer program was used to estimate an appropriate sample size for each analysis, except the structural equation modeling. For the ANCOVA, a

model with an effect size of .3 and power set at .8 requires a sample size of 111. Therefore, this analysis is underpowered in the current sample. Results may be masked because of the small sample size. For the paired-sample *t*-tests, using a two-tailed model with an effect size of .25 and power set at .8, the program suggested a sample size of 72. Therefore, this analysis is adequately powered for the *t*-tests. For the linear multiple regressions with the effect size set at .15 and power set at .8, the program suggested a sample size of 55. Therefore, this analysis is adequately powered.

As a general rule of thumb, a sample size of 100 is the minimum for structural equation modeling (Wolf, Harrington, Clark, & Miller, 2013). However, recent studies have found that a sample size as low as 50 can be utilized for relatively simple SEM models (Wolf et al., 2013; Sideridis, Simos, Papanicolaou, & Fletcher, 2014). Another way to estimate sample size for adequate power in structural equation models is to multiply the number of estimated parameters by 5 or 10 (Bentler & Chou, 1987; Bollen, 1989). For the basic APIM, there are 8 parameters being estimated. Using these rules of thumb, the estimated sample size would be 40 or 80. If we take the higher sample size, the model would be adequately powered. For the APIM with phantom variables, 10 parameters were estimated. Using these rules of thumb, the estimated sample size would be 50 or 100. If we take the higher, the model will be underpowered, and results may be masked because of small sample size.

Data Screening

These data screening procedures used in this study were modeled after a data screening checklist (Tabachnick & Fidell, 2001), and were used to determine if the present data were acceptable to analyze. First, it is imperative to check for missing data. If there are missing data, it is necessary to discern if the data are missing randomly or due to a systematic reason. In this

dataset, there was a fair amount of missing data, although they appear to be randomly missing. Analyses were conducted with and without the subjects with missing data, and the results in each analysis were similar.

Next, descriptive statistics were calculated for all study variables to check for distributional properties and univariate outliers. Histograms were visually checked and standardized scores were computed. Those with extremely large standardized scores (exceeding ± 3.30) and that did not fall in line with the rest of the distribution were evaluated on an individual score basis.

Univariate outliers for infant codes included infant negative affect during baseline for case 2099. However, each of these outliers passed visual inspection of the scatterplot and did not have extremely high standardized scores. It was decided to leave these cases in the dataset. Univariate outliers for maternal codes included negative affect during baseline for cases 2055 and 2082 and negative affect during reunion for cases 2120 and 2055. Case 2055 did not pass the visual inspection of the scatterplot; however because power is a concern with these analyses, it was decided to leave this case in the dataset. For demographic codes, maternal education was an outlier for cases 2058 and 2185. Both of these cases passed visual inspection of the scatterplot and their standardized scores were not extreme. These cases were left in the dataset.

Once the presence of univariate outliers had been detected, multivariate outliers were assessed using the Mahalanobis Distance for each score. Any case exceeding the critical χ^2 value were deleted to eliminate the multivariate outlier's influence on the subsequent analyses. There were no significant multivariate outliers in this dataset.

Skew and kurtosis were also calculated with the descriptive information. If the skew and kurtosis scores were too large (exceeding ± 3.30), transformations were used to correct the data.

There were quite a few skewed variables. Infant baseline negative affect and still-face positive and negative affect were all positively skewed. Baseline negative affect was severely positively skewed, and therefore an inverse transformation was performed. The transformation resulted in a variable that is no longer skewed. Positive affect during the still-face was moderately skewed, so a log10 transformation was performed. The result is that this variable is no longer skewed. Negative affect during the still-face was mildly skewed, and therefore a square root transformation was performed. The result is that this variable is no longer skewed. Maternal negative affect during the baseline and reunion episodes were both severely and positively skewed. No transformation was able to return these variables to normality. Marital status, paternal education, paternal race, maternal education, maternal race, infant age at 7 month visit, and income were all positively skewed. Maternal education and income were both mildly skewed; therefore, square root transformations were performed. The results are that these variables are no longer skewed. Marital status, paternal education, and maternal race were moderately skewed; therefore, a log10 transformations were performed and these variables are no longer skewed. Finally, infant age at 7 month visit was severely skewed. An inverse transformation was performed, and as a result, this variable is no longer skewed. Performing these transformations also fixed any incidences of kurtosis that were in this data. The transformed variables were used in the subsequent analyses.

Multicollinearity was assessed through collinearity diagnostics and bivariate correlations. There is evidence for multicollinearity if any bivariate correlation is above .80, tolerance levels are less than .10, VIF scores are greater than 10, any condition indices are above 30, or if there are two or more variables that have variance proportions above .50. There were no variables in the dataset that displayed evidence of multicollinearity or singularity.

Identification of Potential Covariates. Because infant sex has been shown to play an important role in the responses of the infant to the SFP (Weinberg et al., 1999), it is important to test whether infant sex moderates the hypothesized associations among variables in the present study. In this data, infant sex was negatively correlated with infant social engagement during the baseline play session ($p < .05$) and was evaluated as a potential moderator.

Two key demographic variables (income and maternal education) were evaluated as potential covariates in the present study due to their robust associations with parenting and infant behavior (Evans, Boxhill, & Pinkava, 2008). Income was not significantly correlated with any of the infant interaction variables or the mother-rated infant temperament variables (IBQ-R). However, income was positively correlated with maternal positive parenting during the baseline play session ($p < .05$). Income was not associated with any other maternal interaction variables. Maternal education was positively related to infant negative affect in the baseline ($p < .05$) and positively related to the positive parenting composite in both the baseline ($p < .001$) and reunion ($p < .05$). Because maternal education and income were highly correlated ($p < .001$), maternal education was used as a covariate in all subsequent analyses.

Plan for Hypothesis Testing. Following the preliminary analyses, bivariate analyses and hierarchical linear regressions were conducted to evaluate the first three study aims and hypotheses, as follows:

The first aim was to evaluate the relative stability and change in maternal and infant scores across the episodes of SFP. These analyses allowed us to evaluate whether the classic still-face and reunion effects could be identified in these data (Weinberg & Tronick, 1996). The current sample included mostly low-income, urban African American mothers, a population that is understudied in the still-face literature (Mesman et al., 2009).

To evaluate these aims, we conducted partial correlations and multiple repeated-measures episode by infant sex ANCOVAs, controlling for maternal education. Dependent variables included infant object engagement, social engagement, positive affect, and negative affect, assessed in all three episodes of the SFP (baseline, still-face, reunion).

The second aim was to assess whether the three dimensions of infant temperament (surgency, infant negative affect, and effortful control) predicted positive and negative parenting during the baseline and reunion play episodes of the SFP. This aim was evaluated using partial correlations and four hierarchical regressions. The first two regressions evaluated maternal positive parenting during the baseline and reunion episodes as the dependent variable, and the last two evaluated maternal negative parenting during the baseline and reunion episodes.

In the first block of each regression, maternal education was entered, as it met criteria to be included as a covariate. In the second block, the three infant temperament measures (infant surgency, negative affect, and effortful control) were entered.

The third aim was to assess whether maternal ratings of infant temperament (surgency, negative affect, or effortful control) predicted observed infant behavior during the still-face and reunion episodes of the SFP. This was analyzed with hierarchical regression.

The fourth aim was to assess whether mothers' level of positive and negative parenting during the baseline play episode of the SFP was associated with infants' observed reactivity during the still-face episode of the SFP. This aim was evaluated using hierarchical regression. Maternal education was entered in the first step, followed by the maternal positive parenting composite during baseline play in the second step. The dependent variable in this analysis was infant negative emotionality during the still-face episode. A second regression was then conducted with parental hostility as the predictor.

The fifth aim was to assess correspondences between maternal and infant affect at the dyadic level. This was accomplished using a structural equation modeling approach to the actor-partner interdependence model (APIM). First, we examined the effects that maternal and infant positive affect during the baseline have on their own and each other's positive affect during the reunion using the APIM. Secondly, we examined the effects that maternal and infant negative affect during the baseline have on their own and each other's negative affect during the reunion using the APIM. See figures 1 and 2 for a depiction of the basic models that were tested.

The APIM was tested using structural equation modeling. First, a basic model was constructed with the actor being the infant and the partner being the mother. In the first APIM, we tested the effects of positive affect during the baseline for both actor and partner on the positive affect displayed during the reunion for both actor and partner. After observing the model's fit indices and correlations and covariances, we then made a second model that included a phantom variable (P), from which the ratio of the partner and actor effects (the k parameter) could be calculated. This helped us to distinguish different types of dyadic patterns that may be occurring (Fitzpatrick, Gareau, Lafontaine, & Gaudreau, 2016).

With the second model, we are able to observe how the k parameters differed between actor to partner and partner to actor. There are four possible patterns that can occur in dyadic data: actor-only pattern, partner-only pattern, couple-oriented pattern, and contrast pattern (Fitzpatrick et al., 2016). For the contrast pattern and the couple-oriented pattern, both the actor and partner effects have to be significant. However, for the couple-oriented pattern, the direction of effects are the same. For the contrast pattern, the directions of effects are opposite one another. For the actor-only or partner-only pattern, only one of the effects can be significant. If the actor effect is significant, there is an actor-only pattern. If the partner effect is significant,

there is a partner-only pattern (Fitzpatrick et al., 2016). With that knowledge, we then constructed a third model that constricted each one of the k parameters (separately and together) to see if that had an effect on the model.

This procedure was repeated to observe the effects of negative affect during the baseline for both actor and partner on the negative affect displayed during the reunion for both actor and partner.

Figure 3
APIM with phantom variable for positive affect

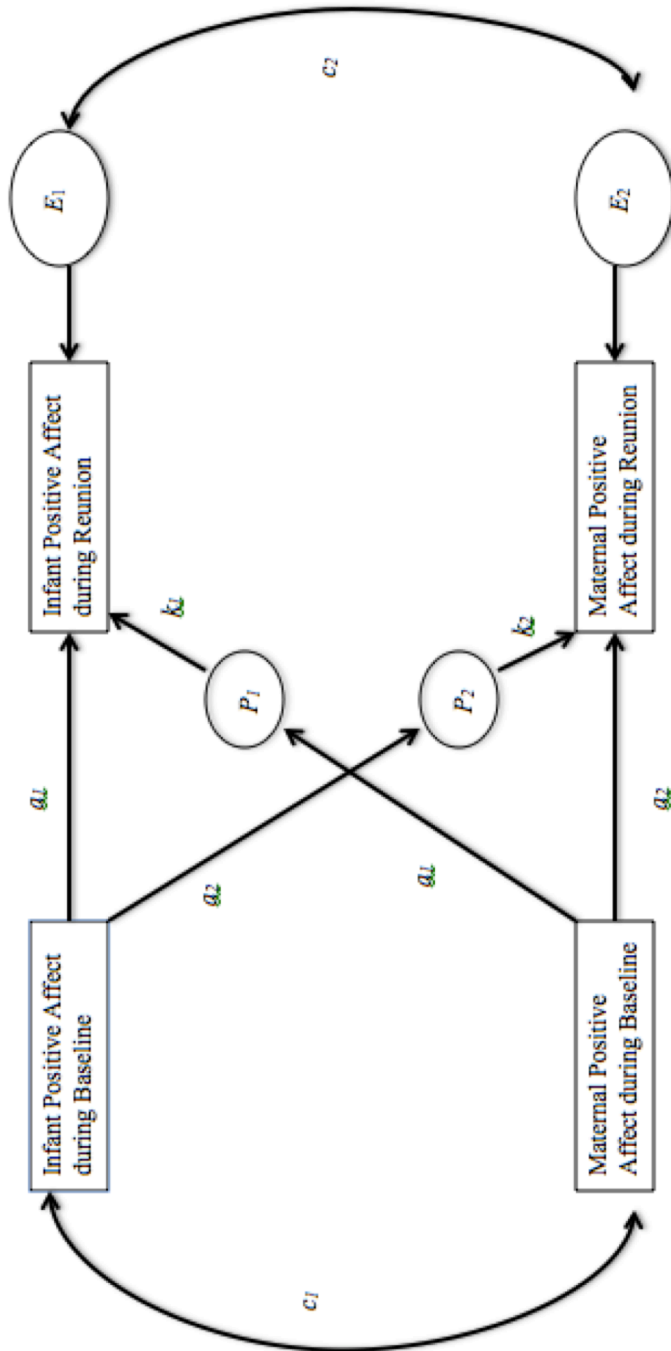
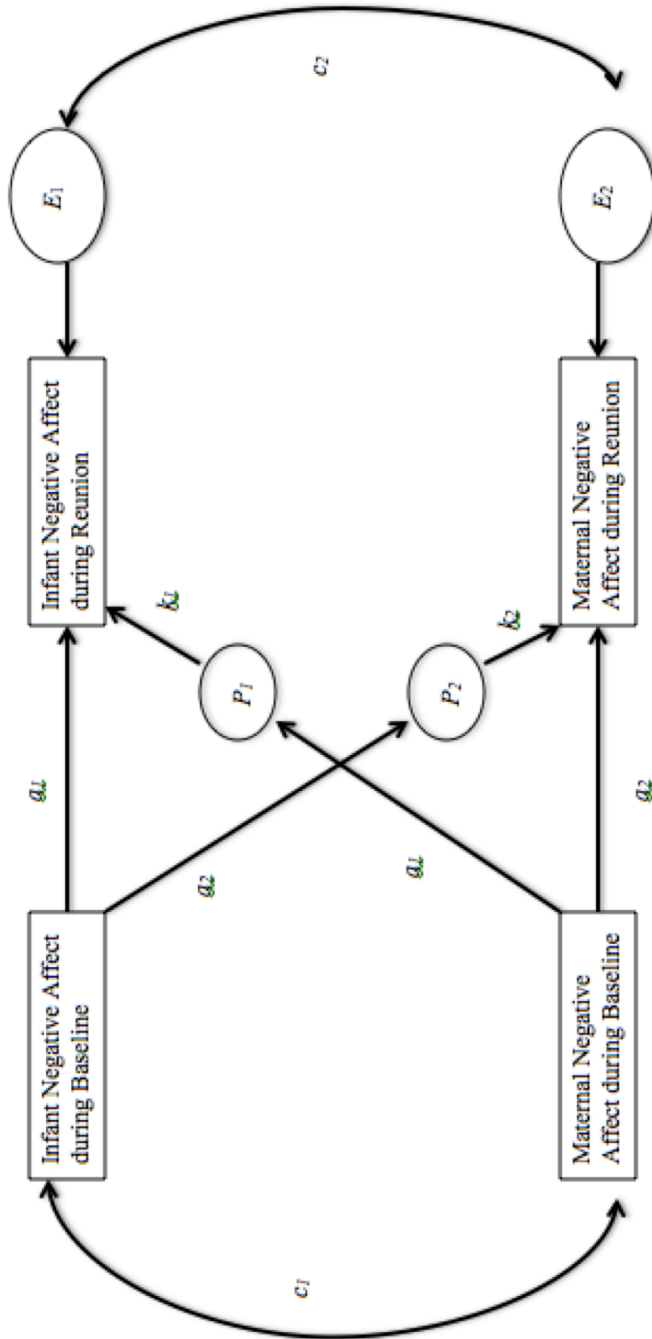


Figure 4.
APIM with phantom variable for negative affect.



CHAPTER 3: “Results”

Hypothesis Testing

Descriptive Statistics Results

Bivariate correlations were inspected for all study variables to assure that correlations were in the expected directions. The correlational results also provides information on the relative stability of maternal and infant behavior across episodes. Table 4 displays bivariate and partial correlations (controlling for maternal education) between maternal-reported infant temperament (IBQ-R), and maternal positive parenting during both the baseline and reunion play sessions of the SFP. Table 5 displays correlations among maternal-reported infant temperament (IBQ-R) and infant interaction variables in each episode of the SFP: object engagement, social engagement, positive affect, and negative affect.

As expected, all three IBQ-R temperament variables were significantly correlated with one another. However, interestingly, infant surgency and negative affect were positively correlated ($p < .001$).

Mother-Mother Correlations

In addition, many of the maternal SFP interaction variables were significantly correlated with one another. The positive parenting composite during the baseline was positively correlated with positive parenting in the reunion, and negatively correlated with negative parenting in the baseline and negative affect in the baseline and reunion. The positive parenting composite during the reunion was negatively related to infant negative affect during the reunion. Maternal negative parenting during the baseline was positively related to negative parenting in the reunion and infant negative affect during the baseline. Finally, infant negative affect in the baseline was positively correlated with infant negative affect in the reunion.

Infant-Infant Correlations

Similarly, many of the infant SFP interaction variables were significantly correlated with one another. Infant object engagement during the baseline was negatively correlated with infant social engagement during the baseline, infant positive affect during the baseline, and infant negative affect during the reunion. It also was positively correlated with infant object engagement during the SF.

In turn, infant social engagement during the baseline was positively correlated with infant positive affect during the baseline, infant social engagement during the reunion, and infant positive affect during the reunion. Infant social engagement during the baseline was also negatively correlated with infant negative affect in both baseline and reunion.

Infant positive affect during the baseline was positively correlated with infant social engagement during the reunion and positive affect during the reunion. It was negatively correlated with infant negative affect during the baseline.

Infant negative affect during the baseline was positively correlated with infant negative affect during the SF and reunion. It was negatively correlated with infant object engagement during the SF and reunion, infant positive affect during the SF and reunion, and infant social engagement during the reunion.

Infant object engagement during the SF was positively correlated with object engagement during the reunion. It was negatively correlated with infant social engagement during the SF and infant negative affect during the SF and reunion.

Infant social engagement during the SF was positively correlated to infant negative affect during the SF. Infant positive affect during the SF was negatively related to infant negative affect during the SF and reunion. Infant negative affect during the SF was negatively related to

infant object engagement, social engagement, and positive affect during the reunion. Infant object engagement during the reunion was negatively related to infant negative affect during the reunion. Infant social engagement during the reunion was positively correlated to infant positive affect during the reunion and negatively related to infant negative affect during the reunion. Finally, infant positive affect during the reunion was negatively correlated with infant negative affect during the reunion.

Mother-Infant Correlations

Table 6 displays correlations among maternal and infant behaviors during the SFP. Maternal positive parenting during baseline was positively correlated with infant social engagement during the baseline ($p < .001$) and in the reunion ($p < .01$), and was positively correlated with infant positive affect during the baseline ($p < .001$) and reunion ($p < .001$). Maternal positive parenting during the baseline was negatively related to infant negative affect in the baseline ($p < .001$) and the reunion ($p < .01$). Maternal positive parenting during the reunion was correlated with infant social engagement during the baseline ($p < .05$) and during the reunion ($p < .001$), and infant positive affect during the reunion ($p < .001$), and negatively correlated with infant negative affect during the baseline ($p < .001$) and reunion ($p < .001$). Maternal negative parenting during the baseline was negatively related to infant social engagement during the baseline ($p < .05$) and infant positive affect during the baseline ($p < .05$), still-face ($p < .05$), and reunion ($p < .05$). Contrary to expectations, maternal negative parenting was not correlated with any infant behaviors in the SFP.

Contrary to expectations, many of the differential study variables were not significantly correlated to one another. Only one temperamental variable (negative affect) had a significant

inverse relationship with one child SFP variable (infant positive affect during the baseline, $p < .05$).

Aim 1 Results: The first aim was to evaluate whether prior findings regarding the SFP (particularly the classic still-face effect and sex moderation) can be replicated in this largely low-income sample of mostly African American mother-infant dyads.

Infant Object Engagement. An ANCOVA was conducted to determine whether there was a statistically significant effect of episode on infant object engagement, controlling for maternal education and also testing for moderation by infant sex.

Episode effect. The ANCOVA was significant with a quadratic trend, $F(2, 84) = 39.88, p < .001$ (see Figure 8). Object engagement was relatively low in the baseline, increased during the still-face, and decreased during the reunion episode.

Infant sex effects. The main effect for infant sex was not significant.

Infant Social Engagement. A second ANCOVA was conducted to determine whether there was a statistically significant effect of episode on infant social engagement object engagement, controlling for maternal education and also testing for moderation by infant sex. The ANCOVA was not significant and there was no evidence for sex moderation.

Infant Positive Affect. A third ANCOVA was conducted to determine whether there was a statistically significant difference between episode (baseline, still-face, reunion) on infant positive affect during the SFP, controlling for maternal education. The ANOVA also tested for a main effect of infant sex and an infant sex X episode interaction effect.

Episode effect. There was a significant main effect for infant positive affect, with a quadratic trend, $F(2, 84) = 39.79, p < .001$ (see Figure 6). Positive affect was relatively high in

the baseline episode, displayed a large decrease during the still-face episode, and then recovered in the reunion episode.

Infant sex effects. There was no significant main effect for infant sex on infant positive affect displays during the SFP. There also was no significant infant sex X episode interaction effect for infant positive affect.

Infant Negative Affect. A fourth ANCOVA was conducted to determine whether a statistically significant difference exists between episode on infant negative affect, controlling for maternal education and also testing for moderation by infant sex.

Episode effect. The ANCOVA was significant with a linear trend, $F(2, 84) = 4.71, p < .05$ (see Figure 7). Negative affect was relatively low in the baseline and displayed an increase in both the SF episode and reunion.

Infant sex effects. The ANCOVA was not significant with differences between sexes.

Maternal Positive and Negative Parenting. Paired sample *t*-tests were conducted to evaluate whether mothers' average scores for positive and negative parenting changed in magnitude from baseline to reunion. Both paired sample *t*-tests were not significant.

Aim 2 Results: Because hypotheses 2 and 3 assume the variables are correlated with one another, only analyses relating infant positive affect during baseline, infant negative affect during reunion, maternal positive parenting during baseline and reunion were conducted.

The first regression tested part of hypothesis 2 and was conducted to discover whether the infant temperamental variable of negative affect could significantly predict maternal positive parenting during the reunion play session (see table 7). Maternal education was entered into the first block as a covariate and maternal-reported negative affect from the IBQ-R was entered into the second block. As hypothesized, child negative affective temperament did explain a

significant portion of variance in maternal behavioral sensitivity, above and beyond the effects of maternal education.

Aim 3 Results: The second regression tested part of hypothesis 3 to see if maternal reported infant negative affect could predict infant positive affect during the baseline of the SFP. The regression was not significant, nor were any predictors.

Aim 4 Results: The third regression tested hypothesis 4 and was conducted to see if maternal positive parenting during the baseline play session could predict infant negative affect during the still-face. This regression was not significant and did not have significant predictors.

Aim 5 results: The Actor-Partner Interdependence Model (APIM) and cross-lagged models were used to address hypothesis 5. Positive affectivity in mother and infant was addressed first. First, a basic APIM was created (see figure 8) to understand the actor and partner influences from baseline to reunion. There were significant actor effects for both mother ($p < .001$) and infant ($p < .001$). There was also a significant partner effect from mother to infant ($p < .05$). Then, a model that included a phantom variable was created (see figure 9). A phantom variable is a latent variable that does not have meaning or disturbance within the model (Kenny & Ledermann, 2010). From this phantom variable, the k parameter was created which is a ratio of the actor and partner effect. Fitzpatrick et al. (2016) provided a flow chart to interpret the k parameters (see figure 11). After observing the k parameters, three new models were created. The first fixed k_1 to 0. The second fixed k_2 to 0. The third fixed both k parameters to 0. Table 8 displays all of the results for positive affect. Setting k_1 to 0 decreased the fit of the model. This suggests that this k was contributing greatly to model fit. Setting k_2 to 0 did not decrease the fit of the model. This suggests that this k was not greatly contributing to model fit. Setting both k parameters to 0 slightly decreased fit of the model. These results suggest that the actor effects of

the infant and the partner effects of the mother are the most important to influence infant positive affectivity in the reunion.

Next, negative affect was analyzed. First, a basic APIM was created (see figure 10) to understand the actor and partner influences from baseline to reunion. There were no significant actor or partner effects and therefore further models were not created.

Table 4.

Partial Correlations+ among Infant Temperament and Maternal Interaction Variables (N = 85).

	1	2	3	4	5	6	7	8	9
IBQ-R Infant Temperament									
1. Surgency	1	.47***	.49***	.01	-.08	-.02	.01	-.04	.22
2. Negative Affect		1	.34**	-.11	-.24*	.20	.20	-.16	.30**
3. Effortful Control			1	-.03	-.09	-.03	-.01	-.21	.12
Maternal Interactive Behavior									
4. Positive Parenting: Baseline				1	.54***	-.24*	.01	-.37**	-.34**
5. Positive Parenting: Reunion					1	-.04	-.19	-.12	-.46***
6. Negative Parenting: Baseline						1	.28*	.23*	.06
7. Negative Parenting: Reunion							1	-.19	-.01
8. Negative Affect: Baseline								1	.25*
9. Negative Affect: Reunion									1

Note. * $p < .05$, ** $p < .01$, *** $p < .001$; IBQ-R=Infant Behavior Questionnaire-Very Short Form;

+Controlling for maternal education.

Table 5
Partial Correlations among Child Temperament Characteristics and Child SFP Variables, Controlling for Maternal Education (N = 85).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Infant Surgency	1	.46***	.48***	.001	.06	.09	-.05	-.10	.07	.08	.12	-.09	-.08	-.13	.14
2. Infant Negative Affect		1	.33***	.13	-.20	-.24*	.04	.13	-.05	.004	.09	.02	.09	-.18	.11
3. Infant Effortful Control			1	.06	.09	.03	-.07	.02	-.04	.01	-.11	-.06	.11	-.05	-.04
4. Infant Object Engagement: Baseline				1	.22*	-.26*	-.26*	.28*	-.16	.06	-.27*	.21	.11	-.03	-.26*
5. Infant Social Engagement: Baseline					1	.80***	.35***	.03	-.04	.07	-.17	.08	.33**	.52***	-.28*
6. Infant Positive Affect: Baseline						1	.35***	-.04	.01	.18	-.05	.03	.23*	.54***	-.18
7. Infant Negative Affect: Baseline							1	.24*	.06	.28*	.68***	-.37**	.43***	.50***	.77***
8. Infant Object Engagement: Still-Face								1	.43***	.05	.46***	.57***	.14	.06	.44***
9. Infant Social Engagement: Still-Face									1	.06	.25*	-.19	.14	.01	.16
10. Infant Positive Affect: Still-Face										1	.39***	.12	.16	.21	-.30**
11. Infant Negative Affect: Still-Face											1	.55***	-.30**	-.28*	.87***
12. Infant Object Engagement: Reunion												1	.07	.16	.54***
13. Infant Social Engagement: Reunion													1	.66***	.42***
14. Infant Positive Affect: Reunion														1	.50***
15. Infant Negative Affect: Reunion															1

Note. Infant Temperament Characteristics from the IBQ-R, Very Short form.

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 6.

Correlations between Infant Behavior and Maternal Behavior during the Still Face Paradigm, Controlling for Maternal Education (N= 85)

Maternal Interaction Variables		Positive Parenting: Baseline	Negative Parenting: Baseline	Positive Parenting: Reunion	Negative Parenting: Reunion
Infant Variables	Interaction				
Object Baseline	Engagement:	.05	.01	.16	0.11
Social Baseline	Engagement:	.44***	-.24*	.28*	.13
Positive Affect: Baseline		.44***	-.28*	.17	.12
Negative Affect: Baseline		-.44***	.18	-.41***	-.07
Object Engagement: Still-face		.02	-.07	.08	.15
Social Engagement: Still-face		.10	.06	.14	-.16
Positive Affect: Still-face		.12	-.30**	.11	-.01
Negative Affect: Still-face		-.12	.16	-.23*	-.07
Object Engagement: Reunion		.05	-.15	.06	-.02
Social Engagement: Reunion		.36**	-.15	.54***	.13
Positive Affect: Reunion		.48***	-.27*	.49***	-.001
Negative Affect: Reunion		-.30**	.13	-.40***	-.11

* $p < .05$. ** $p < .01$, * $p < .001$

Figure 5

ANCOVA Results: Changes in infant positive affect across the baseline (1), still-face (2), and reunion (3) episodes of the Still Face Paradigm, controlling for maternal education

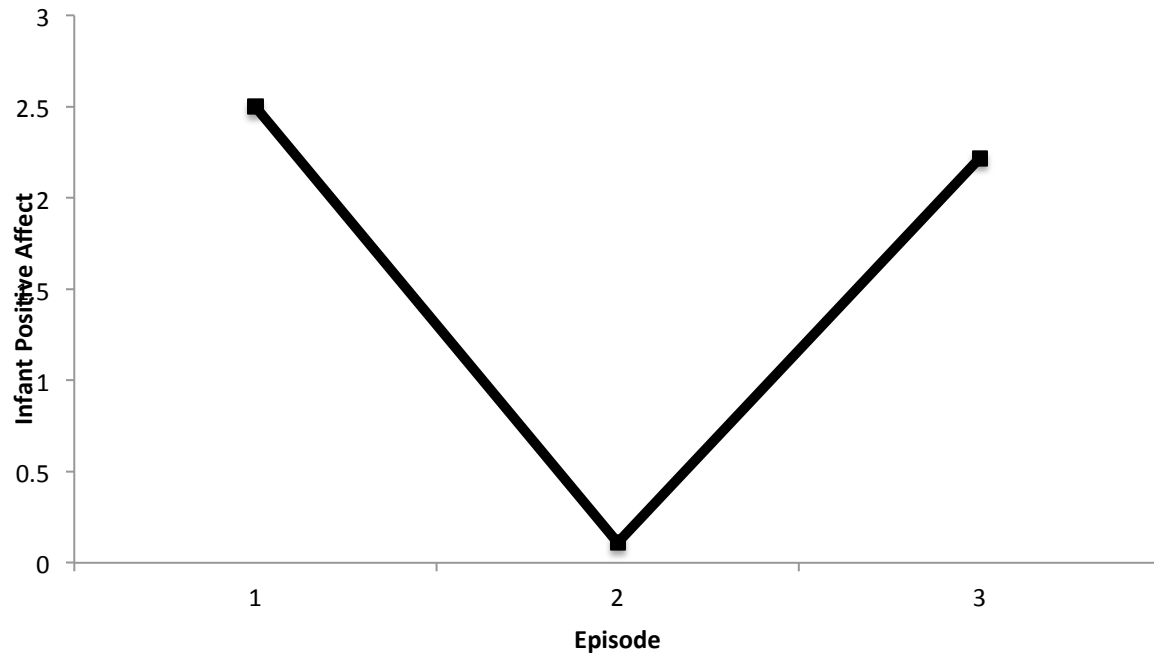


Figure 6

ANCOVA Results: Changes in infant negative affect across the baseline (1), still-face (2), and reunion (3) episodes of the Still-Face Paradigm, controlling for maternal education.

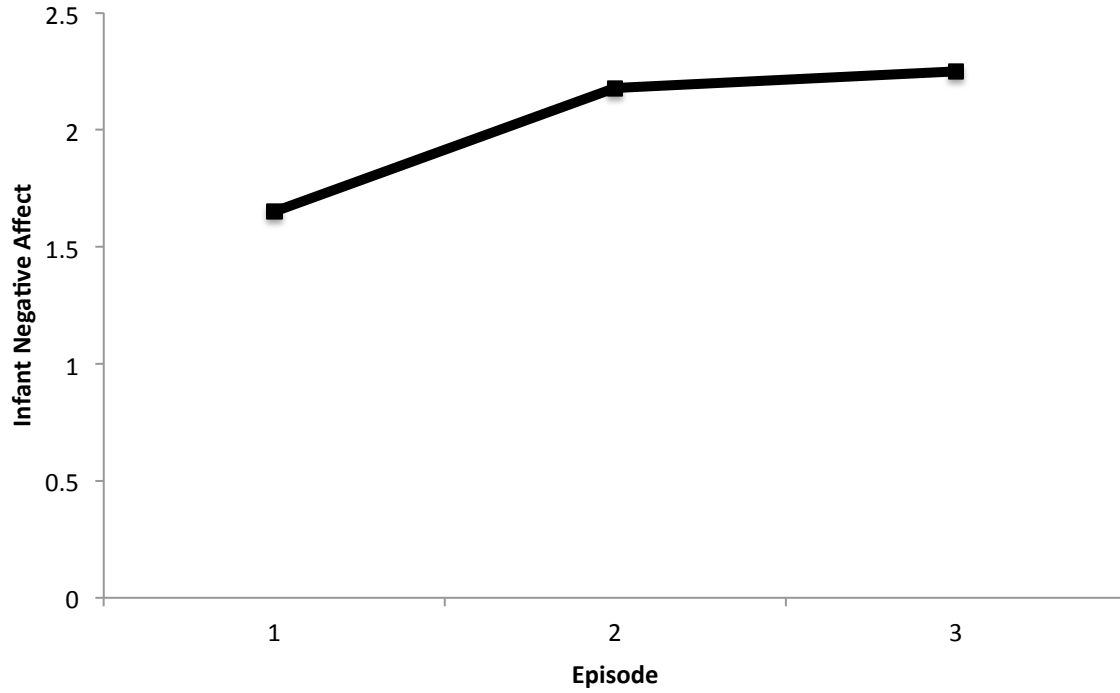


Figure 7

ANCOVA Results: Changes in infant object engagement across the baseline (1), still-face (2), and reunion (3) episodes of the Still-Face Paradigm, controlling for maternal education.

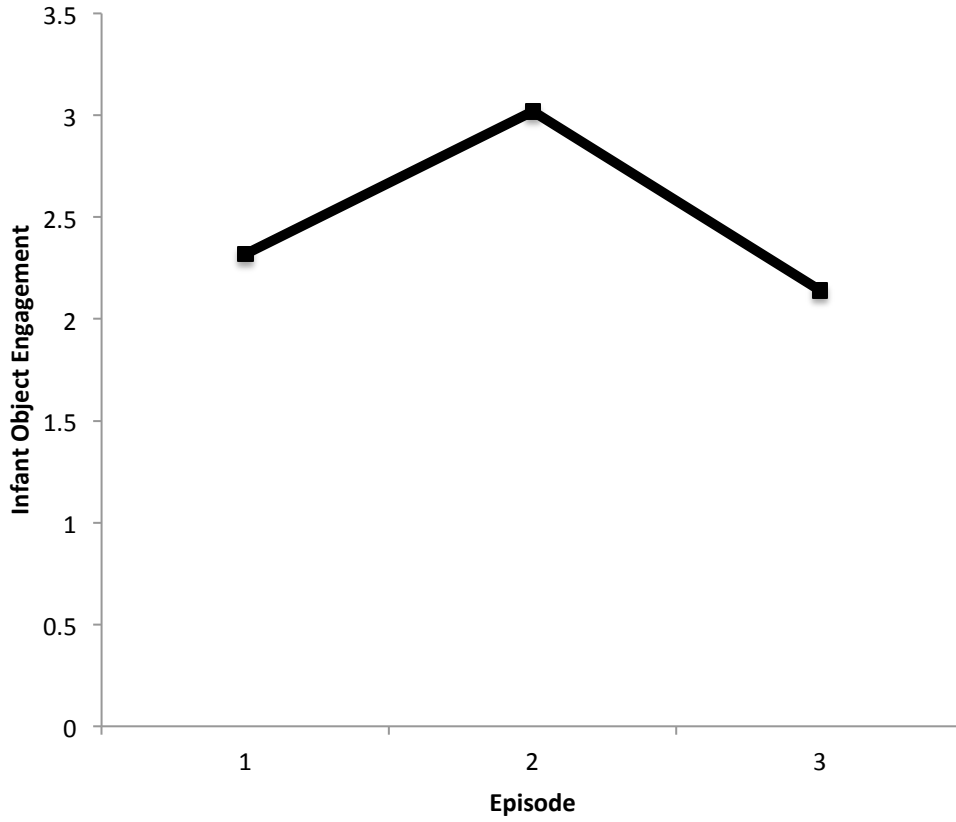


Table 7
Summary of Hierarchical Regressions: IBQ-R Infant Negative Affect Predicting Maternal Positive Parenting during Reunion

	Model 1			Model 2		
	B	SE(B)	β	B	SE(B)	β
			.26			
Maternal Education	.39	.16	*	.38	.16	.25*
IBQ-R Infant Negative Affect				-.01	.01	-.23*
R^2		.07			.12	
ΔR^2		.07			.05	
F for ΔR^2		5.88*			4.59*	

IBQ-R=Infant Behavior Questionnaire-Revised, Very Short Form

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 8
Results of the basic APIM for positive affect.

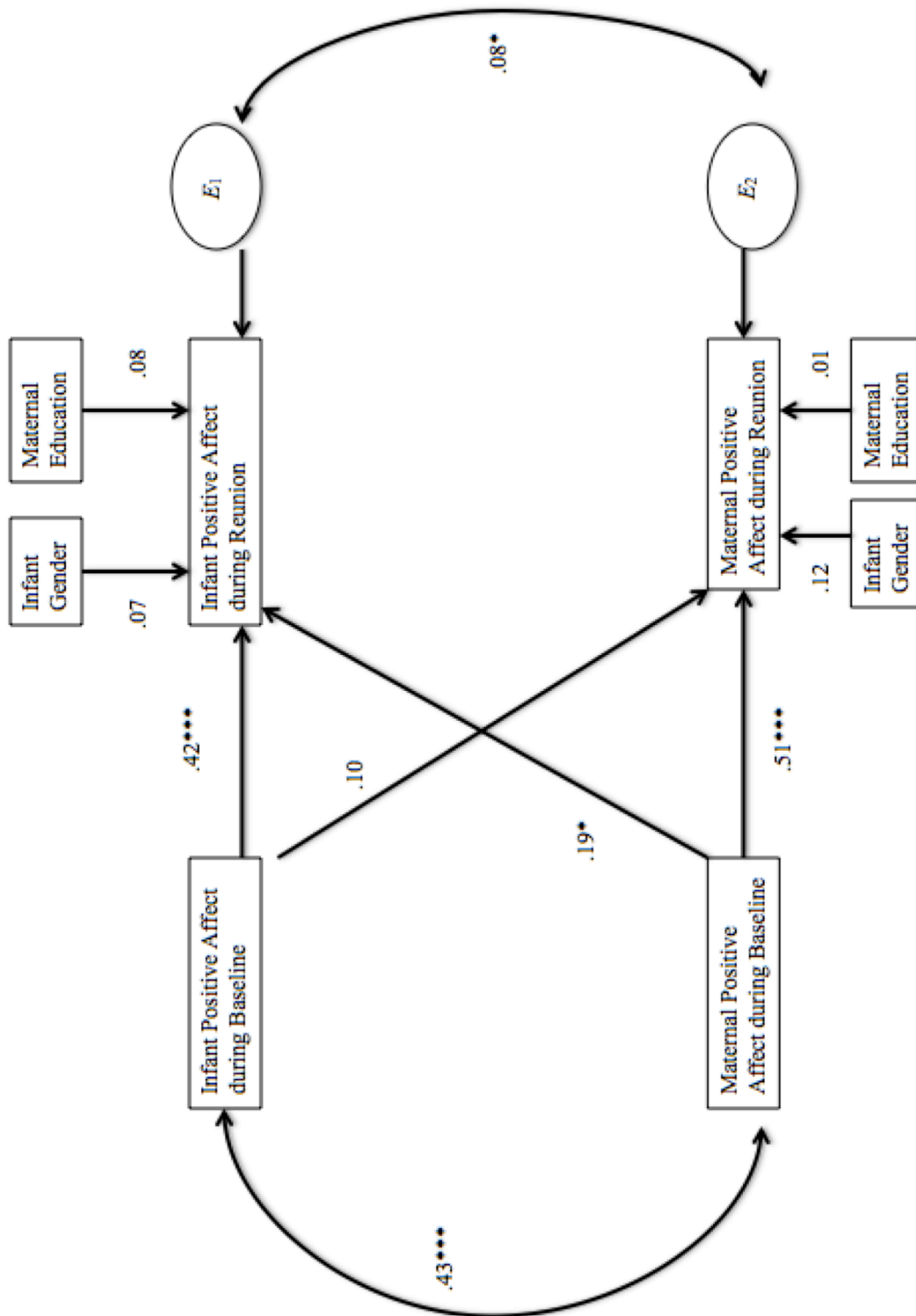


Figure 9
Results of the APIM with phantom variables for positive affect.

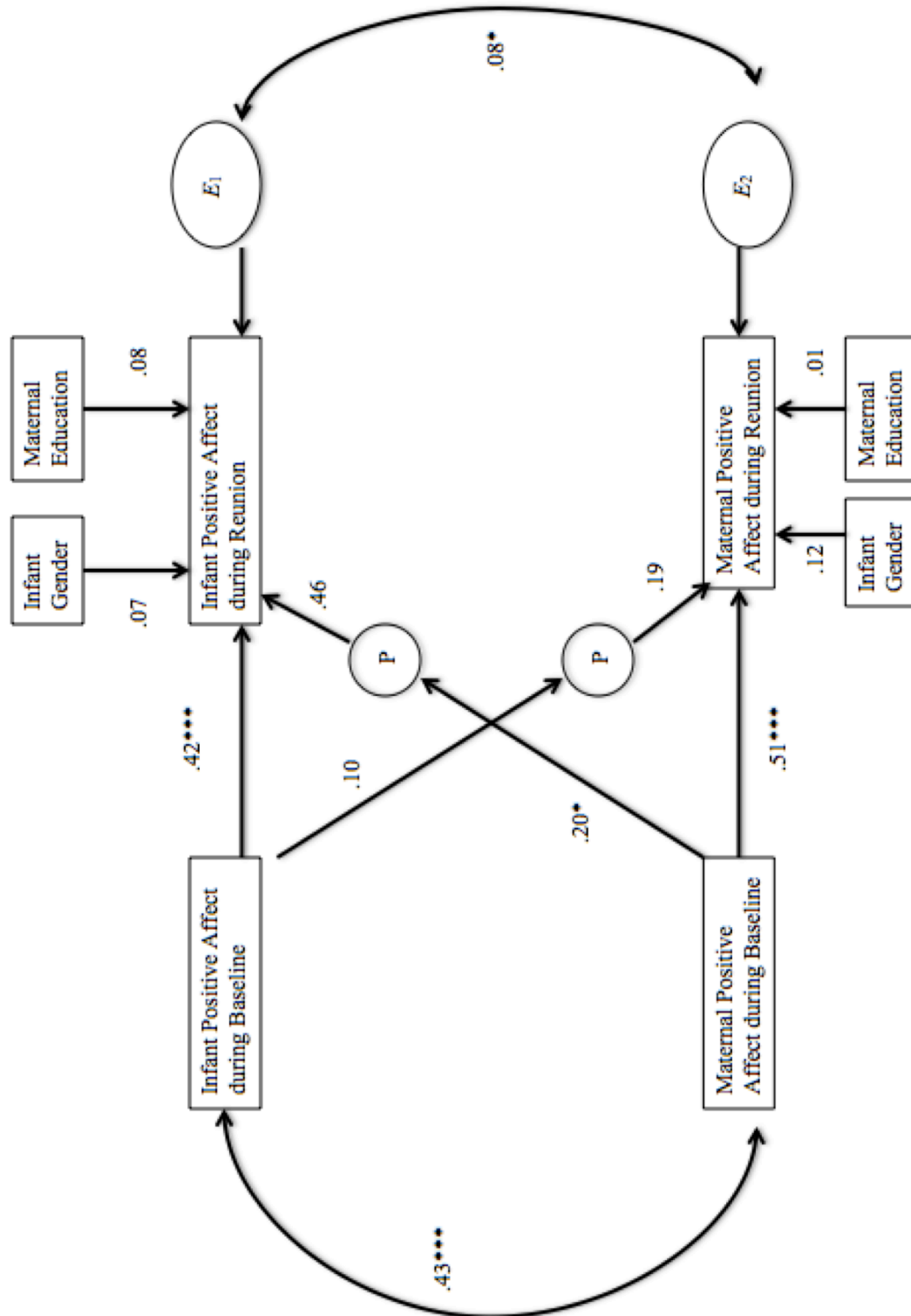


Figure 10
Results of APIM with phantom variables and $k1$ set to 0

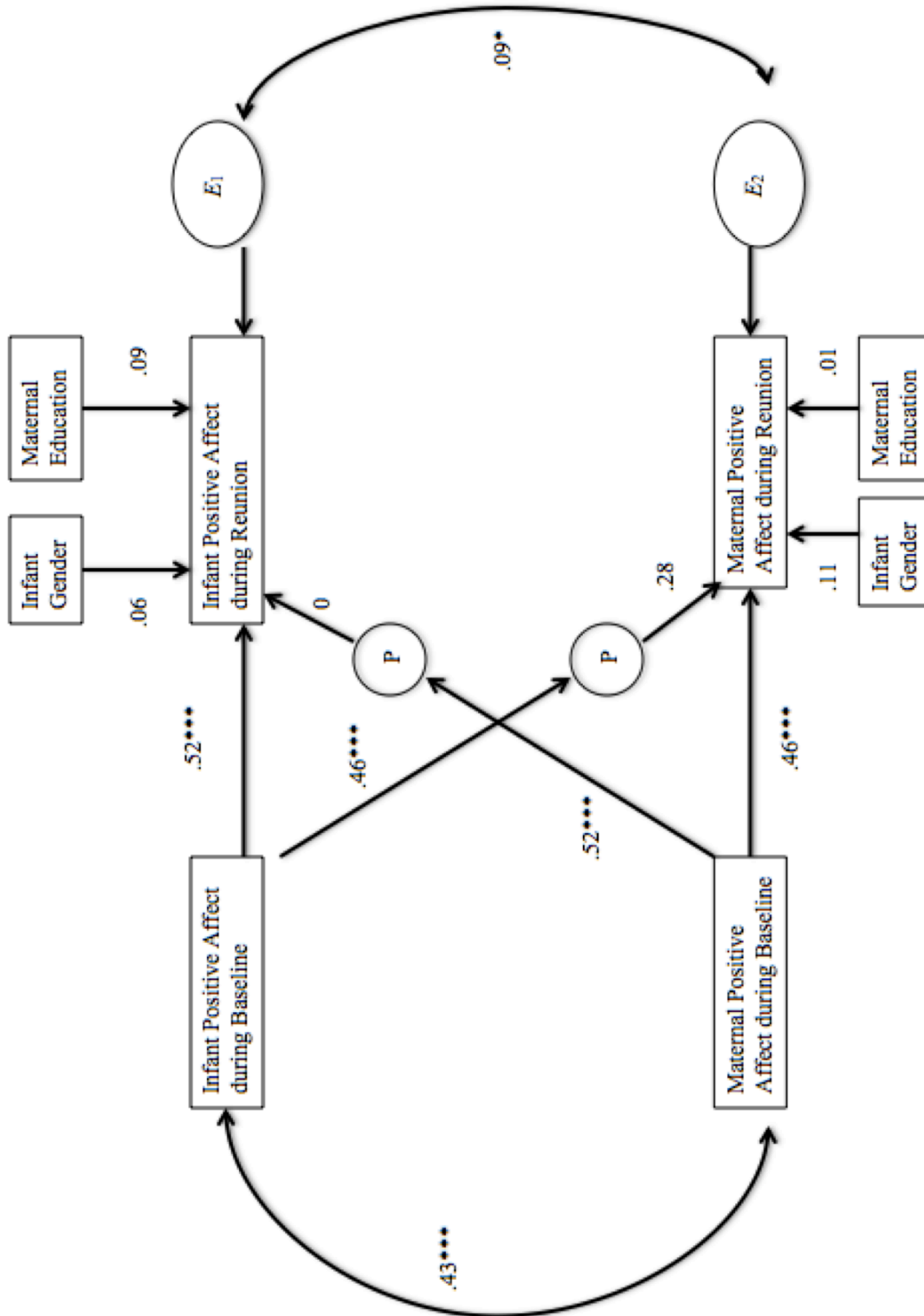


Figure 11
 Results of APIM with phantom variables and k2 set to 0

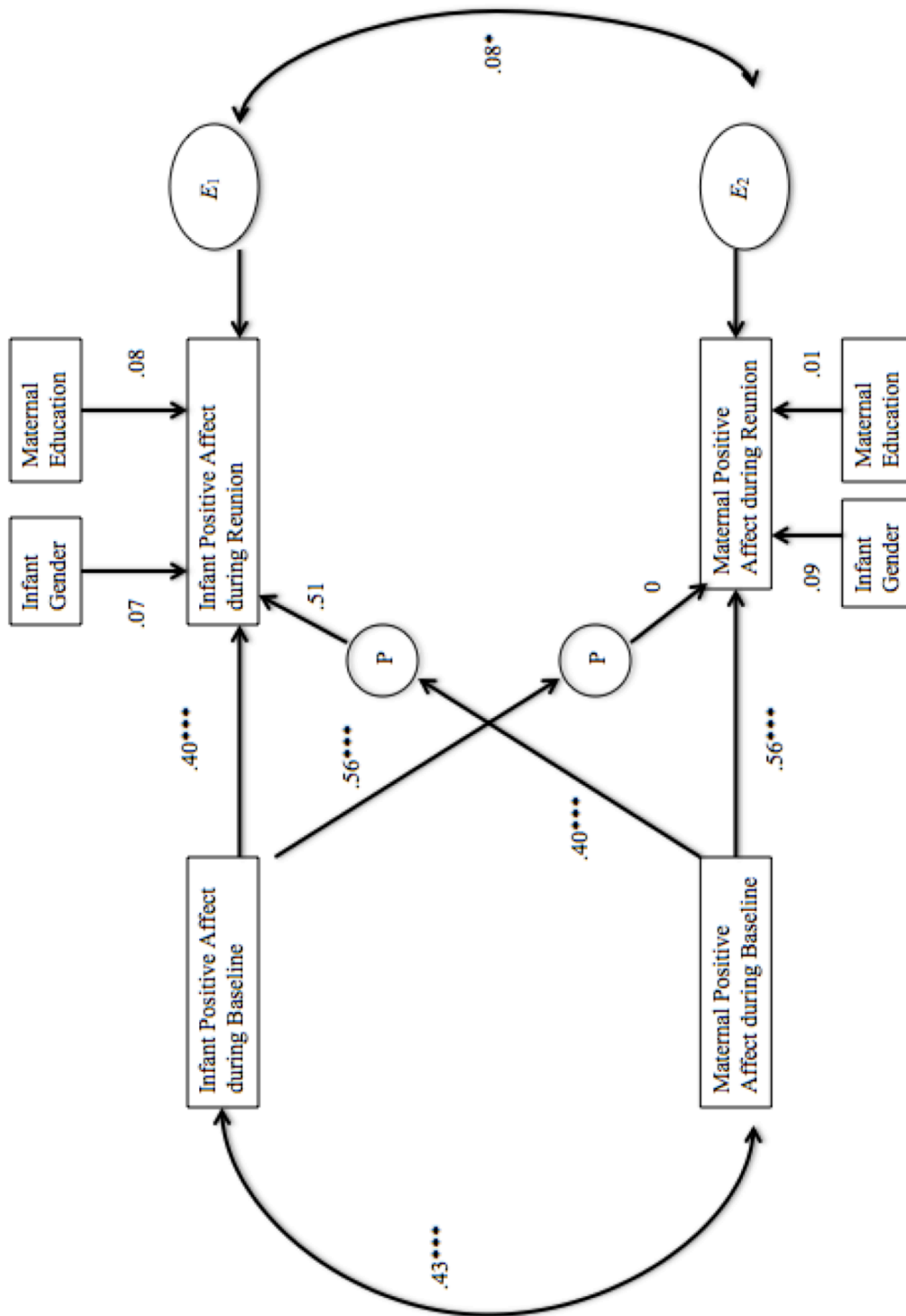


Figure 12
Results of APIM with phantom variables and both k_1 and k_2 set to 0

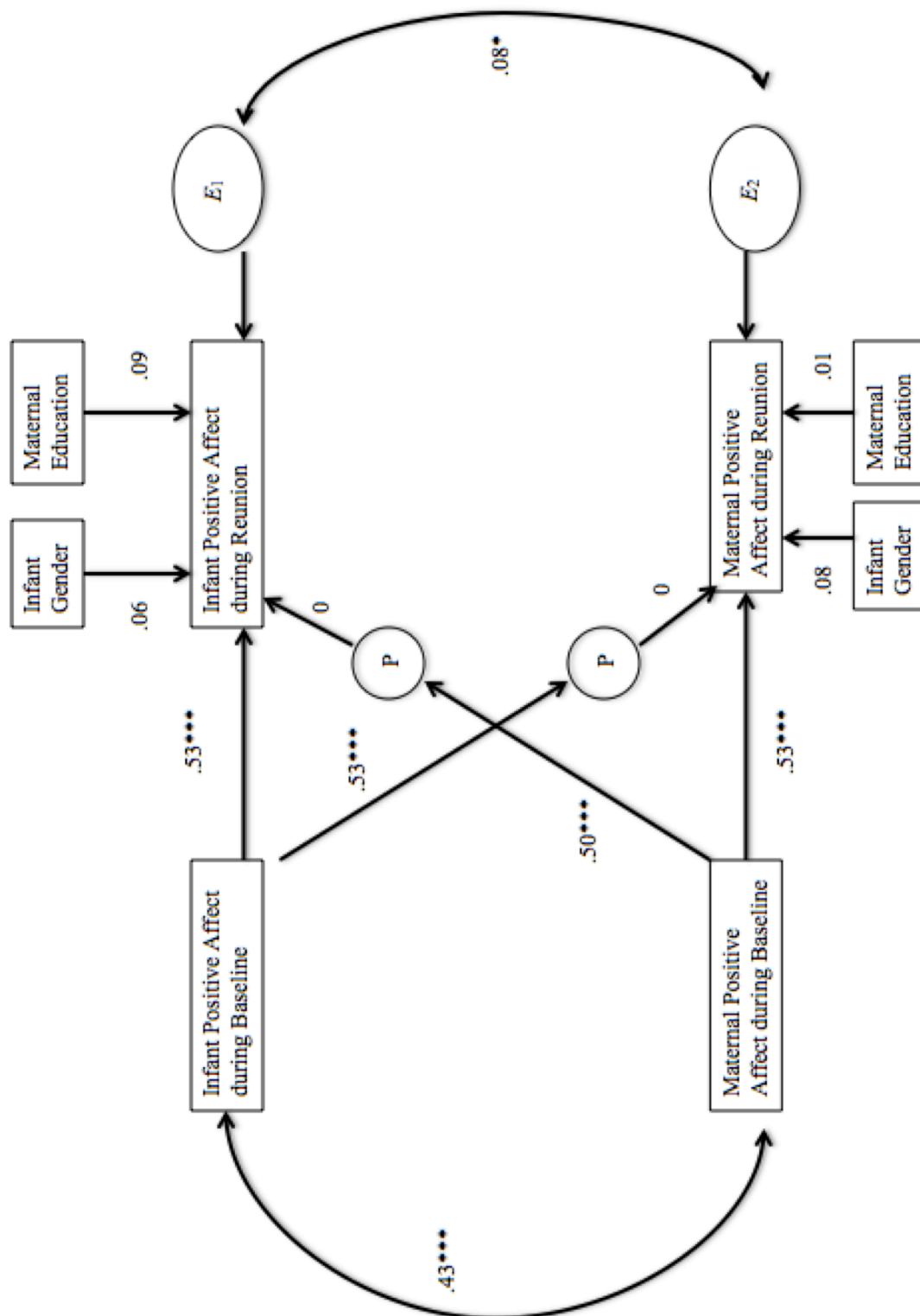


Table 8
Summary of APIM results for all steps for positive affect.

Steps	Results																																										
Step 1: Look for non-trivial actor and partner effects	<p>Actor effects: $a_1 = .22^{***}$; $a_2 = .51^{***}$</p> <p>Partner effects: $p_1 = .10$; $p_2 = .19^*$</p>																																										
Step 2: Add the k parameter to estimate dyadic patterns	<p>Ratio parameter (k=p/a)</p> <p>$k_1 = .46$ CI [.05, .97] 0 is not included</p> <p>$k_2 = .19$ CI [-.16, .63] 0 is included</p>																																										
Step 3: Interpret the k parameter	<table border="1"> <thead> <tr> <th>Models</th> <th>df</th> <th>χ^2</th> <th>SRMSR</th> <th>RMSEA</th> <th>TLI</th> <th>CFI</th> </tr> </thead> <tbody> <tr> <td>Basic APIM</td> <td>4</td> <td>4.72</td> <td>.07</td> <td>.05</td> <td>.98</td> <td>.99</td> </tr> <tr> <td>APIM with k parameter</td> <td>4</td> <td>4.72</td> <td>.07</td> <td>.05</td> <td>.98</td> <td>.99</td> </tr> <tr> <td> k1@0</td> <td>5</td> <td>10.03</td> <td>.08</td> <td>.11</td> <td>.90</td> <td>.94</td> </tr> <tr> <td> k2@0</td> <td>5</td> <td>5.83</td> <td>.07</td> <td>.05</td> <td>.98</td> <td>.99</td> </tr> <tr> <td> k1@0; k2@0</td> <td>6</td> <td>11.9</td> <td>.08</td> <td>.11</td> <td>.90</td> <td>.93</td> </tr> </tbody> </table>	Models	df	χ^2	SRMSR	RMSEA	TLI	CFI	Basic APIM	4	4.72	.07	.05	.98	.99	APIM with k parameter	4	4.72	.07	.05	.98	.99	k1@0	5	10.03	.08	.11	.90	.94	k2@0	5	5.83	.07	.05	.98	.99	k1@0; k2@0	6	11.9	.08	.11	.90	.93
Models	df	χ^2	SRMSR	RMSEA	TLI	CFI																																					
Basic APIM	4	4.72	.07	.05	.98	.99																																					
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k1@0	5	10.03	.08	.11	.90	.94																																					
k2@0	5	5.83	.07	.05	.98	.99																																					
k1@0; k2@0	6	11.9	.08	.11	.90	.93																																					

Figure 13
Results of the basic APIM for negative affect.

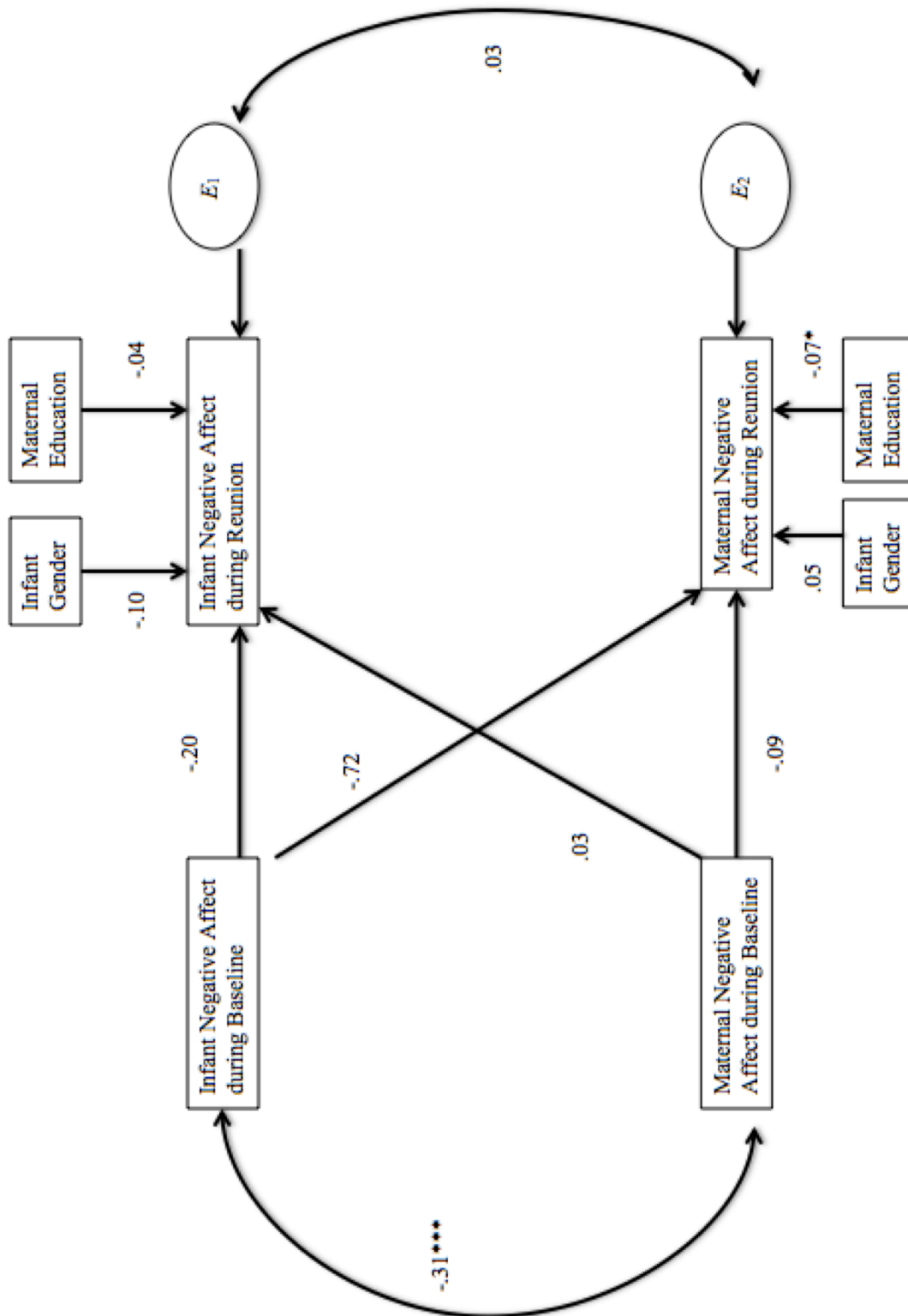
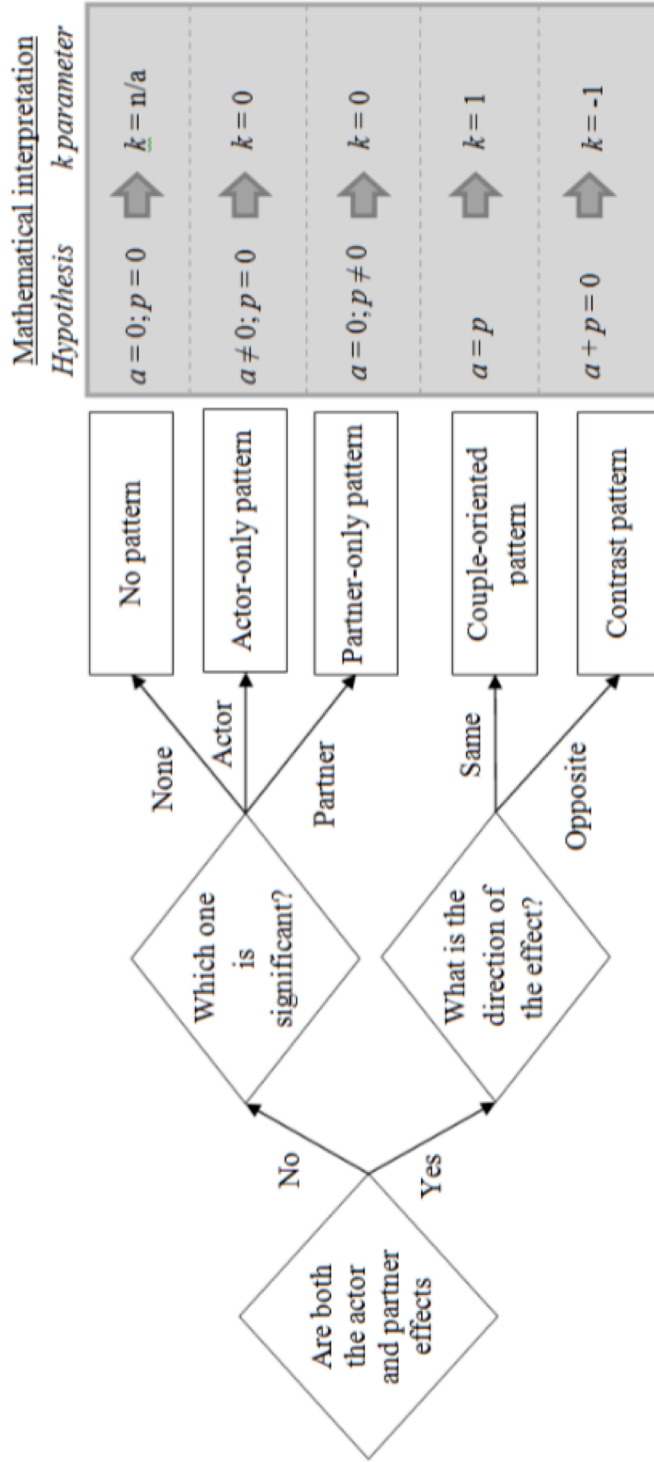


Table 9
 Summary of APIM results for all steps for negative affect.

Steps	Results												
Step 1: Look for non-trivial actor and partner effects	<p>Actor effects: $a_1 = -.20$; $a_2 = -.09$ Partner effects: $p_1 = .03$; $p_2 = -.72$</p>												
	<p>Model</p> <table border="1"> <thead> <tr> <th>df</th> <th>χ^2</th> <th>SRMSR</th> <th>RMSEA</th> <th>TLI</th> <th>CFI</th> </tr> </thead> <tbody> <tr> <td>4</td> <td>3.94</td> <td>.05</td> <td>.00</td> <td>1.01</td> <td>1.00</td> </tr> </tbody> </table> <p>Basic APIM</p>	df	χ^2	SRMSR	RMSEA	TLI	CFI	4	3.94	.05	.00	1.01	1.00
df	χ^2	SRMSR	RMSEA	TLI	CFI								
4	3.94	.05	.00	1.01	1.00								

Figure 14
Flow chart for interpreting the k parameters (Fitzpatrick et al., 2016)



CHAPTER 4: DISCUSSION

The aim of this study was to investigate bidirectional effects in interactions between mainly African American, low-income mothers and their 7-month old infants.

Aim 1: The first aim was to evaluate the stability and changes in magnitude of maternal and infant behavior during the SFP. Firstly, as predicted, the results of this study did replicate the still-face effect findings of many different studies (Tronick et. al., 1978; Carter, et al., 1990; Adamson & Frick, 2003). Many of the infant characteristics were correlated with each other between baseline and reunion, as well as the maternal characteristics with one another.

The ANCOVA results mostly supported the tenets of the Mutual Regulation Model (Tronick, 1989; Tronick & Beeghly, 2011) and the idea that interactions are bidirectional in nature and both the infant's and mother's contributions matter (Kuczynski, 2003).

As expected, infant object engagement showed an increase during the still-face as a possible coping method during stress. This object engagement then decreased during the reunion, when the infant could engage with their mother once again. This is consistent with the effect found in previous studies (Moszkowski & Stack, 2007; Rosenblum, McDonough, Muzik, Miller, & Sameroff, 2002; Tronick et al., 2005).

Interestingly, infant social engagement did not statistically differ between episodes. This is in contrast to previous findings (Weinberg & Tronick, 1996). Perhaps this could be because the infant continuously attempted to re-engage the mother during the still-face episode and was eager to comply when the mother re-engaged during the reunion. Future research should investigate this further, perhaps looking at the second still-face episode (in a double still-face paradigm) to see if the infant still has relatively high levels of social engagement.

Infant positive affect displayed a large decrease from baseline to still-face episode and then a recovery of positive affect in the reunion. This is consistent with prior research findings (Kogan & Carter, 1996; Haley & Stansbury, 2003).

In contrast, infant negative affect increased during the still-face and increased even more during the reunion. This suggests that the infants in our sample were unable to regulate themselves or be soothed by their mothers after a stressful situation.

As expected, we did not find any main or interaction effects of infant sex on any of the still-face variables in this study. In the present study, girls and boys displayed similar levels of positive affect, negative affect, object engagement, and social engagement across all three episodes of the SFP. This null finding contrasts with reports by Weinberg et al., (1999), who found that male infants have greater difficulty than female infants in regulating their negative emotions during each episode of the SFP. However, our lack of findings is consistent with those from a multitude of other studies using the the SFP (Abelkop & Frick, 2003; Cossette, Pomerleau, Malcuit, & Kaczorowski, 1996; Forbes, Cohn, Allen, & Lewinsohn, 2004; Garrity-Rokous, 1999; Haley & Stansbury, 2003; Hart, Carrington, Tronick, & Carroll, 2004; Lowe, Handmaker & Aragon, 2006; Stacks & Muir, 1990; Toda & Fogel, 1993; Weinberg et al., 2006; Yiramiya, Gamliel, Pilowsky, Feldman, Baron-Cohen, & Sigman, 2006). In their meta-analytic review of the SFP literature, Mesman et al. (1999) also reported equivocal evidence for sex differences in infant and maternal behavior during the SFP.

Aim 2: The second aim was to assess whether infant temperament was related to maternal parenting strategies during the SFP. Unexpectedly, many of the maternal-reported infant temperament variables were not correlated with maternal parenting behavior during the SFP or infant behavior during the SFP. Interestingly, two other studies have found similar

results. Cohn, Campbell, and Ross (1991) and Tarabulsky and colleagues (2003) found that infant irritability or difficultness, as reported by mothers, was not related to still-face responses at a variety of infant ages. There are a few reasons that could explain why our study had these results. Perhaps infant temperament was not correlated with many actual infant behaviors because the mothers were biased in their reporting of their infants. However, since infant temperament was not correlated with maternal parenting, it does not seem that maternal perceptions of infant temperament relate to maternal parenting behavior. Also, it could be that the infants acted differently in the controlled research environment and this paradigm does not represent their usual interactions with their mothers. Another possibility is that infant behavior is more dependent on the here-and-now parenting behavior. This could be why results showed many correlations between maternal parenting behavior during the SFP and infant behavior during the SFP.

Aim 3: The third aim was to assess whether infant temperament predicted infant behavior during the SFP. Contrary to expectations, there were no significant hierarchical regressions. Perhaps maternal perceptions of infant temperament are biased and not accurate for how the infants actually behave in stressful situations. Having multiple reporters of infant temperament could help to better understand the relationship between infant temperament and behavior during a stressful situation (Stanovich, 1986).

Aim 4: The fourth aim was to assess whether maternal parenting behaviors were associated with infants' behavior during the SFP.

Positive parenting was correlated with more infant behavior than negative parenting. This may reflect the fact that negative parenting occurred relatively infrequently during the SFP. Alternatively, it may suggest that infants are more reactive and responsive to maternal positivity

than to maternal negativity. Interestingly, maternal negative parenting during the reunion episode was not correlated with any infant SFP variables. This suggests that exposure to a social stressor (maternal still-face) may disrupt the attunement between maternal and infant behavior that were observed before the stressor was introduced. Alternatively, infants may be more affected by their mother's affect before a stressful event occurs than after. In this study the mother's affect are more affected by the mother's behavior during the baseline than during the reunion.

Contrary to expectations, only one hierarchical regression was significant in these analyses. Maternal-reported infant negative affect from the IBQ-R predicted maternal positive parenting during the reunion, over and above the effects of maternal education. This suggests that mothers who perceive their infants as being more negative display less positive parenting strategies when the level of challenge increases in the reunion episode. Alternatively, mothers may believe that their infants will display negative affect no matter what, so they no longer attempt to display positive maternal behaviors (Donovan, 1981). This could be a form of learned helplessness (Abramson, Seligman, & Teasdale, 1978; Seligman, 1975).

Aim 5: The fifth aim was to assess dyadic behavior between mother and infant during the SFP. To our knowledge, this is the first study that used the APIM to investigate dyadic affective interactions during the SFP.

For positive affect, the APIM results showed that actor effects were significant for both mother and infant. This means that how positive one member of the dyad was in the baseline episode was associated with how positive that same member was in the reunion. So, how one acts in the baseline is significantly associated with how he/she acts in the reunion. This makes logical sense and could be a result of temperament and personality.

Interestingly, the only significant partner effect was from mother's positive affect in the baseline to infant's positive affect in the reunion. This could demonstrate that mothers who are more positive with their infant during normal social interactions have children who are better able to cope with stressful situations (Kogan & Carter, 1996; Mesman et al., 2009).

Notably, the infant's positive affect during the baseline episode did not affect the mother's positive affect in the reunion. This could suggest that, although both members in the dyad are important, the mother has a more powerful influence on the baby's functioning than the other way around. Alternatively, the baby could be modeling the mother's positive engagement during baseline play, resulting in better infant coping following the still-face (Kagan, 1983).

Next, phantom variables were created in order to create the k parameter, which is a ratio of the actor and partner effects. k_1 , which included the ratio of infant actor effects to maternal partner effects, was larger and had a confidence interval that did not include 0 as compared to k_2 , which included the ratio of mother actor effects to infant partner effects.

Model fit indices were analyzed for the basic APIM, the APIM with the addition of phantom variables, and models where each k was set to 0 and both k 's were set to 0. When k_1 was set to 0, model fit largely decreased. This shows that k_1 had a large effect on model fit. When k_2 was set to 0, model fit remained close to the same. This suggests that k_2 does not have as much of an effect on the model. Once again, this demonstrates the importance of the actor effects of the infant, as well as the partner effects of the mother on infant's positive affect during reunion. The infant's positive affect after a stressful situation is both dependent on infant and maternal behaviors, whereas the mother's positive affect after a stressful situation is mostly dependent on her own behaviors. This is consistent with a theory proposed by Field (1994;

Stoller & Field, 1982), which states that the parent is more important in regulating her immature infant's emotional states in order to repair the mismatch and resume synchronous interactions.

Negative affect was also analyzed using the APIM. However, maternal negative affect during the baseline and reunion was very rarely observed during this paradigm. This could be one reason why there were no significant actor or partner effects for this variable.

In conclusion, results from this study are largely consistent with the tenets of the Mutual Regulation Model and provide further evidence that both members of a dyad contribute to the nature of mother-infant interactions before and after a stressful episode. The APIM results further suggest that the affective displays of mothers play a greater role in regulating their infants' affect following exposure to a stressor than the other way around, at least at 7 months postpartum.

Limitations, Strengths, and Future Directions

As with all research, there were both limitations and strengths in this study.

The sample was relatively small and was underpowered for the ANCOVA and structural equation modeling analyses. This could explain, in part, why maternal and infant negative affect produced few significant results in the APIM. It could be that there actually are actor-partner effects for negative affect, but we were not able to detect them in the current sample. With a larger sample, more minute and accurate results could potentially be found. Future research is needed to investigate dyad-level interactive processes using the APIM in larger sample sizes to replicate and extend these findings.

In addition, the APIM could only investigate mothers and their infants on the same variables (in this case, positive and negative affect). In future research, investigators could use cross-lagged models, analyzed by structural equation modeling or less sophisticated techniques,

to investigate questions of how the infant's level of responsivity/compliance to the mother during baseline and reunion play are associated with mothers' level of engagement during baseline and reunion.

A second limitation was that both maternal negative parenting and negative affect were relatively rare and had small variances. It may be that the mothers in the current sample generally exhibit low negativity with their infants, or they were acting in a more positive way than usual because they knew that cameras were filming them and that they were in a research study with child development specialists at a large university. Whatever the reason, the results for these aspects of maternal behavior were relatively limited. Objectively, it is a good thing that we did not witness high levels of negative parenting from the mothers in our study. Future research may address these questions with a more naturalistic setting and longer observation times of mother-child interaction.

A third limitation concerns the fact that these data were taken from a larger study, so there were restrictions as to what questions could be asked and answered with these data. The study would have benefitted from the inclusion of maternal personality measures, as well as multiple reporters and direct assessments of infant temperament. Measures of infant attachment would also be valuable to have in this data set.

A fourth limitation has to do with sample characteristics. The mothers in the current study were mostly African Americans from low-income urban backgrounds. Findings may not generalize to mother-infant dyads in different socioeconomic or racial/ethnic groups. A related issue is that low-income status is confounded with race/ethnic status for many of the participants in this sample. To untangle socioeconomic status and race, future research should investigate

these questions with a larger, more economically and racially diverse sample of minority families.

In addition, there were a small number of mothers whose annual household income was much higher than mothers in the majority of the sample. Although income was not related to many interactive behavior variables in the current study, the uneven distribution of income might have obscured other associations.

Another issue is that the current study was cross-sectional in design, which limits our ability to make causal inferences. Future research should investigate longitudinal associations between maternal, infant, and dyadic behavior in the SFP at 7 months and later maternal, child, and dyadic functioning. Are these 7-month findings associated with mother/child outcomes at later time-points?

Also, the current study did not evaluate other characteristics of mothers and infants that may have affected their behavior in the SFP. For instance, variations in the presence/absence of DNA risk alleles or infant health may have contributed to infants' differential susceptibility to stress in the SFP. For example, studies have found that infants who were at-risk for autism, by virtue of having a sibling with autism, were less upset during the still-face episode and displayed less crying than infants without a sibling with autism (Cassel et al., 2007; Merin, Young, Ozonoff, & Rogers, 2007; Yirmiya et al., 2006). In addition, infant girls who were exposed to alcohol in utero displayed more negative affect than unexposed girls during the reunion episode (Haley et al., 2006; Lowe et al., 2006).

Similarly, maternal psychosocial factors such as depressive symptoms social support, or reflective functioning capacity may have contributed to their parenting quality in this context (Field et al., 2007; Forbes et al., 2004; Weinberg et al., 2006). Evaluation of these factors is a

topic for future research. The results of such future studies are likely to contribute significantly to our knowledge base about how maternal, infant, and broader contextual factors contribute to the nature of mother-infant interactive processes during the SFP.

Clinical Implications

The information provided by this and other studies on mother-infant interaction processes may be useful for clinical intervention work. It is important for new mothers to understand how their positive affect displays with their infant during normal en face play are directly associated with their infants' later affective reactions following exposure to a stressor. Supporting the quality of mother-infant interactions is a worthwhile undertaking for practitioners, because these interactions, especially when repeated over time and context, are foundational in building secure attachment relationships. In turn, secure attachment in infancy is linked to later social competence and other child outcomes. Because this was mostly a low-income sample, this population may be especially at-risk for poor mother-infant relationships because higher socioeconomic stress is linked to decreased maternal responsiveness (Bradley & Corwyn, 2003; Evans, Boxhill, & Pinkava, 2008). Interventions that help mothers become more aware of infant engagement and disengagement cues and respond to them sensitively and appropriately may help regulate infants' distress and promote positive outcomes. This type of intervention might be of special importance in high-risk samples such as that used in the current study.

APPENDIX A

Coding System for Maternal and Infant Behavior during the Still-Face Paradigm (SFP)

Maternal Codes:

Behavioral Sensitivity/Supportive Presence (Adapted from the MACY sample; Huth-Bocks & Dayton (2001), who used Ainsworth et al., 1971; 1974; 1978; & Lyons-Ruth, 1983; 1999); Beeghly, 2006): *Use this scale during all tasks, except the Still Face episode.* This is the mother's awareness of or ability to perceive even the most subtle communications, signals, wishes, and moods (cues) of her infant as manifested in sensitive vocalizations, facial expressions, and physical handling responses. Sensitive responses are well-timed, they reflect empathy with infant's needs and feelings, and they involve behavior that enhances infants' security, comfort, and development, such as praising, providing physical and emotional support, and redirecting sensitively.

1 = NO or VERY LITTLE Sensitivity

Mother's behavior is primarily guided by her own wishes, needs, moods, and she makes no attempt to follow her infant's lead (infant's needs, wishes, and moods). She may respond if her infant's signals are intense and prolonged after an inappropriately long delay (that allowed the infant to get to the intense and prolonged signals). This mother, in general, shows no or very little attempts to respond and/or no or very little awareness of her infant's cues. This mother may appear *disengaged*.

2. SOME Sensitivity

Mother's behavior is often guided by her own wishes, needs, moods, and she makes limited attempts to follow her infant's lead. This mother, in general, sometimes responds to her infants signals, although she misses the more subtle ones, or responds after a moderate delay. This mother shows some attempts to respond and/or limited awareness of her infant's cues (attempts to respond a few times and/or has awareness of her infant's cues a few of times).

3. MODERATE Sensitivity

Mother's behavior is moderately guided by her own wishes, needs, and moods, but she also makes attempts to follow her infant's lead *half* of the time. This mother, in general, responds about half the time to infant's signals, although she misses the other half of the signals, or responds after a short delay. This mother shows adequate attempts to respond and/or adequate awareness of her infant's cues (attempts to respond more than a few times and/or has awareness of her infant's cues more than a few times).

4. MUCH Sensitivity

Mother's behavior is guided mostly by her infant's wishes, needs, and moods. This mother, in general, responds more than half the time to infant's signal, although she misses some of them, or responds after a minor delay. This mother shows more than adequate attempts to respond and/or more than adequate awareness of her infant's cues.

5. VERY HIGH Sensitivity

Mother's behaviors are always guided by her infant's wishes, needs, and moods. This mother always responds to her infants signals in a timely manner. This mother shows exemplary attempts to respond and/or exemplary awareness of her infant's cues.

Positive Engagement/Disengagement (Adapted from Huth-Bocks & Dayton, 2001; Beeghly, 2006; Miller, 1998). *Use this scale during all tasks, except the Still Face Paradigm, Still Face.* This is the degree to which the mother engages in play with her infant as manifested by:

Pacing-flexible turn-taking

body position - on continuums of toward or away; comfortable or awkward, close or distant

vocalizations –commentary regarding interactions and activities

and *involvement in/facilitation of interactions and activities*- or appropriate amounts of control and facilitation, meaning that mother allows infant to control /facilitate when s/he wants to

Also: the degree to which mother is distracted by other things in the environment (phone, pets, TV, radio, etc.), or by her own thoughts, or play that doesn't involve her infant.

1. NO ENGAGEMENT (DISENGAGED) or almost totally DISENGAGED

Mother does not interact with infant interactions and activities as apparent by her seeming obliviousness or attention to other things (distractions). She does not position body appropriately, vocalize about, involve herself in, and/or facilitate interactions or activities with her infant. Mother and infant exist seemingly in “parallel.” May position body appropriately, vocalize about, involve herself in, or facilitate interactions or activities one time, but in general, she is not involved in interaction or activity with her infant.

2. SOME Engagement

Mother sometimes engages in infant interactions and activities. She sometimes positions body appropriately, vocalizes about, involves herself, or facilitates interactions or activities. Mother and infant exist sometimes in “parallel.” In general, mother is somewhat involved in interaction and activity with her infant, and/or somewhat distracted.

3. MODERATE Engagement

Mother engages in infant interactions and activities half of the time. She positions body appropriately, vocalizes about, involves herself in, and/or facilitates interactions and activities half of the time. In general, mother is involved in interaction and activity with her infant half of the time, and/or distracted half of the time. *Note: moderately engaged can mean mom is not appropriately engaged, just engaged half of the time.*

4. MUCH Engagement

Mother engages in infant interactions and activities more than half of the time. She positions body appropriately, vocalizes about, involves herself in, and/or facilitates interactions and activities half of the time. In general, mother is involved in interaction and activity with her infant more than half of the time, and is distracted less than half of the time. *Note: to get a “4” or higher, mom must be appropriately engaged most of the time.*

5. VERY HIGH Engagement

Mother engages in infant interactions and activities all of the time. She positions her body appropriately, vocalizes about, involves herself in, and/or facilitates interactions and activities all of the time. In general, mother is involved in interaction and activity with her infant all of the time, and distracted none of the time. *Note: to get a “5,” mom must be appropriately engaged all of the time.*

Hostile/Rejecting/Discrepant Communication: (As adapted from the MACY sample, Beeghly, 2006; Covert Hostility-Crittenden, 1981; Huth-Bocks & Dayton, 2001; & Miller, 1998). *Use this scale during all tasks, except the Still Face Paradigm, Still Face.* This scale measures the frequency, duration, and intensity of the mother's rejection, hostility, and/or ambivalence during interaction with her infant. Score if mother perceives rejection rather than disinterest. Manifestations include:

Vocal expressions: convey hostile content or bitterness (e.g.: "You don't want to play with mommy," or "You're mad at mommy," or "You're too big to pick up."). May also use exaggerated, fast paced, or artificial-sounding tone that does not match her demands (message is "mixed") (e.g., sweet tone with harsh hands; pleasant voice with hostile intent, gentle insistence combined with indications of disgust when infant doesn't comply). Also: Teasing or taunting, such as holding a toy out of reach ("Do you want that? Come get it!") to a baby who can't crawl yet. Negative or derogatory remarks. Can be said mildly or angrily (intensely). ***Score lower if instances are more covert. Score higher if instances are angry or intense (overt).***

Prohibitions/Restrictions (Verbal "zaps"): such as: "No!" "Uh uh!" "You can't chew on that" "It doesn't go there!" ***Score lower if instances are more covert. Score higher if instances angry or intense (overt).***

Facial expressions: exaggerated expressions, inappropriate happiness or glee when baby is unhappy or fussy or cannot see mother's face. Eye rolling. Can be mild or intense expressions. ***Score lower if instances are more covert. Score higher if instances are angry or intense (overt).***

Physical restrictions (Nonverbal "zaps"): removes toy from infant's grasp or vision while infant is attending to it; prevents infant from moving away, shakes finger or head at infant, teases infant non-verbally (e.g. pretends to give infant toy, then takes it away). Can be mild "zaps," or more intense "zaps." ***Score lower if instances are more covert. Score higher instances are angry or intense (overt).***

Expressions of Affection: pseudo-affectionate behavior that can appear similar to affectionate behavior, but which is irritating to the infant such as jabbing, poking, pinching, loud "kissing," and which produces startles, wincing, and withdrawal by the infant. Can look affectionate and playful, but in a sharp manner that is "out of sync" with the child. (e.g. using a puppet to "kiss" the baby on his/her face repeatedly while the child attempts to withdraw). Can be mild or more intense pseudo-affection. ***Score lower if instances are more covert. Score higher if instances are angry or intense (overt).*** ***Note: If infant does not respond negatively to an instance, it still counts as an instance; if infant responds negatively, score instance higher.***

1. **NO Instances of Hostile/Rejecting/Discrepant Communication**
2. **ONE or two mild instances of Hostile/Rejecting/Discrepant Communication**
3. **Several mild instances, or one angry/intense instance of Hostile/Rejecting/Discrepant Communication.** Note: if coded a 3,
4. **Recurrent mild instances of, or two angry/intense instances, or one prolonged instance of Hostile/Rejecting/Discrepant Communication**

5. MANY instances, all associated with angry/intense affect, or several prolonged instances of Hostile/Rejecting/Discrepant Communication

Flexibility: (As adapted from the MACY sample, and from Feldman’s (1998) *Resourcefulness*). Use this scale during all tasks **except the Still Face Paradigm, Still Face**. This scale measures the degree to which the mother is resourceful, creative, and flexible in handling her infant’s distress, lack of interest, and/or fussiness; or the degree to which the mother does not “give up,” but proceeds to change strategies or redirect her infant, rather than appear helpless or incompetent. If the infant is not fussy or disinterested, pay attention to mother’s creativity regarding engaging her infant in the task. If she mother is resourceful, and creatively and flexibly engaged with her infant, she will be coded as flexible. Mothers who are not flexible appear either *helpless* (they may try briefly to regulate their infants, but give up quickly; or *rigid*, appearing to not know any other way of regulating their infant.

1. NO Flexibility or VERY HIGH Helplessness or Rigidity

Mother is not resourceful, creative, and flexible in handling her infant’s distress, lack of interest or fussiness. Mother, instead, sticks to the same strategies that do not regulate her infant, OR she does not try to calm her infant’s distress, or mitigate her infant’s lack of interest or fussiness.

2. SOME Flexibility or MUCH Helplessness or Rigidity

Mother is somewhat resourceful, creative, and flexible in handling her child’s distress, lack of interest, or fussiness, in the she changes strategies, or redirects her child once or twice.

3. MODERATE FLEXIBILITY or MODERATE RIGIDITY or HELPLESSNESS

Mother is moderately resourceful, creative, and flexible in handling her infant’s distress, lack of interest, or fussiness, in that she is successful in changing strategies, or redirecting her infant, or mother is resourceful, creative, and flexible in handling her infant’s distress during about half of the interaction. During the other half of the interaction, mother either sticks to strategies that are not working, or does not do anything to help her distressed or fussy infant.

4. MUCH Flexibility or SOME Helplessness or Rigidity

Mother is resourceful, creative, and flexible in handling her child’s distress, lack of interest, or fussiness more than half of the time, in that she is successful in regulating her infant by changing strategies, or redirecting.

5. VERY HIGH Flexibility or NO Helplessness or Rigidity

Mother is resourceful, creative, and flexible in handling her infant’s distress, lack of interest, or fussiness during the entire interaction OR mother creatively and flexibly engages her infant (who is not distressed, fussy, and/or disinterested). **Note:** to get a “5,” mother must be able to read even subtle cues of her infant.

Affective Sensitivity: (As adapted from the MACY sample, Clark, 1985; and *Affect Attunement* of Huth-Bocks & Dayton, 2001). *Use this scale during all tasks.* This is a mother's attunement with and empathy for her infant's subjective experience (the infant's affective states, intentions, motives, wishes, etc.) Importantly, attunement can be positive or negative. This is evidenced by the mother's comments about and sharing of the infant's experience. For example, mothers may reflect infant's affect or behavior primarily through vocalizations and/or through echoing, gazing, mirroring, or confirming the child's internal feeling state (e.g. "You love that toy," or "You're frustrated because you can't make that work."). Importantly, this scale rates the mother's attunement to the infant's affective experience, rather than her behavior, per se.

1. NO or VERY LITTLE Affective Sensitivity

Mother exhibits no understanding of or empathy for her infant's affective experience. Mother does not understand her infant's affect, intentions, motives, or wishes, and therefore cannot reflect or mirror them.

2. SOME Affective Sensitivity

Mother exhibits some understanding of or empathy for her infant's affective experience. Mother mostly does not understand her infant's affect, intentions, motives, or wishes, but may elicit a few instances of understanding or empathy.

3. MODERATE Affective Sensitivity

Mother exhibits moderate understanding of or empathy for her infant's affective experience, or understanding of or empathy for her infant's distress half of the time. Mother understands her infant's affect, intentions, motives, or wishes half of the time, and demonstrates instances of understanding or empathy half of the time.

4. MUCH Affective Sensitivity

Mother exhibits understanding of or empathy for her infant's affective experience more than half of the time. Mother understands her infant's affect, intentions, motives, or wishes more than half of the time, and elicits instances of understanding or empathy more than half of the time.

5. VERY HIGH Affective Sensitivity

Mother exhibits understanding of or empathy for her infant's affective experience all the time. Mother understands her infant's affect, intentions, motives, or wishes all the time, and demonstrates instances of understanding or empathy all the time.

Warmth: (Adapted from the MACY sample, Huth-Bocks & Dayton, 2001, who adapted it from Lyons-Ruth, 1983). *Use this scale during all tasks.* This is the degree to which mother expresses affection for her infant, as manifested in instances of warmth involving positive facial expressions, tone and/or content of verbalizations, gentle patting stroking, hugging, and kissing. The extent of warmth is measured in terms of degree of intensity and frequency.

1. NO or VERY LITTLE Warmth

Mother's behavior consistently fails to convey warmth; interactions lack maternal affection. Mother appears to not enjoy interaction with her infant. Mothers may exhibit one instance of warmth.

2. SOME Warmth

Mother's behavior occasionally exhibits warmth; interactions mostly lack maternal affection. Mother appears to occasionally enjoy interaction with her infant. Mothers may exhibit a few instances of warmth.

3. MODERATE Warmth

Mother's behavior exhibits moderate warmth, or warmth half of the time; interactions lack maternal affection half of the time. Mother appears to enjoy interaction with her infant half of the time. Mother exhibits instances of warmth half the time.

4. MUCH Warmth

Mother's behavior exhibits warmth more than half of the time; interactions are affectionate more than half of the time. Mother appears to enjoy interaction with her infant most of the time. Mother exhibits instances of warmth most of the time.

5. VERY HIGH Warmth

Mother's behavior exhibits warmth all the time; interactions are affectionate all the time. Mother appears to enjoy interaction with her infant all the time. Mother exhibits instances of warmth all the time.

PositiveAffect/Enthusiasm/Joy: (Adapted from the MACY sample; Beeghly, 2006; Huth-Bocks & Dayton, 2001; & Miller, 1998). *Use this scale during all tasks.* This is a graduated scale from positive affect, to enthusiasm, to joy, with positive affect on the low end and enthusiasm/joy on the high end. Each end refers to the degree and intensity of the mother's pleasure and enjoyment of her infant with Positive Affect representing the low degree of positive facial expressions and/or vocal tone, vocal remarks, and vocal excitement; enthusiasm representing more of these, including vocal excitement and some laughter, and joy representing the highest degree of these, including much excitement and laughter, along with playfulness, glee, wonder, and amazement regarding her infant.

1. NO Positive Affect

Mother's interactions with her infant exhibit neutral, flat, or negative facial expressions, vocal tones, and remarks.

2. Positive Affect

Mother's interactions with her infant exhibit positive facial expressions (including consistent smiles), vocal tones, and remarks at least half the time.

3. Positive Affect AND Enthusiasm

In addition to meeting the positive affect criteria (positive facial expressions, vocal tones, and remarks), mother exhibits some (less than half the time) vocal enthusiasm and laughter.

4. SOME Enthusiasm

In addition to meeting the positive affect criteria (positive facial expressions, vocal tones, and remarks), mother exhibits moderate (half of the time) vocal excitement and laughter.

5. MUCH Enthusiasm/Joy

In addition to meeting the positive affect criteria (positive facial expressions, vocal tones, and remarks), mother must meet the enthusiasm criteria (vocal excitement and laughter), as well as exhibit more than one of the following: playfulness, glee, wonder, and amazement regarding her infant.

Negative Affect/Flat Affect: (Adapted from the MACY sample, Huth-Bocks & Dayton, 2001). *Use this scale during all tasks.* This is a graduated scale from neither flat or negative affect to much negative affect with neither flat or negative affect on the low end and much negative affect on the high end. The ends differentiate sadness/depression from very little flat affect, with the middle point being a combination of the two (moderate sadness and/or much flat affect). The points of the scale differentiate types facial responses including sad, wistful, or blank gazing and facial responses, and flat, monotone, slowed, and/or mechanical types of vocal expression and speech.

1. NEITHER Flat OR Negative Affect

Mother's interactions with her infant exhibit positive facial expressions, vocal tones, and remarks.

2. SOME Flat Affect

Mother is slightly flat. She gazes off infrequently, smiles occasionally, and she may speak in flat tones or monotone.

3. Negative AND Flat Affect

Mother appears alternately sad and flat. Flatness is manifested as expressionless gazing, while sadness is manifested as wistful, sad gazing. Both are manifested as infrequent smiles, and slowed and/or limited speech and/or monotone and/or mechanical speech.

4. Negative Affect

Mother is sad and/or flat more than half of the time. Sadness is manifested by sad, wistful gazing, infrequent smiles, limited speech, and limited speech and/or monotone and/or mechanical speech.

5. MUCH Negative Affect

Mother is despondent as manifested by sad gazing, no smiling, and limited and/or monotone and/or mechanical and/or slowed speech. Mother may look as if she will cry.

APPENDIX B

Coding System for SFP

Infant Codes:

Object Engagement: (adapted from the MACY sample; Beeghly, 2006; Clark, 1985; Tronick & Weinburg, 1999). Use this scale during all tasks. This is the degree to which the infant is able to initiate and/or sustain active interest in and engagement with objects. “Active” refers here to intent toward focused attention and/or manual inspection/examination of objects. At seven months, this includes reaching for an object, banging, shaking, or mouthing objects, in addition to rudimentary attempts to sort and manipulate objects. In the Still Face Paradigm, “objects” refer to car seat straps, clothing, parts of body (e.g., fingers, toes), the person filming/camera, or self (reflection) in the mirror. *Note:* infants may engage with objects alone, or with mom; joint attention to objects will *also* be addressed in *Infant Social Engagement*. **Scores are assigned based on frequency and duration of Object Engagement.**

1. **NO instances of Object Engagement**
2. **SOME instances (1 or 2) of Object Engagement, or one moderate instance of Object Engagement**
3. **MODERATE instances (3 or 4) instances of Object Engagement, or two moderate or prolonged instances of Object Engagement (infant is engaged half of the time).**
4. **MANY instances (5 or 6) of Object Engagement, 3 or 4 instances of moderate or prolonged Object Engagement (the infant is engaged more than half of the time).**
5. **VERY HIGH (7 or more) instances of Object Engagement, or many moderate or prolonged instances of object engagement (the infant is engaged almost all/all the time).**

Infant Social Engagement: (adapted from the MACY sample; and Beeghly, 2006). *Use this scale with all tasks.* This scale measures the extent to which the infant participates with the mother for sustained amounts of time in social activities and social games (with or without toys). At this age, activities will usually be mother-initiated. This includes joint attention to toys, during mastery or pretend tasks, social games such as hide and seek, peek-a-boo, tickling games, and any social game involving turn-taking, all count as social engagement. In coding, consider nonverbal cues that signal social engagement. For example, the degree to which the infant is physically oriented to the mother (e.g., does the infant face the mother? Or is the infant's body oriented toward the mother? Does the infant seek proximity to the mother?). *Note:* An infant whose attempts to engage are ignored, unnoticed, or rebuked by the mother should be given credit for his/her attempts (desire to engage with the mother). *Note: in the Still Face Paradigm Still Face, scores are assigned based on the percentage of time the infant looks at mom.*

1. NO instances of Infant Social Engagement. No social engagement or joint object play with the mother is observed. The infant primarily explores toys alone or engages in negative social interactions with the mother.

2. SOME instances of Infant Social Engagement Infant is engaged infrequently in social interaction with the mother. The infant rarely exhibits any active, sustained effort to include the mother in play activities or social interaction. In the SFP, Infant infrequently looks at mom.

3. MODERATE instances of Infant Social Engagement. Infant engages in social interaction with the mother or in joint attention to objects about half the time. Or there are a few periods of sustained, active social engagement. In the SFP, infant *looks at* mom about half of the time.

4. MANY instances of Infant Social Engagement. Infant is actively engaged with the mother more than half the time. This includes many brief periods of social interaction, and/or more than a few periods of sustained, active positive social engagement. In the SFP, infant *looks at* mom more than half of the time.

5. VERY HIGH instances of Infant Social Engagement. The infant is almost all or always engaged in social interactions or joint object play with the mother. His/her active involvement and persistence may wax and wane to some extent, but this occurs infrequently and does not characterize the interaction. In the SFP, infant *looks at* mom almost all/all the time.

Positive Affect: (Adapted from the MACY sample, Beeghly, 2006; Clark, 1985; Miller, 1998). *Use this scale during all tasks.* This is the extent to which the infant expresses pleasure and enjoyment in general; not only toward the mother or when engaged in a task. Instances of positive affect include

subtler, milder signs, such as: smiles, face-brightening, “chipper, upbeat” vocal tones, positive utterances

enthusiastic positive affect includes: laughter, excitement, interest, expressions of pleasant surprise; vocal excitement and/or enthusiasm; and

very high (joyful) positive affect includes: clapping, arm-waving, exuberant vocal utterances (squeals of pleasure). Ratings are based on these instances, as well as on frequency, duration and intensity of (subtle to joyful) positive affect.

1. NO Positive Affect

Infant exhibits negative or flat affect or a combination of the two the entire time.

2. SOME Positive Affect

Infant exhibits occasional subtle instances of positive affect, or one instance of enthusiastic positive affect, but no instances of very high (joyful) positive affect.

3. MODERATE Positive Affect

Infant exhibits subtle positive affect for about half of the time, and/or shows enthusiastic positive affect occasionally.

4. MUCH Positive Affect

Infant exhibits subtle positive affect for more than half of the time, and/or exhibits enthusiastic or joyful affect more than a few times.

5. VERY HIGH Positive Affect

Infant exhibits subtle mixed positive affect, enthusiasm, and joy the entire time.

Negative Affect: (Adapted from MACY sample; Clark, 1985; Feldman, 1998). *Use this scale during all tasks.* This is a graduated scale from no negative affect to high negative affect. Instances of negative affect are: (*subtle*): brief or mild facial expressions of sadness or anger, negative vocalizations (fussing, whining); (*moderate*): clear-cut and frequent negative facial expressions, more sustained negative vocalizations (fussing), marked nonverbal indices of frustration or agitation (limb flailing), irritability; or intermittent crying; (*high*): full-blown sustained crying, clear-cut sustained indices of anger (e.g., rejection of parents while angry) Ratings are based on type of instance, as well as on frequency, duration and intensity.

1. NO Negative Affect

Infant exhibits positive or flat affect or a combination of the two the entire time.

2. SOME Negative Affect

Infant exhibits some instances of subtle negative affect, or one moderate or prolonged instance of subtle negative affect.

3. MODERATE Negative Affect

Infant exhibits subtle or moderate negative affect half of the time.

4. MUCH Negative Affect

Infant exhibits some moderate instances of negative affect along with a few high instances of negative affect, or are one prolonged instance of moderate negative affect.

5. VERY HIGH Negative Affect

Infant exhibits many instances of moderate to high negative affect or one long instance (e.g. inconsolable crying) of negative affect.

APPENDIX C**Rothbart Infant Behavior Questionnaire – Revised**

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Mary K. Rothbart
 Maria A. Gartstein
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Infant Behavior Questionnaire – Revised
Very Short Form

Subject No. _____

Date of Baby's Birth _____
month. day year

Today's Date _____

Age of Child _____
mos. weeks

Sex of Child _____

INSTRUCTIONS:

Please read carefully before starting:

As you read each description of the baby's behavior below, please indicate how often the baby did this during the LAST WEEK (the past seven days) by circling one of the numbers in the left column. These numbers indicate how often you observed the behavior described during the last week.

1	2	3	4	5	6	7	NA
Never	Very Rarely	Less Than Half the Time	About Half the Time	More Than Half the Time	Almost Always	Always	Does Not Apply

The "Does Not Apply" (X) column is used when you did not see the baby in the situation described during the last week. For example, if the situation mentions the baby having to wait for food or liquids and there was no time during the last week when the baby had to wait, circle the (X) column. "Does Not Apply" is different from "Never" (1). "Never" is used when you saw the baby in the situation but the baby never engaged in the behavior listed during the last week. For example, if the baby did have to wait for food or liquids at least once but never cried loudly while waiting, circle the (1) column.

Please be sure to circle a number for every item.

1. When being dressed or undressed during the last week, how often did the baby squirm and/or try to roll away?

1 2 3 4 5 6 7 NA

2. When tossed around playfully how often did the baby laugh?

1 2 3 4 5 6 7 NA

3. When tired, how often did your baby show distress?

1 2 3 4 5 6 7 NA

4. When introduced to an unfamiliar adult, how often did the baby cling to a parent?

1 2 3 4 5 6 7 NA

5. How often during the last week did the baby enjoy being read to?

1 2 3 4 5 6 7 NA

6. How often during the last week did the baby play with one toy or object for 5-10 minutes?

1 2 3 4 5 6 7 NA

7. How often during the week did your baby move quickly toward new objects?

1 2 3 4 5 6 7 NA

8. When put into the bath water, how often did the baby laugh?

1 2 3 4 5 6 7 NA

9. When it was time for bed or a nap and your baby did not want to go, how often did s/he whimper or sob?

1 2 3 4 5 6 7 NA

10. After sleeping, how often did the baby cry if someone doesn't come within a few minutes?

1 2 3 4 5 6 7 NA

11. In the last week, while being fed in your lap, how often did the baby seem eager to get away as soon as the feeding was over?

1 2 3 4 5 6 7 NA

12. When singing or talking to your baby, how often did s/he soothe immediately?

1 2 3 4 5 6 7 NA

13. When placed on his/her back, how often did the baby squirm and/or turn body?

1 2 3 4 5 6 7 NA

14. During a peekaboo game, how often did the baby laugh?

1 2 3 4 5 6 7 NA

15. How often does the infant look up from playing when the telephone rings?

1 2 3 4 5 6 7 NA

16. How often did the baby seem angry (crying and fussing) when you left her/him in the crib?

1 2 3 4 5 6 7 NA

17. How often during the last week did the baby startle at a sudden change in body position (e.g., when moved suddenly)?

1 2 3 4 5 6 7 NA

18. How often during the last week did the baby enjoy hearing the sound of words, as in nursery rhymes?

1 2 3 4 5 6 7 NA

19. How often during the last week did the baby look at pictures in books and/or magazines for 5 minutes or longer at a time?

1 2 3 4 5 6 7 NA

20. When visiting a new place, how often did your baby get excited about exploring new surroundings?

1 2 3 4 5 6 7 NA

21. How often during the last week did the baby smile or laugh when given a toy?

1 2 3 4 5 6 7 NA

22. At the end of an exciting day, how often did your baby become tearful?

1 2 3 4 5 6 7 NA

23. How often during the last week did the baby protest being placed in a confining place (infant seat, play pen, car seat, etc.)?

1 2 3 4 5 6 7 NA

24. When being held, in the last week, did your baby seem to enjoy him/herself?

1 2 3 4 5 6 7 NA

25. When showing the baby something to look at, how often did s/he soothe immediately?

1 2 3 4 5 6 7 NA

26. When hair was washed, how often did the baby vocalize?

1 2 3 4 5 6 7 NA

27. How often did your baby notice the sound of an airplane passing overhead?

1 2 3 4 5 6 7 NA

28. When introduced to an unfamiliar adult, how often did the baby refuse to go to the unfamiliar person?

1 2 3 4 5 6 7 NA

29. When you were busy with another activity, and your baby was not able to get your attention, how often did s/he cry?

1 2 3 4 5 6 7 NA

30. How often during the last week did the baby enjoy gentle rhythmic activities, such as rocking or swaying?

1 2 3 4 5 6 7 NA

31. How often during the last week did the baby stare at a mobile, crib bumper or picture for 5 minutes or longer?

1 2 3 4 5 6 7 NA

32. When the baby wanted something, how often did s/he become upset when s/he could not get what s/he wanted?

1 2 3 4 5 6 7 NA

33. When in the presence of several unfamiliar adults, how often did the baby cling to a parent?

1 2 3 4 5 6 7 NA

34. When rocked or hugged, in the last week, did your baby seem to enjoy him/herself?

1 2 3 4 5 6 7 NA

35. When patting or gently rubbing some part of the baby's body, how often did s/he soothe immediately?

1 2 3 4 5 6 7 NA

36. How often did your baby make talking sounds when riding in a car?

1 2 3 4 5 6 7 NA

37. When placed in an infant seat or car seat, how often did the baby squirm and turn body?

1 2 3 4 5 6 7 NA

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ABSTRACT**THE BIDIRECTIONAL RELATIONSHIP BETWEEN MOTHERS AND THEIR INFANTS: A STUDY OF DYADS USING THE STILL FACE PARADIGM**

by

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The central goal of this study was to describe maternal, infant, and dyadic contributions to mother-infant interaction processes at 7 months postpartum; i.e., how both mother and infant contribute to the quality of the interaction, in an understudied mostly low-income, African American sample. Eighty-five mothers and their 7-month-old infants participated. Dyads were videotaped during the Still-Face Paradigm (SFP) to analyze how a social stressor (maternal still-face) affects infant reactivity and mother-infant social interaction processes. The SFP includes 3 successive 2-minute episodes: normal play (baseline), maternal still-face, during which the mother holds a neutral, expressionless face, and resumption of normal play (reunion). Multiple dimensions of maternal and infant behavior and affect were scored from the videotapes by masked reliable coders. The data were analyzed using ANCOVAs, paired-sample *t*-tests, hierarchical linear regression, and the Actor-Partner Interdependence Model (APIM). The still-face effect was replicated in this sample, although infant sex did not moderate the results. APIM results provided evidence for bidirectional effects in mother-infant positive affective exchanges from baseline to reunion episodes, with larger effects observed for mothers' positive affect during baseline play to infants' positive affect during the reunion. Findings confirm that both

mothers and infants contributed to dyadic interaction processes, but mothers appear to play a larger role in dyadic positive affect exchanges at 7 months postpartum.

AUTOBIOGRAPHICAL STATEMENT

Jordan Boeve is currently a psychology doctoral student at Wayne State University with a major in Cognitive, Developmental, and Social psychology and a minor in quantitative methods. She graduated from the University of Michigan in 2013 with a B.A. in psychology and a minor in writing.