ABSTRACT

EXAMINING THE RECIPROCAL LONGITUDINAL RELATIONS BETWEEN MATERNAL DEPRESSIVE SYMPTOMS AND INFANT POSITIVE EMOTIONALITY IN THE FIRST YEAR POSTPARTUM

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The present study examined the relationship between maternal depressive symptoms and infant positive emotionality (PE) in the first year postpartum. It was anticipated that a reciprocal relationship between the variables would be identified. One hundred thirty-five mothers and their infants (62 males, 73 females) were recruited to participate in a larger study examining the development of temperament and emotion regulation in the first three years of life. Mothers provided demographic information and participated in a structured clinical interview when their infants were four months old. When infants reached 6, 8, and 10 months of age, mothers completed questionnaires which assessed maternal depressive symptoms and infant PE. Infants participated in a structured game of Peek-a-Boo with their mothers during laboratory visits and these interactions were later coded for several indicators of infant PE. Trained research assistants also observed infants during laboratory visits and then rated their degree of happiness. Structural equation modeling was utilized to test the study’s key hypothesis. Surprisingly, results did not support a reciprocal relationship between maternal depressive symptoms and infant PE in the first year of life. However, results did suggest that mothers who had experienced clinical levels of depression within their lifetime rated their eight-month-old infants as less positive on the Infant Behavior Questionnaire–Revised than other mothers. Mothers with a history of clinical depression also tended to have infants who displayed more positivity during the Peek-a-Boo
game when they were 6 and 8 months old as compared to other infants. Examination of autoregressive effects indicated consistency with regard to the severity of maternal depressive symptoms between the time infants were 6 and 10 months old. The pattern of autoregressive effects for infant PE depended on the method used to assess the construct, but overall results suggest that infant PE develops considerably in the first 8 months of life. In addition to results concerning autoregressive and cross-lagged effects, analyses revealed important similarities and differences between methods of assessing maternal depression and infant positive emotionality in the first year of life. Implications of the present study’s findings for future research and practice are discussed.
EXAMINING THE RECIPROCAL LONGITUDINAL RELATIONS BETWEEN MATERNAL DEPRESSIVE SYMPTOMS AND INFANT POSITIVE EMOTIONALITY IN THE FIRST YEAR POSTPARTUM

BY

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CHAPTER 1

INTRODUCTION

Statement of the Problem

Prior research has demonstrated that maternal depression is associated with infant temperament. For example, Cutrona and Troutman (1986) found that infant “temperamental difficulty” was strongly related to the concurrent severity of maternal postpartum depressive symptoms both directly and through the mediation of parenting self-efficacy at three months postpartum. Similarly, Galler, Harrison, Ramsey, Butler, and Forde (2004) reported a concurrent association between maternal depressive symptoms and infant “difficult” temperament at six months postpartum. These authors also examined relations between maternal depressive symptoms and specific infant temperament characteristics. Results demonstrated that maternal depressive symptoms were significantly associated with reduced infant adaptability, low approach, poor mood, and increased sensory threshold. Although associations between maternal depression and both broad and specific indicators of infant temperament have been identified, due to methodological limitations, these relations are difficult to interpret. That is, concurrent associations between maternal depression and infant temperament could indicate that: (1) depressed mothers are biased in rating their infants’ temperament characteristics, (2) maternal depression influences infant temperament, (3) infant temperament influences maternal depression, or (4) maternal depression influences infant temperament and vice versa (i.e., a
bidirectional relationship exists). Therefore, research that circumvents the methodological limitations of prior work is needed in order to elucidate the directionality of the relationship between maternal depression and infant temperament in the first year postpartum.

Prior work that has examined associations between maternal depression and infant temperament is further limited by its primary examination of associations between maternal depression and “difficult” infant temperament (i.e., a combination of high negative emotionality and low self-regulation) to the exclusion of other temperament variables such as infant positive emotionality (PE). It is surprising that research has paid little attention to associations between maternal depression and infant PE to date as PE, broadly defined, has been linked to several unfavorable developmental outcomes including externalizing behavior problems, depression, mania, peer relations, and academic performance (see Putnam, 2012 for a review). If maternal depressive symptoms were found to negatively influence the development of infant PE, there would be significant developmental and clinical implications. For example, such findings would suggest that early intervention for maternal depressive symptoms could be beneficial for both mothers and infants. With regard to developing infants, early intervention for depressed mothers may help mitigate the negative outcomes associated with low levels of infant PE (e.g., externalizing behavior problems, depression).

The present study sought to examine the longitudinal association between maternal depressive symptoms and infant temperament, specifically infant PE. In doing so, it addressed some of the limitations of prior work. For example, the present study assessed maternal depressive symptoms and infant positive emotionality through multiple methods. A sophisticated statistical technique (i.e., structural equation modeling which specifies a fully cross-lagged panel
design) was also used to test the present study’s hypothesis. The use of this methodology had the potential to identify the direction and strength of the association between maternal depression and infant PE in the first year postpartum which, as already discussed, has important implications for both mothers and developing infants.

Postpartum Blues and Postpartum Depression

Following childbirth, somewhere between 15 and 84 percent of new mothers experience “postpartum blues” (Henshaw, 2003). The term *postpartum blues* refers to a set of physical and emotional symptoms that arise sometime between one and five days postpartum (Kennerley & Gath, 1989). Physical symptoms of postpartum blues may include food cravings or a loss of appetite and a lack of energy and sleep. Emotional symptoms include anxiety, irritability, sadness, confusion, nervousness, not feeling like oneself, feeling overwhelmed, and lacking self-confidence. Symptoms of postpartum blues typically resolve within ten days and are best treated with rest, proper nutrition, and support from family members and friends (Sakumoto, Masamoto, & Kanazawa, 2002).

A smaller proportion of women experience more severe and long-lasting symptoms following childbirth and are diagnosed with postpartum depression. According to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR; American Psychiatric Association, 2000), postpartum depression is characterized by symptoms such as depressed mood, diminished interest or pleasure in various activities, changes in weight or appetite and sleep, feelings of worthlessness or guilt, diminished ability to concentrate or indecisiveness, and thoughts of death or suicide that develop within four weeks of parturition.
Several large-sample studies have estimated the prevalence of postpartum depression to be between 20% and 40% in mothers and a somewhat lower percentage in fathers (Goodman, 2004; McCoy, Beal, Shipman, Payton, & Watson, 2006). A more recent study conducted by the Centers for Disease Control (2008) examined the self-reported prevalence of postpartum depressive symptoms in 17 states in the U.S. Prevalence rates were found to range from 11.70% in Maine to 20.40% in New Mexico. Research concerning stability has indicated that the severity of postpartum depressive symptoms tends to decrease throughout the first year postpartum (Blissett & Farrow, 2007; DiPietro, Costigan, & Sipsma, 2008; Wu, Selig, Roberts, & Steele, 2011); however, evidence of rank-order stability has also been provided, indicating that women who have more severe depressive symptoms early on in the postnatal period also tend to have more severe depressive symptoms at the end of the first year postpartum (Blissett & Farrow, 2007).

Research has demonstrated that depression is characterized by high levels of negative affect, defined as the disposition to experience negative emotions including sadness and loneliness, and low levels of positive affect, defined as the extent to which a person feels enthusiastic, active, and alert (Watson, Clark, & Carey, 1988; Watson, Clark, & Tellegen, 1988). Therefore, mothers experiencing symptoms of depression are likely to be distressed, to experience negative mood states including sadness, and to be somewhat lethargic. Mothers experiencing postpartum depression are also likely to experience cognitive difficulties. For example, research has shown that depressed individuals demonstrate negatively distorted perceptions of their environment (see Beck, Rush, Shaw, & Emery, 1979) and difficulties with executive functions (i.e., higher-level cognitive processes which effortfully guide behavior
towards a goal; Snyder, 2013). These affective and cognitive difficulties, commonly experienced by mothers with postpartum depression, have significant implications for their interactions with others, especially their developing infants. In fact, some theorists have postulated that the impact of maternal depression on the child may be greatest during infancy (e.g., Beardslee, Bemporad, Keller, & Klerman, 1983).

Infant Temperament

Definition and prominent theories. Broadly, temperament describes biologically-based characteristics of individuals that have relevance to how they relate to, interact with, and experience their environments (Rothbart, Derryberry, & Posner, 1994). Throughout the last half century, temperament has become an increasingly popular topic of study, resulting in a variety of perspectives and theories. The first modern theory of temperament was outlined by Alexander Thomas and his colleagues. These researchers conducted the New York Longitudinal Study (NYLS), a well-known project which began in the early 1950s and sought to examine how temperamental qualities influence adjustment throughout life. In this study, infants were rated on nine temperamental traits (i.e., activity level, regularity of sleeping and eating patterns, initial reaction, adaptability, intensity of emotion, mood, distractibility, persistence and attention span, and sensory reactivity). Each of these characteristics, by itself, or in association with another, was said to affect how well a child fit in at school, with their friends, and at home (Thomas, Chess, & Birch, 1968; Chess & Thomas, 1996).

Through the completion of the NYLS, a classic typology of temperament was proposed, which included “easy,” “difficult,” and “slow to warm up” temperaments. The easy temperament
is characterized by infants who readily adapt to new experiences, generally display positive moods and emotions, and have normal eating and sleeping patterns. Difficult infants are said to be very emotional, irritable, and fussy, and to typically have irregular eating and sleeping patterns. The slow-to-warm-up temperament characterizes infants who have a low activity level and who tend to withdraw from new situations and people (Thomas et al., 1968). Later work by Thomas and colleagues demonstrated that these broad patterns of temperament are particularly stable throughout childhood and are found in children across many cultures (Thomas & Chess, 1977). As a result, these temperament categories have received a significant amount of attention in both clinical work and research (Brock, et al., 2012; Griggs, Gagnon, Huelsman, Kidder-Ashley, & Ballard, 2009; Hwang, Soong, & Liao, 2009).

Despite the ease of explanation of the three categories of temperament described by Thomas and colleagues, this framework has several limitations. For example, some children do not fit neatly into one of the three temperamental categories. Thomas and colleagues found that only approximately 65 percent of children fit into the easy, difficult, and slow-to-warm-up categories. Of that 65 percent, 40 percent of children are said to fall into the easy temperament category while 10 percent fall into the difficult category and 15 percent fall into the slow-to-warm-up category (Thomas et al., 1968). Therefore, the temperament of approximately 35 percent of children cannot be described by Thomas and colleagues’ model. Additionally, among the variety of temperament measures developed for infants and toddlers as a result of Thomas and Chess’s NYLS, few have demonstrated acceptable internal consistency (see Gartstein, Bridgett, & Low [2012] for an overview). Finally, the three temperamental categories developed
based on the NYLS tend to be assessed by observing or reporting on a wide variety of behaviors, suggesting loose definitions for each construct (Rothbart, 2004).

Although Thomas and colleagues conducted what is considered the pioneering work in the area of temperament, as conceptualized in modern times, other researchers have also made significant contributions to the field. For example, Jerome Kagan and his colleagues have been influential in increasing the depth of knowledge regarding temperament broadly and the temperament characteristic of inhibition specifically. Kagan defines temperament as stable behavioral and emotional reactions that appear early and are influenced in part by genetic constitution (Kagan, Snidman, Arcus, & Reznick, 1994). Kagan’s research has placed a heavy emphasis on the temperamental characteristic of inhibition, which refers to a shy or fearful response to novelty (e.g., Kagan, Reznick, & Snidman, 1987). Kagan proposed two temperament profiles: the inhibited and uninhibited temperaments. The inhibited temperament characterizes a shy, timid, and fearful child while the uninhibited temperament characterizes a child who is bold, sociable, and outgoing. Kagan and his colleagues have identified various precursors to childhood inhibition including fearfulness, indicated by crying and increased motor activity (Kagan & Snidman, 1991), and a lack of approach in response to unfamiliar situations (Moehler et al., 2008). Recently, Kagan and his colleagues sought to determine whether behavioral inhibition in adulthood could be predicted by certain temperamental characteristics in infants and children. It was determined that early temperamental characteristics have the ability to influence later behavior, depending on how they interact with the environment (Moehler et al., 2008), demonstrating the salience of infant temperament for later functioning.
The psychobiological model of temperament. While the majority of previous work has considered temperament to be categorical in nature (i.e., the majority of previous work has identified categories of temperament, such as the easy, difficult, and slow-to-warm-up temperaments), more recent work, conducted by Mary Rothbart and colleagues, has proposed a dimensional model of temperament. Rothbart and colleagues have proposed what is termed the psychobiological theory of temperament, which defines temperament as constitutionally based individual differences in reactivity and self-regulation (Rothbart & Derryberry, 1981). According to this model, reactivity refers to characteristics of an individual’s reactions to stimulus change, reflected in their observable behavior, while self-regulation is considered to be the processes which function to modulate this reactivity. Additionally, the term “constitutionally based” acknowledges that temperament characteristics are partially innate, but also influenced by one’s environment and experiences. The psychobiological model identifies three broad factors of infant temperament: Negative Emotionality (NE), Positive Emotionality (PE, also referred to as Surgency/ Extraversion), and Orienting/Regulation (O/R; Gartstein & Rothbart, 2003; Rothbart & Ahadi, 1994).

Infant orienting/regulation. The O/R factor within the psychobiological model of temperament refers to early attentional processes (i.e., duration of orienting, defined as attention to and/or interaction with a single object for extended periods of time), soothability (i.e., a reduction in fussing, crying, or distress when soothing techniques are used by the caregiver), cuddliness, and low-intensity pleasure (i.e., the amount of pleasure or enjoyment related to low stimulus intensity, rate, complexity, novelty, and incongruity; Gartstein & Rothbart, 2003; Rothbart, Ahadi, & Evans, 2000). Characteristics within the Orienting/Regulation domain begin
to emerge in early infancy and can be reliably assessed as early as 3 months of age (Putnam, Rothbart, & Gartstein, 2008). The developmental course of attentional orienting is considered to be U-shaped in the first year of life with decreases in Duration of Orienting being reported for infants between six and nine months of age and increases being reported for infants between nine and 12 months old (Costa & Figueiredo, 2011; Ruff & Rothbart, 1996). Soothability has been shown to remain relatively stable between the time infants are three and 12 months of age while Cuddliness decreases toward the end of the first year of life (Costa & Figueiredo, 2011), likely as a result of increased mobility of infants at this stage of life.

*Infant negative emotionality.* The NE factor of the psychobiological model of temperament reflects the extent to which an infant exhibits irritability, fear, sadness, anger, frustration, and discomfort as well as the rate at which an infant is able to recover from peak levels of distress. Developmentally, expressions of irritability and fear have been shown to increase throughout the first year of life (Carranza, Pérez-López, González, & Martínez-Fuentes, 2000; Rothbart, 1986, 1988). More specifically, developmental increases in fear have been noted for infants between four and ten months of age, with less dramatic growth occurring after 10 months of age (Gartstein et al., 2010). Although fear cannot be reliably assessed until approximately the second half of the first year of life (Gartstein et al., 2010), frustration can be observed much earlier (i.e., when infants are as young as two months old, Rothbart, 2007). Researchers have suggested that the developmental trajectory of anger is U-shaped throughout the first year of life, with a decrease in anger responses occurring between two and six months of age (Carranza et al., 2000; Rothbart, 1981) potentially due to greater flexibility in attention shifting around this time (Johnson, Posner, & Rothbart, 1991).
Infant positive emotionality. Compared to the other temperamental factors, the tendency for infants to display positive emotions has received considerably less attention in psychological research. For example, although the pioneering work of Thomas and Chess (1977) identified mood as a salient aspect of temperament, their temperamental dimensions emphasized negativity and their three temperamental classifications (i.e., easy, difficult, slow-to-warm-up) largely described patterns of adaptability rather than displays of positive affect. Additionally, some research has examined positive emotionality in infants, but only as a corollary to negative emotionality. For example, Kagan and colleagues included lack of positive affect as a marker of behavioral inhibition in some assessments, but the mechanisms under investigation were those associated with restraint rather than positive emotions (Putnam, 2012).

Rothbart and her colleagues seemed to place a larger emphasis on infant positive emotionality compared to other researchers. For example, she and her colleagues included a Smiling and Laughter scale on the Infant Behavior Questionnaire (IBQ; Gartstein & Rothbart, 2003) which has been combined with other scales, such as those measuring vocalizations and activity level, to form a higher-order positive emotionality factor (Rothbart, 1986). Within the psychobiological model of temperament, the PE factor, also commonly referred to as Surgency/Extraversion, is indicated by infant smiling and laughter, vocal reactivity, activity level, high-intensity pleasure, perceptual sensitivity, and approach. Vocal reactivity refers to the amount of vocalization exhibited by an infant in daily activities such as dressing and undressing, while high-intensity pleasure is the extent of enjoyment an infant receives from high stimulus intensity, rate, complexity, novelty, and incongruity. Perceptual sensitivity is indicated by an
infant’s detection of slight, low-intensity stimuli from the environment such as scratchy textures (e.g., wool).

Positive emotionality is rarely expressed during the newborn period, but is observed more reliably between 2 and 3 months of age (Rothbart, 1989). Activity level is a relatively early emerging temperamental characteristic, as it can be assessed as early as one month postpartum (Worobey & Anderson-Goetz, 1985). Between two and three months of age, smiling and laughter begins to emerge (Rothbart, 2007). Vocalizations begin very early in infancy, and by seven months of age, infants begin to vary their vocalization patterns based on social context (Lin & Green, 2009). As compared to the other indicators of infant PE, approach tends to emerge later in infancy (i.e., during the latter portion of the first year of life; Rothbart, 1988). Individual differences in PE, such as infants’ activity level, smiling and laughter, approach, and vocalizations have been shown to gradually emerge throughout the first year of life (Field, Vega-Lahr, Goldstein, & Scafidi, 1987; Lin & Green, 2009; Rothbart, 1988; 2007). Also, compared to infant NE, PE tends to be less longitudinally stable (Belsky, Fish, & Isabella, 1991; Wachs & Bates, 2001).

Although few sex differences have been reported for temperament characteristics in infancy, a sex difference in infant activity level has been consistently reported. That is, higher activity level has been reported for male infants as compared to females (Campbell & Eaton, 1999; Garstein & Rothbart, 2003; Maziade, Boudreault, Thivierge, Capéraà, & Côté, 1984). Campbell and Eaton (1999) conducted a meta-analysis to summarize 46 studies addressing activity level in infancy. The authors estimated that the size of the sex difference between male and female infants in activity level is 0.20 standard deviations. Research concerning sex
differences in the broader PE factor of temperament has provided mixed results (Dougherty, Klein, Durbin, Hayden, & Olinio, 2010; Majdandžić & van den Boom, 2007; Zhou, Lengua, and Wang, 2009). For instance, Zhou et al. (2009) and Dougherty et al. (2010) found higher positivity in girls than boys while Majdandžić and van den Boom (2007) reported greater exuberance among boys as assessed through the use of the Laboratory Temperament Assessment Battery (Lab-TAB). A recent meta-analysis, which sheds light on these inconsistencies, demonstrated higher positive mood among girls, but greater high-intensity pleasure among boys. Consistent with these findings, Gartstein and Rothbart (2003) reported greater high-intensity pleasure among boys as compared to girls.

Relations between infant temperament characteristics and subsequent outcomes. Prior research has indicated that early temperamental differences influence subsequent child outcomes. A brief review of some of the work linking early infant O/R, NE, and PE to subsequent outcomes is provided below.

Infant orienting/regulation. Prior research has linked the broad O/R factor of temperament to various outcomes. For example, higher infant O/R has been shown to be associated with higher effortful control (i.e., the ability to inhibit a dominant response in order to perform a subdominant response, to detect errors, and to engage in planning; Rothbart & Bates, 2006; Rothbart & Rueda, 2005) in toddlerhood (Bridgett et al., 2011; Gartstein & Rothbart, 2003). Higher effortful control, in turn, has been linked with better socioemotional development, higher school achievement, and lower prevalence of externalizing behavior problems (Eisenberg, Hofer, & Vaughan, 2007; Rueda, 2012; Tackett, Martel, & Kushner, 2012). Specific components of the O/R factor of temperament have also been linked to later outcomes. Gartstein, Crawford,
and Robertson (2008), for example, found that infant duration of orienting was a strong predictor of later vocal reactivity (i.e., the amount of vocalization exhibited in daily activities), suggesting that early attention skills may be associated with later language skills. Research has also suggested that early attention skills may be related to emotion regulation ability in toddlerhood (Morales, Mundy, Crowson, Neal, & Delgado, 2005). Last, although the majority of research linking early temperament to later depressive symptoms has focused on infant NE and PE (as discussed below), Gartstein and Bateman (2008) found that low infant regulatory capacity, one component of O/R, predicted depression-like symptoms in toddlerhood.

**Infant negative emotionality.** A large body of research has examined the childhood correlates of infant NE. First, high NE has been found to be associated with greater symptoms of depression and anxiety (Klein, Dyson, Kujawa, & Kotov, 2012). For example, Gartstein and Bateman (2008) reported that infants high in NE tend to exhibit more frequent/intense depression-like symptoms in toddlerhood as compared to less negative infants. In addition to demonstrating an association between high NE and depression, Marakovitz, Wagmiller, Mian, Briggs-Gowan, and Carter (2011) also found that high NE was associated with later symptoms of anxiety. NE, conceptualized both broadly and specifically, has also been linked to externalizing behavior problems (Tackett et al., 2012). For instance, Sanson, Oberklaid, Pedlow, and Prior (1991) found that difficult temperament, typically conceptualized as a combination of high NE and low O/R, was associated with an increase in behavior problems at preschool age. Last, infant NE and its components have been linked with physical health difficulties. Darlington and Wright (2006) demonstrated that infant fear and distress to limitations, two components of NE, are related to weight gain.
Infant positive emotionality. Research involving infants, children, and adults has indicated that the tendency to experience and express positive emotions is associated with both good and bad outcomes. Broadly speaking, high levels of PE have been linked to happiness, good mental health, positive peer relations, good academic performance, and attachment security (DeNeve & Cooper, 1998; Mesman, van IJzendoorn, & Bakermans-Kranenburg, 2009; Putnam, 2012). Mesman et al. (2009), for instance, reported that higher infant PE during a stressful mother-infant interaction task (i.e., the Face-to-Face Still Face Paradigm) is consistently predictive of secure attachment. Additionally, Bridgett, Laake, Gartstein, and Dorn (2013) demonstrated that higher levels of infant smiling and laughter, one aspect of PE, at four months of age and more rapid development of infant smiling and laughter between four and 12 months of age predicted fewer reports of negative parenting practices when children reached 18 months of age. However, research has also linked high PE with adverse outcomes including externalizing behavior problems, mania, and a higher incidence of lifetime injuries (Plumert & Schwebel, 1997; Putnam, 2012; Vollrath, Landolt, & Ribi, 2003; Schwebel & Plumert, 1999). For example, Rothbart, Derryberry, and Posner (1994) found that activity level and smiling and laughter in infants were related to parent reports of high aggression at ages six and seven. Also, exuberant toddlers identified by Stifter, Putnam, and Jahromi (2008) demonstrated high externalizing behavior problems at four and a half years of age.

Although high levels of PE have been linked to greater externalizing problems, mania, and higher incidence of injuries, research has also demonstrated associations between low levels of PE and adverse outcomes. Several studies have shown that low levels of PE in infants and children are related to the experience of depressive symptoms later in life (Block, Gjerde, &
At a finer-grained level, researchers have identified associations between low levels of PE early in life and depressotypic cognitive styles, elevated morning cortisol, and abnormal EEG asymmetry, all of which are characteristic of depressed individuals, in late childhood (Dougherty et al., 2010; Hayden, Klein, Durbin, & Olino, 2006; Hayden et al., 2008; Shankman et al., 2005).

Maternal Depression and Infant Temperament Characteristics

**Concurrent associations.** Prior research has demonstrated concurrent associations between maternal depressive symptoms and infant temperament (e.g., Dudley, Roy, Kelk, & Bernard, 2001; Milgrom, Westley, & Gemmill, 2004; Whiffen & Gotlib, 1989). For example, Austin, Hadzi-Pavlovic, Leader, Saint, & Parker (2005) demonstrated significant, positive associations between maternal self-reported depressive symptoms and infant “difficult” temperament between four and six months postpartum. In this study, infant “difficult” temperament was conceptualized as a combination of high negative emotionality and low orienting/regulation and was assessed through the use of a parent-report questionnaire completed by both mothers and fathers. Also, Voegtline, Stifter, and the Family Life Project Investigators (2010) found that symptoms of depression endorsed by mothers on a self-report questionnaire were linked with concurrent maternal reports of infant NE. Notably, maternal depressive symptoms were not significantly associated with infant NE as rated by observers in the laboratory or as coded from a fear-eliciting task or a frustration task. Furthermore, Tikotzky, Chambers, Gaylor, and Manber (2010) demonstrated that the severity of self-reported maternal
depressive symptoms significantly predicted two specific aspects of infant NE as indicated by maternal ratings on the Infant Behavior Questionnaire, Revised (IBQ-R; Gartstein & Rothbart, 2003): (1) Distress to Limitations, defined as fussing, crying or showing distress while in a confining place or position, in caretaking activities, or when unable to perform a desired action, and (2) Falling Reactivity, defined as the rate of recovery from peak distress, excitement, or general arousal and the ease with which an infant falls asleep.

Research examining associations between maternal depression and infant PE is scarce. Of the few studies that have examined these associations, results have been mixed. For example, Hart, Jones, Field, and Lundy (1999) demonstrated that infants of depressed mothers exhibited less positive affect during a laboratory-teaching task than infants of non-depressed mothers. In this study, maternal depressive symptoms were evaluated through the use of a self-report questionnaire while infant PE was indicated by smiling during the teaching task, which required mothers to teach their children how to use a “Jack-in-the-Box” toy. Also, Forbes, Cohn, Allen, and Lewinsohn (2004) reported that during the Face-to-Face Still-Face Paradigm, infants of parents with a lifetime history of depression, as indicated by the Structured Clinical Interview for Axis I DSM-IV Disorders (SCID; First et al., 2002), were less likely to exhibit positive affect (i.e., a positive rather than negative or neutral facial expression) than infants whose parents were never depressed. However, Forbes et al. (2004) found a non-significant relation between infant positive affect and parents’ concurrent severity of depressive symptoms. Similarly, Ramchandani et al. (2011) reported non-significant differences in parent reports of infant smiling and laughter and activity level on the IBQ-R among infants in a family with a depressed and non-depressed father. Paternal depression in this study was evaluated through the use of a self-report
questionnaire. With regard to associations between maternal depression and PE in older children, research is also limited; only two studies were identified that have examined these associations. However, these studies provided support for concurrent associations between low PE, maternal history of a mood disorder (Durbin, Klein, Hayden, Buckley, & Moerk, 2005), and current maternal depression (Hayden, Klein, & Durbin, 2005) in samples of preschoolers.

Although concurrent associations between maternal depressive symptoms and infant and child temperament are intriguing, due to methodological issues, they are difficult to interpret. That is, an association between concurrent maternal depression and infant temperament could suggest: (1) that depressed mothers are biased in reporting on their infants’ temperament characteristics (e.g., depressed mothers tend to rate their infants as more negative and less positive than non-depressed mothers); (2) that infant temperament characteristics (e.g., high NE, low PE) lead to elevated depression scores among mothers; or (3) that postnatal maternal depression impacts negatively on the development of infant temperament characteristics, such as PE.

**Longitudinal and reciprocal relations.** Several longitudinal studies have examined the relationship between maternal depression and infant temperament characteristics over time. First, some prior research has suggested that maternal postpartum depressive symptoms have a negative impact on the development of infant temperament characteristics. For example, Bridgett and colleagues (2009) utilized latent growth modeling to examine maternal and family factors that may affect developing infant NE and O/R. Results demonstrated a trend such that more intense/frequent symptoms of maternal depression, as self-reported by mothers, were linked with sharper increases in infant NE between four and 12 months of age, as indicated by maternal
ratings on the IBQ-R. Additionally, Sugawara, Kitamura, Toda, and Shima (1999) examined the longitudinal relationship between maternal depression and infant temperament in a Japanese population. The authors found that self-reported maternal depression, both five days after childbirth and when infants were 12 months old, unilaterally predicted infant fear of strangers and strange situations and frustration tolerance at 18 months of age. In this study, infant temperament was assessed through the use of Japanese versions of well-known parent-report questionnaires. Results of these studies suggest that maternal postpartum depressive symptoms influence the development of infant temperament characteristics in infancy and toddlerhood.

Although these studies suggest that maternal depression influences later infant temperament, other work has suggested that infant temperament characteristics may be implicated in the etiology of postpartum depression. A review of this literature indicates that excessive infant crying and the extent of infant adaptability and predictability are the primary temperament characteristics associated with the development of maternal postpartum depression (Mayberry & Affonso, 1993). However, other temperamental qualities, such as irregularity of behavior, have also shown to be important predictors of maternal depression (Cutrona & Troutman, 1986; Hopkins, Campbell, & Marcus, 1987). Murray, Stanley, Hooper, King, and Fiori-Cowley (1996) examined the relations between infant temperament characteristics and maternal depressive symptoms in a group of women at high and low risk for postnatal depression within the first few months of life. The authors found that poor motor scores and high infant irritability on the Neonatal Behavioural Assessment Scale (see Brazelton & Nugent, 2011) were strongly predictive of the onset of maternal depression by 8 weeks postpartum. These effects
were obtained after taking into account maternal mood in the neonatal period and maternal perceptions of infant temperament.

Although prior longitudinal work has suggested unidirectional associations between maternal postpartum depression and infant temperament, the relationship between the two constructs is likely bidirectional, with each influencing the other over time. However, limited research to date has examined whether reciprocal relations exist between maternal depression and infant temperament characteristics. Only one study was identified that has examined reciprocal relationships between these constructs. Sugawara and colleagues (1999) identified reciprocal relationships between two temperament al dimensions and maternal depression: (1) rhythmicity, defined as the level of predictability in an infant’s functioning (e.g., sleeping, eating) and (2) attention span and persistence, which refers to the length of time an infant spends on a task and the infant’s ability to continue with a frustrating task. More specifically, maternal depression in the early postpartum period was found to be related to early infant low rhythmicity, which was itself related to later maternal depression; maternal depressive symptoms in late infancy were then related to low infant rhythmicity later on in life. A similar relationship was found for attention span and persistence until 12 months postpartum. Notably, this study relied on self-reported maternal depressive symptoms as well as maternal ratings of infant temperament. In light of this work, and that reviewed above, it seems highly plausible that maternal depressive symptoms influence the development of infant temperament characteristics and vice versa. However, additional research is needed to clarify the specific longitudinal relationship between these constructs.
The majority of longitudinal studies examining unidirectional or reciprocal associations between maternal depression and infant temperament have focused on broadly-conceptualized difficult temperament (i.e., a combination of high NE and low O/R) or specific negative infant temperament characteristics (e.g., irritability, distress to limitations), to the exclusion of other temperament variables. No studies were identified that have examined the longitudinal relationship between maternal depression and broadly conceptualized infant PE. However, Galler and colleagues (2004) examined the longitudinal association between maternal depression and infant activity level and approach, two constructs often considered sub-components of an infant PE factor. These authors found non-significant associations between maternal depression, measured seven weeks postpartum, and infant activity level and approach which was measured approximately four months later (i.e., when infants were six months old). A significant limitation of this study, which may account for the lack of significant associations between maternal depression and variables indicative of infant PE, is the use of the Carey Revised Infant Temperament Questionnaire (RITQ or Carey-R scales; Carey & McDevitt, 1978). The RITQ is a parent-report measure developed based on the New York Longitudinal Study model of temperament which, as described above, has several limitations, including the lack of emphasis on positive infant temperament characteristics. Although infant activity level and approach are assessed through the use of this measure, other indicators of infant PE, such as smiling and laughter, positive vocalizations, and positive mood, are not. Therefore, research examining the longitudinal, and potentially bidirectional, relationship between maternal depression and infant PE, as conceptualized by a model of temperament that emphasizes PE, such as the psychobiological model of temperament, is clearly needed.
Potential Mechanisms of Effect

In addition to the empirical work reviewed above which provides evidence in support of relations between maternal depression and infant temperament, there are also theoretical and conceptual arguments to be made.

Distortion hypothesis. Research comparing the reports of depressed mothers with reports provided by others, or observations made by others, has shown that depressed or dysphoric mothers report higher levels of negative child characteristics. In particular, a large body of research has shown that depressed mothers tend to report more instances of child behavior problems than non-depressed mothers (e.g., Boyle & Pickles, 1997; Campbell, Pierce, Moore, Marakovitz, & Newby, 1996; Chi & Hinshaw, 2002; Egeland, Kalkoske, Gottesman, & Erickson, 1990; Gartstein, Bridgett, Dishion, & Kaufman, 2009; Krain & Kendall, 2000; Thomas, Forehand, & Neighbors, 1995; Webster-Stratton & Hammond, 1988). The depression–distortion hypothesis (Richters & Pellegrini, 1989) was proposed as a means of explaining the association between maternal depression and increased reports of child behavior problems. The distortion hypothesis suggests that dysphoric emotions associated with depression activate a negative perceptual bias among mothers that, in turn, leads to over-reporting of child adjustment difficulties (Field, 1992; Geller & Johnston, 1995; Griest, Wells, & Forehand, 1979; Johnston & Short, 1993). This hypothesis is consistent with prior work indicating that depressed individuals, due to their negative mood, tend to interpret their environment negatively and more readily recall negatively-toned information (e.g., Blaney, 1986; Bower, 1981; Gotlib, 1983; Gotlib & Cane, 1987).
Some research has provided support for the depression–distortion hypothesis. For example, Chi and Hinshaw (2002) examined the effects of maternal depressive symptoms on cross-informant discrepancies in reports of child behavior problems among a sample of children diagnosed with Attention-Deficit Hyperactivity Disorder (ADHD), Combined Type. Overall, maternal depressive symptoms were found to predict negative biases in reports made by depressed mothers of their child's ADHD symptoms, general behavior problems, and their own negative parenting style. Interestingly, increases in mothers’ symptoms of depression were associated with maternal reports of negative parenting, but not with indicators based on laboratory observations of parent–child interactions, which suggests possible depression–distortion effects.

Recent research has demonstrated discrepancies in reports of infant temperament characteristics between depressed and non-depressed individuals. For instance, McGrath, Records, and Rice (2008) had women report on their level of depressive symptoms and their infant’s temperament characteristics at two and six months postpartum. Reports of infant temperament were significantly different for depressed and non-depressed mothers, with depressed mothers reporting more difficult infants at both time points. Additionally, Durbin and Wilson (2012) examined the convergent validity of maternal reports of child emotion with observer reports. Results showed that mothers experiencing symptoms of depression rated their children as more fearful and less happy than observers. Given that differences in infant temperament characteristics have been noted between depressed and non-depressed reporters, it seems plausible that the depression–distortion hypothesis may explain the relationship between maternal depression and infant PE.
Parent-infant interactions. As discussed below, maternal depression and infant temperament characteristics have been associated with the quality of parent-infant interactions in prior work. Therefore, low-quality interactions between parent and infant may help to explain the existence of a longitudinal (i.e., unidirectional or bidirectional) relationship between maternal depression and infant temperament, including infant PE.

Evidence that maternal depression influences parent-infant interactions, which in turn, influence infant temperament. A large body of research has demonstrated that interactions between mothers experiencing depression and their infants are disrupted (see Field, 2010 for a review). Affectively, as compared to non-depressed mothers, mothers experiencing depressive symptoms tend to exhibit less emotion or to exhibit more irritability and hostility during interactions with their infants (Lovejoy, Graczyk, O’Hare, & Neuman 2000). Depressed mothers are also less engaged in interactions with their infants and tend to exhibit less warmth, responsiveness, and sensitivity (Kertz, Smith, Chapman, & Woodruff-Borden, 2008; Lovejoy et al., 2000; Radke-Yarrow, Nottelmann, Belmont, & Welsh, 1993). Relatedly, depressed mothers have been shown to touch their infants less frequently and in a less affectionate (Ferber, Feldman, & Makhoul, 2008) and more negative manner (e.g. rough pulling, tickling and poking; Fergus, Schmidt, & Pickens, 1998; Malphurs, Raag, Field, Pickens, & Pelaez-Nogueras, 1996) than non-depressed mothers.

The vocal behavior of depressed and non-depressed mothers is also markedly different. Depressed mothers have been shown to use longer utterances, less repetition, fewer explanations, suggestions and questions, and fewer references to their infants’ behavior than non-depressed mothers (Herrera, Reissland, & Shepherd, 2004; Kaplan, Bachorowski, & Zarlengo-Strouse,
Additionally, in face-to-face interactions, which are the primary form of play for young infants, depressed mothers have been shown to vocalize, smile, imitate, and play games less than non-depressed mothers (Field, Diego, & Hernandez-Reif, 2006). Importantly, the interaction disturbances of depressed mothers and their infants seem to be universal across different cultures and socioeconomic status groups (e.g., Danaci, Dinç, Deveci, Sen, & İçelli, 2002; Eapen, Ghubash, Salem, & Sabri, 2005; Righetti-Veltema, Conne-Perreard, Bousquet, & Manzano, 2002).

The poor-quality interactions between depressed mothers and their infants have been proposed to be one of the mechanisms by which depression exerts long-term negative effects on children. For example, Milgrom and colleagues (2004) demonstrated that interactions between depressed mothers and their infants were impaired when infants were six months of age. Subsequent cognitive deficits were noted in children’s Full Scale IQ scores on the Wechsler Preschool Primary Scale of Intelligence (WPPSI-R) at 42 months of age, and statistical modeling confirmed that these effects were overwhelmingly explained by lowered maternal responsiveness on the part of depressed mothers during interactions with their infants.

Given that children of depressed mothers are at risk for a variety of negative outcomes including social, academic, and physical health difficulties, cognitive delays, and internalizing and externalizing behavior problems (Beardslee, Versage, & Gladstone, 1998; Downey & Coyne, 1990; Murray, Kempton, Woolgar, & Hooper, 1993; Whiffen & Gotlib, 1989), potentially as a result of characteristics of their interactions with their mothers, it also seems plausible that maternal depression may influence the development of infant temperament characteristics, including infant PE, by means of low-quality mother-infant interactions.
However, no studies were identified that have examined the impact of negative mother-infant interactions on the development of negative infant temperament characteristics (i.e., infant NE) or the impact of positive mother-infant interactions on the development of infant PE. It is likely that negative mother-infant interactions serve to promote the development of high NE among infants, while positive mother-infant interactions bolster the development of infant PE.

_Evidence that infant temperament influences parent-infant interactions, which in turn, influence maternal depression._ Both early and recent theorists (e.g., Belsky, 1984; Putnam, Sanson, & Rothbart, 2002; Scarr & McCartney, 1983) have suggested that infant temperament characteristics are important determinants of the quality of the parent-infant relationship. For example, Scarr and McCartney (1983) proposed that easy, positive babies evoke different reactions from caregivers than difficult, negative babies. In general, empirical research has shown that infant characteristics which reflect a higher-order PE or O/R factor of temperament are associated with more positive parent-child interactions (Eisenberg et al., 2005; Gartstein & Fagot, 2003; Kochanska, Friesenborg, Lange, & Martel, 2004) while temperamental characteristics of infants/children which reflect a higher-order NE factor tend to be associated with more negative parent-child interactions (Clark, Kochanska, & Ready, 2000; Kochanska et al., 2004). Kochanska and colleagues (2004) examined the impact of infant temperamental joy, anger, fear, and attention on the mother-infant and father-infant relationship. Infant joy was shown to positively predict maternal shared positive emotion, maternal and paternal responsiveness, and maternal consistent tracking (i.e., indicators of the quality of the parent-infant relationship). Additionally, infant anger was shown to be a significant negative predictor of maternal and paternal shared positive emotion as well as paternal responsiveness.
Furthermore, Clark and colleagues (2000) demonstrated that infant NE was a significant positive predictor of maternal power assertion. These studies, in addition to the theoretical work referenced above, suggests that infants with positive temperament characteristics tend to have more positive interactions with their mothers while infants with negative temperament characteristics tend to have more negative interactions with their mothers.

Disturbances in the mother–infant relationship, which are partially influenced by infant temperament characteristics, have repeatedly been shown to be associated with postpartum depression (Diego et al., 2002; Cooper & Murray, 1997; Reck et al., 2004; 2006). The majority of the work supporting this theory has focused on the influence of negative mother-infant interactions on the development of depressive symptoms. For instance, studies have noted that infantile colic and prolonged crying (i.e., one aspect of infant NE according to Rothbart’s psychobiological model of temperament) are associated with parental depression concurrently and longitudinally (Howell, Mora, & Leventhal, 2006; Maxted et al., 2005; Pinyerd, 1992; van den Berg et al., 2009; Vik et al., 2009). These associations may be the result of parents’ increased negative perceptions of their infants, feelings of incompetence as a parent, or the activation of low positive affect and high negative affect among parents (see Dix & Meunier, 2009 for a related discussion). At a broader level, researchers have indicated that infants high in NE are difficult to soothe (van den Boom, 1994) and provide few opportunities for successful mother-child interactions (Leerkes & Burney, 2007). As such, caring for a child high in NE may require increased effort with less frequent opportunities for positive reinforcement (Troutman, Moran, Arndt, Johnson, & Chmielewski, 2012), which may put mothers at risk for experiencing depression.
Although the work reviewed above suggests that negative infant temperament characteristics may be associated with maternal depression through negative mother-infant interactions, it also seems likely that infant PE is linked with maternal depression through the experience of positive interactions. Specifically, it may be the case that mothers of highly positive infants have more pleasant interactions with their children and, in turn, are less likely to develop depression as compared to mothers who have more negative infants and more negative interactions with their children. This may be because mothers of highly positive infants have more pleasant interactions which result in increased positive perceptions of their infants, feeling more competent in the parenting role, or tending to be more positive themselves as a result of their interactions with their infants (see Dix & Meunier, 2009 for a related discussion). Additionally, it could be that mothers of positive infants have more frequent positive and less frequent negative interactions with their infants which results in infants requiring less care (e.g., soothing) or mothers receiving more frequent positive reinforcement from their infants, protecting them from developing significant symptoms of depression.

**Observational learning.** Given that depression is characterized by high levels of negative affect and low levels of positive affect (Watson, Clark, & Carey, 1988; Watson, Clark, & Tellegen, 1988), mothers who experience postpartum depression are expected to exhibit sadness, irritability, or hostility and to be relatively unengaged and lethargic during interactions with their infants. Prior research has provided support for this characterization of depressed mothers in interactions with their infants (Field et al., 2006; Kertz et al., 2008; Lovejoy et al., 2000; Radke-Yarrow et al., 1993). Therefore, it seems plausible that the development of infant temperament, specifically NE and PE, early in life could be impacted by infants’ exposure to high negative
affect and low positive affect on the part of their mothers through an early observational learning mechanism (Bandura, 1977). More specifically, infants may become more negative (as evidenced by frequent sadness and distress) and less positive (as reflected by lower activity levels, less frequent smiling and laughing, and less approach toward novel stimuli in the environment) over time as a result of observing similar behavior from their mothers. In support of this theory, prior research has shown that infants, especially toward the end of the first year of life, are capable of learning through observation (Collie & Hayne, 1999; Esseily, Nadel, & Fagard, 2010; Gergely, 2003; Meltzoff, 1988) and regulate their behavior on the basis of affective messages from adults (Hutman & Dapretto, 2009). Also, research involving older children (i.e., 15- to 20-month-olds) has shown that modeling constitutes a mechanism by which emotions (e.g., fear, avoidance) may be acquired early in life (e.g., Gerull & Rapee, 2002).

Biological/genetic mechanisms. Given that temperament is considered to be, at least partially, biologically based, a biological/genetic argument could be made to help explain a relationship between maternal depression and infant temperament. Twin studies that utilize parent ratings or observational measures of infant temperament provide strong evidence of genetic influences on temperament. Such studies consistently find that monozygotic (MZ) twins are more similar than dizygotic (DZ) twins across a wide variety of temperament dimensions including those listed next, which are most relevant to the present investigation: emotionality, activity, sociability, approach, and positive affect (Cyphers, Phillips, Fulker, & Mrazek, 1990; Goldsmith, Buss, & Lemery, 1997; Saudino & Cherny, 2001; Stevenson & Fielding, 1985). Although estimates of heritability tend to differ from sample to sample, they generally fall within the range of 0.20 to 0.60, suggesting that genetic differences among individuals account for
approximately 20 to 60% of the variability of PE within a population. In conjunction with prior work demonstrating associations between low PE and increased risk of depression (e.g., Block et al., 1991; Caspi et al., 1996; Kendler et al., 1993; van Os et al., 1997), the studies referenced above, which provide evidence of modest heritability of PE, suggest that children who inherit the propensity for lower PE may also be at greater risk for developing depression. This possibility may partially account for potential links between maternal depression and infant PE.

Additional support for a biological explanation of the relationship between maternal depression and infant temperament, specifically infant PE and NE, has been provided by prior work. For example, genetic research has demonstrated that variation in the catechol-o-methyltransferase (COMT) gene and synaptosomal-associated protein 25 (SNAP25) levels are associated with the experience of depression (Doornbos et al., 2009; Fatemi, Earle, Stary, Lee, & Sedgewick, 2001; Hatzimanolis et al., 2013; Kawasaki & Ordway, 2009). In turn, research has linked the COMT gene with positive affect among infants between six and seven months of age and the SNAP25 protein with negative affect among infants six to seven months and 18 to 20 months of age (Sheese, Voelker, Posner, & Rothbart, 2009). Therefore, genetic transmission of the COMT gene or SNAP25 levels may help to explain links between maternal depression and the early expression of positive and negative affect in infants.

The Current Study

The present study sought to address some of the limitations of prior work in examining the longitudinal association between maternal depressive symptoms and infant temperament. First, given that prior research has largely focused on associations between “difficult” infant
temperament and maternal depressive symptoms or between specific indicators of infant NE and maternal depression, despite research highlighting the importance of infant PE for subsequent child outcomes (e.g., Gartstein & Bateman, 2008; Jacques & Mash, 2004; Lonigan, Phillips, & Hooe, 2003), the present study examined the longitudinal relationship between maternal depressive symptoms and infant PE. Importantly, this was the first study to systematically examine such effects, which is an important prerequisite to considering mechanisms (e.g., environmental or genetic links) of potential associations between maternal depressive symptoms and infant PE.

In examining the longitudinal relationship between maternal depression and infant PE, the present investigation improved upon a methodological limitation of prior research. The majority of prior studies examining the relationship between maternal depression and infant temperament have relied on maternal report of both constructs. However, as mentioned above, research calls into question the validity of reports made by depressed individuals (Blaney, 1986; Bower, 1981; Edhborg, Seimyr, Lundh, & Widström, 2000; Gotlib, 1983; Gotlib & Cane, 1987), suggesting that they are negatively biased as a result of affective difficulties. Therefore, the strict use of self-report measures in examinations of the relations between maternal depression and infant temperament is problematic. To circumvent this methodological issue, the present study assessed maternal depression and infant PE through the use of multiple methods. The history and current experience of a Major Depressive Episode among mothers was evaluated at the start of the study through the use of a well-known structured interview, the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) Axis I Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 2002). Mothers also
reported on the severity of their depressive symptoms and the extent to which they felt stressed in the parenting role as a result of their symptoms of depression at three time points throughout infancy. Consistent with methodology utilized in prior research examining associations between maternal depression and infant temperament, mothers reported on their infant’s temperament, specifically infant PE, via questionnaire at three time points. Infant temperament was also rated at each time by two laboratory personnel who observed the infant for approximately one and a half to two hours. Finally, infant PE was coded from a structured laboratory task specifically designed to elicit infant PE. Therefore, parent, observer, and laboratory indicators of infant PE were collected over three time points.

The present project also overcame some of the limitations of prior research by utilizing structural equation modeling (SEM), a sophisticated and comprehensive approach to testing hypotheses about relations among observed and latent variables, to hypothesize a fully cross-lagged panel model which included three time points. This fully cross-lagged panel model was able to: (1) identify whether concurrent and/or longitudinal relationships exist between maternal depression and infant PE, (2) identify the direction of the association between maternal depressive symptoms and infant PE over time (i.e., whether maternal depressive symptoms influence developing infant PE, whether infant PE influences the presence and severity of maternal depressive symptoms, or both), (3) determine the timing, pattern, and strength of the relations between maternal depression and infant PE in the first year postpartum, and (4) examine relations between maternal depression and infant PE late in infancy while controlling for levels of maternal depressive symptoms and infant PE early in life, all things that prior research has not been able to do.
The Primary Hypothesis

Based on the information reviewed above, the present study formulated one key hypothesis. That is, it was believed that a reciprocal relationship between maternal depression and infant PE would be identified between the time infants were six and 10 months of age. In other words, it was anticipated that higher infant PE early in life would be associated with lower severity of maternal depressive symptoms later in infancy and that higher severity of maternal depressive symptoms early in infancy would be associated with lower infant PE later in infancy. This hypothesis was formulated based on: (1) prior studies which suggested that maternal depressive symptoms influenced infant temperament and vice versa (Bridgett et al., 2009; Cutrona & Troutman, 1986; Hopkins et al., 1987; Mayberry & Affonso, 1993; Murray et al., 1996; Sugawara et al., 1999), (2) a prior study that provided evidence of reciprocal associations between maternal depression and specific infant temperament characteristics (Sugawara et al., 1999), and (3) theoretical and empirical work concerning depression (Watson, Clark, & Carey, 1988; Watson, Clark, & Tellegen, 1988) and the mechanisms by which parental characteristics and behavior may be transmitted to children (Bandura, 1977; Dix & Meunier, 2009; Doornbos et al., 2009; Hatzimanolis et al., 2013; Sheese et al., 2009).

Although the researcher expected a reciprocal relationship between maternal depression and infant PE would be identified, hypotheses concerning the timing and pattern of this relationship were not made a priori. Rather, given limited prior work, examination of the timing and pattern of associations between maternal depression and infant PE between the time infants are six and 10 months of age was conducted in an exploratory manner.
CHAPTER 2

METHOD

Participants and Procedure

Participants. Mothers and their infants were recruited through a large OB/GYN practice, flyers posted in the community and surrounding areas, and birth announcements in local newspapers to participate in a larger longitudinal study examining the development of temperament, emotion, and emotion regulation in the first three years of life. Eligibility criteria to participate in the broader study included a full-term pregnancy and delivery with no serious complications, maternal age of at least 17 years, and a lack of infant developmental concerns at the time of enrollment. One hundred thirty-five mothers and their infants (62 males, 73 females) participated in the present study. Mothers primarily self-identified as Caucasian/European American (68.90%), African American/Black (12.80%), and Hispanic/Latino (11.30%). A small percentage of mothers identified as Native American (1.50%) or “Other” (4.50%). Similarly, infants were described by their mothers as primarily Caucasian/European American (62.20%), African American/Black (13.30%), and Hispanic/Latino (11.90%). The race of 12.60% of infants was described as “Other.” Mothers ranged in age from 17 to 42 years ($M = 27.60, SD = 6.27$) and, on average, had completed 14.70 years of education ($SD = 2.72$, range = 9 to 20 years). At the time of their enrollment in the study, the majority of mothers (85.70%) were married or in a stable romantic relationship.
Procedure. As part of the broader study, approximately two weeks prior to the time their infants were four, six, eight, and ten months of age, mothers were mailed and asked to complete a set of questionnaires. In addition, mothers attended a laboratory session alone around the time their infant was four months old, which lasted between two and three hours. Mothers and their infants visited the lab around the time infants were six, eight, and ten months of age for about an hour and a half or two hours. Prior to the first laboratory visit, mothers completed demographic questionnaires as well as a questionnaire that assessed their level of temperamental positive affectivity. During their first lab session, mothers participated in a structured interview to assess the history and current experience of a Major Depressive Episode (MDE). In the questionnaire packets mailed home approximately two weeks prior to the time infants were six, eight, and ten months of age, mothers completed questionnaires which assessed the severity of their depressive symptoms and their infant’s level of positive emotionality. During the six-, eight-, and ten-month lab visits, mothers and their infants participated in a Peek-a-Boo game.

An informed consent document was included in the questionnaire packet mailed to mothers prior to their infants’ four month “birthdays.” Mothers were compensated with $50 total for completing initial questionnaires and attending the four-month laboratory visit. For completing later questionnaires and attending the laboratory visits that occurred when infants were six, eight, and ten months of age, mothers were compensated with $30 per visit. All procedures were approved by the Institutional Review Board at Northern Illinois University.
Measures

**Demographics.** Demographic information concerning each mother and infant was provided by the mother through completion of two demographic questionnaires included in the packet mailed home prior to the first laboratory visit (see Appendices A and B). Information collected concerning the mother included partnership status, race/ethnicity, education level, date of birth, age, gender, occupation, family income, religious affiliation, personal and family history of psychopathology (e.g., depression, substance use/abuse), learning or speech difficulties (e.g., learning disability, speech impairment), and personal medical difficulties (e.g., heart disease, cancer). Information collected concerning the infant included date of birth, weight at birth, current age, sex, adoption status, race/ethnicity, whether or not the infant was being raised in a bilingual family environment, and number, age, and gender of siblings. In light of prior research, which has provided mixed results concerning sex differences in infant PE (Dougherty et al., 2010; Majdandžić & van den Boom, 2007; Zhou et al., 2009), infant sex was controlled for in the present study’s analyses.

**Cumulative risk index.** A cumulative risk index was calculated by integrating information obtained from demographic questionnaires completed by mothers. Specifically, participants were assigned one point for each of the following criteria that were met: single motherhood, maternal age less than 20 years (i.e., “teen motherhood”), maternal education level below high school graduate, and family living below the poverty line. Points were summed to create the cumulative risk index (CRI) value for each participant and this variable was used as a covariate in the present study’s analyses. At the time of their enrollment in the study, twelve mothers (8.90% of the sample) were under the age of 20, nineteen (14.10%) indicated that they were single mothers,
14 mothers (10.40%) had an education level below high school graduate, and 32 families (23.70%) were living below the poverty line. The minimum cumulative risk index was 0 while the maximum was 3 ($M = 0.83$, $SD = 0.88$).

**History and current experience of a major depressive episode.** To determine whether mothers met criteria for a Major Depressive Episode (MDE) at their time of enrollment, or at any time prior, they were administered the mood module of the Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Non-Patient Edition (SCID-I/NP; First et al., 2002) when they visited the laboratory around the time their infants were four months of age. A trained graduate or undergraduate student experimenter administered the SCID-I/NP to each mother. In doing so, the experimenter asked mothers to indicate whether or not they were experiencing, or had ever experienced, each symptom of a MDE (i.e., depressed or irritable mood, diminished interest or pleasure in activities, significant weight loss/gain or a decrease or increase in appetite, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue or loss of energy, feelings of worthlessness or excessive or inappropriate guilt, diminished ability to think or concentrate or indecisiveness, and thoughts of death, suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide). Mothers’ responses to these questions were utilized to determine whether they met criteria for a MDE at the time of their enrollment in the study or any time prior, which was controlled for in all analyses. Based on information collected from the SCID-I, 40 mothers (29.60% of the sample) met criteria for a MDE, either prior to or at the time of their enrollment in the study.

A review of the literature indicates that the SCID-I is a reliable diagnostic assessment tool. For example, studies that have assessed inter-rater reliability of the SCID-I with two raters
listening to an audio-recording of the interview indicate that reliability estimates (i.e., kappas) range from 0.66 to 0.81, depending on the mood disorder being rated (Lobbestael, Leurgans, & Arntz, 2011). For studies including rater pairs from multiple sites, inter-rater reliability for mood disorders ranges from 0.76 to 0.80 (Zanarini et al., 2000). In regards to test-retest reliability, estimates for reliability between seven and ten days ranges from 0.60 to 0.73, depending on the mood disorder being rated (Zanarini & Frankenburg, 2001).

Given that the validity of a diagnostic assessment technique is generally measured by determining the agreement between the diagnoses made by the assessment technique and some hypothetical “gold standard,” and the fact that a gold standard for psychiatric diagnoses has yet to be identified, examinations of the validity of the SCID-I have been difficult to conduct. In fact, a number of studies have used the SCID-I as the “gold standard” in determining the accuracy of clinical diagnoses (e.g., Shear et al., 2000; Steiner, Tebes, Sledge, & Walker, 1995). However, several studies which have used the LEAD standard (i.e., a longitudinal assessment (L), done by expert diagnosticians (E), using all data (AD) available on participants) as the gold standard in diagnostic assessment have demonstrated superior validity of the SCID-I over standard clinical interviews at intake (Basco et al., 2000, Fennig, Craig, Lavelle, Kovasznay, & Bromet, 1994; Fennig, Naisberg-Fennig, Craig, Tanenberg-Karant, & Bromet, 1996; Kranzler, Kadden, Burleson, & Babor, 1995; Kranzler, Kadden, Babor, & Tennen, 1996). Therefore, it appears that, through the use of available methods, validity of the SCID-I has been demonstrated.

Maternal positive affectivity. Mothers reported on their level of temperamental positive affect prior to their first visit to the laboratory by completing the Positive Affect (PA) subscale of the short form of the Adult Temperament Questionnaire (ATQ-SF; Evans & Rothbart, 2007;
Rothbart, Ahadi, & Evans, 2000; see Appendix C). The PA subscale of the ATQ is comprised of five items (e.g., “It doesn’t take much to evoke a happy response from me”) that are rated on a scale of one (Extremely untrue of you) to seven (Extremely true of you). Item ratings were averaged to arrive at an indicator of maternal temperamental PA, which was controlled for in the present study’s analyses.

The reliability of the ATQ has been supported in prior work (Evans & Rothbart, 2007; Rothbart et al., 2000). Specifically, the internal consistency of the Positive Affect subscale is considered to be good (i.e., \( \alpha = 0.84 \), Evans & Rothbart, 2007). Validity of the ATQ as a measure of adult temperament has also been demonstrated by prior research (Evans & Rothbart, 2007; Rothbart et al., 2000). That is, a coherent and clean factor structure and convergent validity with the Big Five model of personality has been demonstrated. The ATQ has been translated into several languages, including German and French, and support for the reliability and validity of the ATQ in these samples has been demonstrated as well (Laverdière, Diguer, Gamache, & Evans, 2010; Wiltink, Vogelsang, & Beutel, 2006). Internal consistency of the PA subscale in the present study was poor (\( \alpha = 0.51 \)) and analyses revealed that the deletion of one or more items comprising the subscale did not improve its internal consistency reliability (see Table 1 for additional internal consistency values). Given that temperament is considered to be, at least partially, biologically based (Rothbart & Derryberry, 1981) and that prior research has demonstrated that maternal PA influences infant PE early in life (Bridgett et al., 2013), maternal PA was controlled for in all analyses examining the relationship between maternal depression and infant PE.
### Table 1
Reliability of Study Measures at Each Time Point

<table>
<thead>
<tr>
<th>Measure/Scale/Factor</th>
<th>Four Months</th>
<th>Six Months</th>
<th>Eight Months</th>
<th>Ten Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATQ</td>
<td>.51</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>BDI-II</td>
<td>--</td>
<td>.91</td>
<td>.92</td>
<td>.91</td>
</tr>
<tr>
<td>PSI Depression Subscale</td>
<td>--</td>
<td>.82</td>
<td>.81</td>
<td>.83</td>
</tr>
<tr>
<td>IBQ-R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Emotionality Factor</td>
<td>--</td>
<td>.88</td>
<td>.91</td>
<td>.93</td>
</tr>
<tr>
<td>Activity Level</td>
<td>--</td>
<td>.80</td>
<td>.77</td>
<td>.74</td>
</tr>
<tr>
<td>Smiling and Laughter</td>
<td>--</td>
<td>.85</td>
<td>.83</td>
<td>.79</td>
</tr>
<tr>
<td>High Intensity Pleasure</td>
<td>--</td>
<td>.82</td>
<td>.85</td>
<td>.81</td>
</tr>
<tr>
<td>Perceptual Sensitivity</td>
<td>--</td>
<td>.87</td>
<td>.89</td>
<td>.93</td>
</tr>
<tr>
<td>Approach</td>
<td>--</td>
<td>.83</td>
<td>.81</td>
<td>.82</td>
</tr>
<tr>
<td>Vocal Reactivity</td>
<td>--</td>
<td>.70</td>
<td>.84</td>
<td>.79</td>
</tr>
<tr>
<td>Peek-a-Boo Task</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensity of Smiling</td>
<td>--</td>
<td>.72</td>
<td>.73</td>
<td>.75</td>
</tr>
<tr>
<td>Positive Vocalization</td>
<td>--</td>
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<td>.80</td>
<td>.82</td>
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<tr>
<td>Positive Motor Activity</td>
<td>--</td>
<td>.80</td>
<td>.67</td>
<td>.70</td>
</tr>
</tbody>
</table>

Maternal depressive symptoms. To assess the ongoing frequency/severity of maternal depressive symptoms, mothers completed the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) and the Depression subscale of the Parenting Stress Index (PSI; Abidin, 1995) when their infants were approximately six, eight, and ten months of age. Scores from the BDI-II and the Depression subscale of the PSI were to be used as two indicators of a latent variable (i.e., maternal depression) for each time point in the present study. However, due to problems with the initially-specified model (discussed below), which prevented the use of latent variables, and the strong correlations between maternal ratings on the BDI-II and Depression subscale of the PSI at each time point, the standardized, log-transformed values from each measure were averaged and used as a single observed variable at each time point in the present study.
The BDI-II is a widely used 21-item inventory of affective, cognitive, motivational, and somatic symptoms of depression. Each item is rated on a scale of 0 to 3 and reflects a common symptom of depression (e.g., sadness, loss of pleasure, worthlessness, suicidal thoughts and wishes). The ratings for each item are summed to achieve an overall measure of the severity of depressive symptoms in a two-week period prior to the completion of the measure. Research has demonstrated that the BDI-II has high internal consistency ($\alpha = 0.91$; Beck, Steer, Ball, & Ranieri, 1996) and high one-week test–retest reliability ($r = 0.93$), suggesting that the measure is not overly sensitive to daily variations in mood (Beck, Steer, Ball, et al., 1996). Research has also shown that the BDI-II is positively correlated with other measures of depression (e.g., the Hamilton Depression Rating Scale, $r = 0.71$), providing evidence of convergent validity. Internal consistency in the present study was excellent at all three time points ($\alpha = 0.91$ at the 6-month visit, $\alpha = 0.92$ at the 8-month visit, and $\alpha = 0.91$ at the 10-month visit).

The Depression subscale of the PSI consists of 9 items, each of which states a feeling associated with parenting (e.g., “There are quite a few things that bother me about my life”). The items are rated on a scale from 1 (Strongly Agree) to 5 (Strongly Disagree); however, all items were reverse-scored such that higher scores reflected higher stress related to feelings of depression. Ratings on each item were averaged to achieve an overall indicator of stress related to feelings of depression. Prior work has demonstrated good internal consistency for the Depression subscale of the PSI ($\alpha = 0.84$, Abidin, 1995; Abidin, Flens, & Austin, 2006). Good stability has been demonstrated over periods of 3 weeks (Burke, 1978), three months (Zareski, 1983), and one year (Hamilton, 1980). Correlations between the PSI Depression subscale and general measures of depression have ranged from 0.40 to 0.76 (Abidin et al., 2006), providing
evidence of convergent validity. Similarly, high concordance between self-report and observational measures of parenting stress in a large sample of low-income, urban African American mothers of infants and toddlers has been demonstrated for the PSI (Hutcheson & Black, 1996). Recent research has adapted the PSI for use with diverse populations of parents. That is, as of 2006, the PSI had been officially translated into 28 languages (Abidin et al., 2006), suggesting that the PSI’s factor structure and construct and predictive validity are quite robust. Internal consistency of the Depression subscale of the PSI in the present study was good at each time point (α = 0.82 at the 6-month visit, α = 0.81 at the 8-month visit, and α = 0.83 at the 10-month visit). Supporting the validity of both measures, the correlation between maternal ratings on the BDI-II and the Depression subscale of the PSI was high at each time point in the present study (i.e., .43, p < .001 at the 6-month visit, .52, p < .001 at the 8-month visit, and .53 p < .001 at the 10-month visit).

Infant positive emotionality.

Parent report. The Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003; see Appendix D), developed based on the definition of temperament proposed by Rothbart and Derryberry (1981), is a widely used, comprehensive parent-report measure of infant temperament. The IBQ-R is comprised of 184 items that form fourteen subscales and three broad temperament factors (i.e., Surgency/Extraversion [also often referred to as Positive Emotionality], Negative Affectivity, and Orienting/Regulation). In completing the IBQ-R, parents were asked to read each item, which described a typical infant behavior, and indicate how often their infant engaged in the behavior during the previous seven days. Parents responded
to each item along a 7-point, Likert-type scale (*Never, Very Rarely, Less than Half the Time, Half the Time, More than Half the Time, Almost Always, Always*).

The Surgency/Extraversion factor of the IBQ-R was utilized in the current study as one indicator of infant positive emotionality. This factor includes 72 items which make up six subscales labeled Smiling and Laughter (e.g., “how often during the last week did the baby smile or laugh when given a toy?”), Vocal Reactivity (e.g., “when being dressed/undressed during the last week, how often did the baby coo or vocalize?”), Activity Level (e.g., “when put into the bath water, how often did the baby splash or kick?”), Approach (e.g., “when given a new toy, how often did the baby get very excited about getting it?”), High Intensity Pleasure (e.g., “during a Peek-a-Boo game, how often did the baby smile?”), and Perceptual Sensitivity (e.g., “how often did the baby notice fabrics with a scratchy texture [e.g., wool]?”).

Previous research has demonstrated that all fourteen subscales of the IBQ-R are internally consistent, with Cronbach’s alphas ranging from 0.70 to 0.90 (Gartstein & Rothbart, 2003; Parade & Leerkes, 2008). Inter-rater reliability, typically assessed as concordance between maternal and paternal ratings of infant temperament on the IBQ-R, has ranged from 0.06 to 0.75 for the individual subscales and from 0.31 (Orienting/Regulation) to 0.49 (Surgency/Extraversion) to 0.70 (Negative Affectivity) for the broad temperament factors (Gartstein & Rothbart, 2003; Parade & Leerkes, 2008). Reliability and validity of the IBQ-R has recently been demonstrated in studies involving diverse samples of participants (e.g., Gartstein, Knyazev, & Slobodskaya, 2005; Klein, Putnam, & Linhares, 2009). Convergent validity, between the IBQ-R and laboratory-based indicators of infant temperament, has also been demonstrated (Gartstein & Marmion, 2008; Kochanska, Coy, Tjebkes, & Husarek, 1998).
example, Parade and Leerkes (2008) demonstrated convergent validity between scores based on observations of infant fearfulness in the laboratory and mother and father-reported fear scores on the IBQ-R. Therefore, prior research supports the use of the IBQ-R in assessing infant temperament. In the present study, internal consistency for the subscales that comprised the PA factor ranged from acceptable to excellent ($\alpha$ ranged from 0.70 to 0.93, see Table 1). Internal consistency of the PA factor was good to excellent ($\alpha = 0.88$ at the 6-month visit, $\alpha = 0.91$ at the 8-month visit, and $\alpha = 0.93$ at the 10-month visit).

Laboratory member report. Following the laboratory sessions that occurred when infants were six, eight, and ten months of age, two laboratory members completed the Infant Behavior Rating Scale (IBRS; Bayley, 1993, see Appendix E). The individuals who completed this scale included: 1) the graduate student or advanced undergraduate student who conducted the laboratory session with the mother and her infant and 2) the graduate or undergraduate student who operated cameras during the laboratory session. One item from this scale, which assessed infant degree of happiness throughout the laboratory visit, was used as an indicator of positive emotionality in the present study. This particular item was rated on a Likert-type scale ranging from one (Child seems unhappy throughout the lab visit) to nine (Radiates happiness; nothing is upsetting; animated). Because the relation between the raters on this item was high ($r = 0.69$, $p < .001$), the two ratings of each infant for each laboratory visit were averaged to arrive at a single observer indicator of PE in the present study.

Based on the Bayley-II validation sample, reliability for the full IBRS was moderate to high, with internal consistency coefficients ranging from 0.73 to 0.90. For children who were twenty-four months of age, test–retest reliability coefficients ranged from 0.61 to 0.71 (Bayley,
Correlations between a modified version of the IBRS demonstrated modest to strong correlations (ranging from 0.21 to 0.76) with episodes from the Preschool version of the Laboratory Temperament Assessment Battery (Lab-TAB), providing some evidence of convergent validity (Gagne, Van Hulle, Aksan, Essex, & Goldsmith, 2011). More specifically, correlations between items on Gagne and colleagues’ (2011) measure and Preschool Lab-TAB episodes indicative of infant PE ranged from 0.48 to 0.59. Therefore, it appears that prior research also supports the use of the IBRS in examinations of infant temperament. Because only one item from the IBRS was utilized in the present study, internal consistency values cannot be reported. However, ratings on the degree of happiness item were correlated over time, providing evidence of good test-retest reliability.

Laboratory observation. When infants were approximately six, eight, and ten months of age, they participated in the Modified Peek-a-Boo task with their mothers in the laboratory. The Modified Peek-a-Boo task is part of the Laboratory Temperament Assessment Battery (Lab-TAB), Pre-locomotor Version 3.1 (Goldsmith & Rothbart, 1999). The Lab-TAB Pre-locomotor Version is a standardized instrument used for the assessment of temperament among infants up to twelve months of age. The Modified Peek-a-Boo task was created and incorporated into Lab-TAB in order to measure infant pleasure in response to social stimulation.

During the Modified Peek-a-Boo task, the infant was placed in a highchair in front of a large plywood board that contained four small hinged doors and was placed on a table (see Appendix F). On the back of each door was a small label containing a number that indicated to the mother the pre-arranged sequence of “hiding” she was to follow during the task. Prior to the task starting, the experimenter described the nature of the task to the mother and provided her a
cue card, which listed step-by-step instructions for the game. Next, the mother was asked to kneel behind the plywood board and the experimenter stood to the left of the mother, in front of the plywood board, facing the infant.

Once the mother was out of the infant’s sight, the first trial of the game began. The experimenter playfully asked the infant, “[infant name], where’s Mommy?” After a pause of approximately three seconds, the experimenter knocked on and then opened the door labeled “1” (i.e., the door on the mother’s right, farthest from the experimenter) to reveal a smiling mother who playfully said “Peek-a-Boo.” The experimenter left the door open an additional two seconds and then closed it. This procedure was repeated twice more with the experimenter opening the doors labeled “2” (i.e., the door on the bottom of the board) and “3” (i.e., the door to the mother’s left, closest to the experimenter), respectively. On the fourth and fifth trials of the game, the mother was asked to hide underneath the table on which the plywood board was placed and to not appear through any of the doors’ windows. On these trials, the experimenter opened the doors labeled “4” (i.e., the door on the top of the board) and “2,” respectively, and said, “Uh oh, she’s not there.” On the sixth and final trial of the game, trial one was repeated exactly as it was performed at the start of the game. The final trial of the Modified Peek-a-Boo task was discontinued fifteen seconds after it was started.

**Coding of the modified peek-a-boo task.** The Modified Peek-a-Boo task was audio- and video-recorded at each laboratory visit for coding purposes. The camera operator for each visit was instructed to attempt to capture a full, frontal shot of the infant’s face and upper torso. For coding purposes, the Modified Peek-a-Boo task officially began when the experimenter first said “Where’s Mommy?” and consisted of six trials, each starting with “Where’s Mommy?” and
ending with the beginning of the next “Where’s Mommy?” with the exception of the last trial which, as noted above, ended fifteen seconds after it began. The six trials were coded by indicating the occurrence or intensity of specific behaviors. When an intensity rating was to be made, research assistants were instructed to code the highest intensity of the behavior observed.

Consistent with the Lab-TAB manual, four variables reflecting infant positive emotionality were coded for each of the six trials of the Modified Peek-a-Boo task (see Appendix G). The first variable was labeled Intensity of Smiling. Intensity of Smiling was defined as the peak intensity of facial joy exhibited by the infant throughout the task and was rated on a scale of 0 (No smiling at all), 1 (Small smile, with lips slightly upturned, and no involvement of the cheeks or eyes), 2 (Medium smile, with lips upturned, perhaps mouth open, slight bulging of cheeks, and perhaps some crinkling about the eyes), and 3 (Large smile, with lips stretched broadly and upturned, perhaps mouth open, definite bulging of cheeks and noticeable crinkling of the eyes) for each trial of the task. The second variable reflecting infant positive affectivity was Laughter. Laughter was considered to be more intense than positive vocalizations made by the infant and usually had a rhythmic quality. The presence or absence of laughter in the Modified Peek-a-Boo task was recorded by coding 0 (Not present) or 1 (Present) for each trial. The third variable coded was Positive Vocalization, defined as the presence of positively toned babbling or squealing on the part of the infant. This variable was coded as either 0 (Not present) or 1 (Present) for each of the task’s six trials. The fourth variable was Positive Motor Activity, which was typically indicated by the presence of infants banging their hands on the highchair, clapping, waving their arms in excitement, or reaching toward the Peek-a-Boo board. The presence (1) or absence (0) of this behavior was noted in each of the task’s six trials.
Once coding of the above variables was complete, for each variable, an infant’s ratings on each of the task’s six trials were summed. More specifically, an infant’s ratings on each of the task’s six trials were summed for each of the following variables: Intensity of Smiling, Laughter, Positive Vocalization, and Positive Motor Activity. Once single indicators of each code had been created in the manner described, associations between indicators at each time point were examined. Indicators that were inter-related at each time point (i.e., intensity of smiling, positive vocalization, and positive motor activity) were standardized and then averaged to achieve an indicator of infant positive emotionality for each infant during each laboratory visit in the present study. The laughter variable was discarded for the purposes of this study as it was unrelated to the other variables coded from the Peek-a-Boo task at each time point (see Tables 2, 3, and 4). This approach to combining data from the Peek-a-Boo task is consistent with that taken by other researchers who have also identified non-significant associations between the laughter variable and other variables coded from the Modified Peek-a-Boo task (e.g., Gartstein & Marmion, 2008).

Given that the Modified Peek-a-Boo task was completed with each mother and infant at the six-, eight-, and ten-month laboratory visits, each of the four variables described above had to be coded for approximately four hundred five videos. Given the amount of work involved, four undergraduate research assistants were recruited to complete the coding required for this project. Each research assistant was asked to code approximately 25% of all of the Peek-a-Boo videos (i.e., approximately 101 videos). The videos were assigned such that research assistants only coded a particular infant once.

Prior to the start of coding, research assistants were required to complete intensive training. As the first step in the training process, 14 recordings of the Modified Peek-a-Boo task
Table 2

Correlations between Peek-a-Boo Variables at 6 Months

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Smile 6 Mos.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Laugh 6 Mos.</td>
<td>-0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Vocal 6 Mos.</td>
<td>0.34***</td>
<td>-0.04</td>
<td></td>
</tr>
<tr>
<td>4. Move 6 Mos.</td>
<td>0.52***</td>
<td>-0.06</td>
<td>0.48***</td>
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</table>

Table 3

Correlations between Peek-a-Boo Variables at 8 Months

<table>
<thead>
<tr>
<th>Variable</th>
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<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>1. Smile 8 Mos.</td>
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<td></td>
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</tr>
<tr>
<td>2. Laugh 8 Mos.</td>
<td>0.29**</td>
<td></td>
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</tr>
<tr>
<td>3. Vocal 8 Mos.</td>
<td>0.39***</td>
<td>0.12</td>
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<tr>
<td>4. Move 8 Mos.</td>
<td>0.54***</td>
<td>0.25**</td>
<td>0.55***</td>
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</table>

Table 4

Correlations between Peek-a-Boo Variables at 10 Months

<table>
<thead>
<tr>
<th>Variable</th>
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<td>1. Smile 10 Mos.</td>
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<td></td>
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<tr>
<td>2. Laugh 10 Mos.</td>
<td>0.39***</td>
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<td>3. Vocal 10 Mos.</td>
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<td>0.08</td>
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<tr>
<td>4. Move 10 Mos.</td>
<td>0.41***</td>
<td>0.28**</td>
<td>0.43***</td>
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</table>
were selected by the author of this dissertation and used as training videos. Seven of these videos were selected from the pool of available 6-month Modified Peek-a-Boo videos and the remaining seven were selected from the pool of available 10-month videos. To establish codes for the training videos, the laboratory director and the author of this dissertation co-coded each of the 14 videos and reached 100% agreement on each of the codes. Next, the author of this dissertation met with each of the four undergraduate research assistants assigned to code the Modified Peek-a-Boo task and co-coded seven of the 14 training videos. This step of the training protocol allowed the research assistants to become comfortable with the coding procedure and the rating scales utilized for each variable.

Once the research assistants reached reliability (i.e., 80% agreement or higher) on the four co-coded videos, they coded the remaining training videos until they achieved 80% agreement or higher with the ratings. At this time, the training process was considered complete and the research assistants began coding non-training videos. Throughout the coding process, meetings between the author of this dissertation and the undergraduate research assistants assigned to complete coding for the Modified Peek-a-Boo task were held biweekly to discuss coding issues including coding progress and how to code ambiguous or problematic episodes. Although undergraduate research assistants were generally familiar with the overall goal and hypothesis of this project, they were blind to the diagnostic status of each participant as well as to the participant’s self-reported severity of depressive symptoms at each time point. To establish reliability after all non-training videos had been coded, the author of this dissertation randomly selected and coded 10% of the available participant videos at each time point (i.e., 6, 8, and 10 months of age). To account for chance agreement, intra-class correlations were utilized to
determine inter-rater agreement between the author of this dissertation and other coders (Weir, 2005). Intra-class correlations for videos coded at the 6-month (0.74), 8-month (0.73), and 10-month visits (0.75) were indicative of good inter-rater reliability.

Data Analytic Strategy

All analyses were conducted using SPSS Version 21.0 (IBM Corporation, 2012) and EQS Version 6.1 (Bentler, 2006).

Preliminary analyses. The first step in data analysis was to examine descriptive statistics and the distribution of all study variables. Given that the present study utilized structural equation modeling (SEM) to test hypotheses, the presence of univariate or multivariate outliers could have significantly impacted analyses. Specifically, when outliers are present, they can alter indices of model fit, parameter estimates, and standard errors in SEM, which may lead to erroneous conclusions. They can also cause improper solutions in which estimates of parameters are outside the range of possible values (e.g., Heywood cases in which estimates of error variance are < 0; see Dillon, Kumar, & Mulani, 1987). Therefore, extreme univariate outliers (i.e., ≥ 3 standard deviations), detected through the examination of descriptive statistics, were removed from the data prior to analyses. Multivariate outliers were detected through the examination of Mardia’s index (Mardia, 1970) in EQS 6.1. With Mardia’s index, multivariate outliers are indicated by their Mahalanobis distances (i.e., the squared distance in standard units of an observation from the sample means for all variables). The larger the Mahalanobis distance for an observation, the larger the contribution of that observation to Mardia’s index and to the
departure of data from multivariate normality (Mardia, 1970). Multivariate outliers, identified through the use of Mardia’s index, were removed prior to analyses.

In addition, SEM, which employs maximum likelihood estimation (MLE), a commonly utilized approach to estimating the parameters of structural equation models, assumes that measured variables have a multivariate normal distribution. If this assumption is not met, the $\chi^2$ goodness of fit test is considered to produce an inaccurate estimate of model fit and parameter estimates are expected to be biased, yielding too many significant results (West, Finch, & Curran, 1995). Therefore, in the present investigation, variables with non-normal distributions following the removal of univariate and/or multivariate outliers were square-root or log-transformed prior to analyses. Because transformations improved some distributions, but were not successful in achieving a normal distribution for every variable, the scaled $\chi^2$ statistic and robust standard errors were utilized in interpreting model fit, as they are considered to be less biased by non-normal data than other statistics (Satorra, 1990).

Handling missing data. As is frequently the case in longitudinal research, some attrition between the 6-month, 8-month, and 10-month time points occurred in the present study. As indicated above, 135 mothers participated in the laboratory visit, which occurred when infants were 4 months of age. At the time of the second laboratory visit, which occurred when infants were approximately 6 months old, 115 mother-infant pairs (i.e., 85.20% of the original sample) participated. One hundred eight mothers (i.e., 80% of the original sample) and their infants returned for the third laboratory visit which occurred when infants were 8 months of age and 102 mother-infant pairs (i.e., 75.60% of the original sample) returned for the final laboratory visit which took place when infants were about 10 months old.
To determine whether data lost to attrition in the present investigation was missing completely at random (MCAR), rather than due to a systematic reason, Little’s MCAR test (Little, 1988) was utilized. Little’s MCAR test is a multivariate extension of a univariate t-test approach to testing for data MCAR which separates complete and incomplete cases in a dataset based on a particular variable and then conducts a t-test to examine group mean differences on other variables in the dataset. Unlike the univariate t-test approach, Little’s MCAR test simultaneously evaluates mean differences on every variable in a dataset and calculates a weighted sum of the standardized differences between the subgroup means and the grand means (Enders, 2010). A non-significant $\chi^2$ statistic achieved from Little’s MCAR test indicates that data is missing completely at random. In the present study, results of Little’s MCAR test indicated that missing data was missing completely at random ($\chi^2 (490) = 521.38, p = 0.158$). Because data was MCAR, missing data was imputed using EQS 6.1 software using full information maximum likelihood (FIML) estimation, a procedure considered appropriate for data that is MCAR (Enders, 2010; Kline, 2011).

FIML estimation is a model-based data imputation method that utilizes the expectation-maximization (EM) algorithm. The EM algorithm has two steps (i.e., the E step and the M step). In the E step, missing values in a dataset are imputed by predicted scores in a series of regressions in which each incomplete variable is regressed on the remaining variables for a particular case. In the M step, the whole imputed dataset is submitted for maximum likelihood (ML) estimation. ML estimation, which assumes the presence of multivariate normal data, determines values for missing data points that would make the mean and variance of the available data the most probable (Enders, 2010). These two steps are repeated until a stable
solution is reached across the M steps. FIML estimation was utilized in the present study as it is considered superior to more traditional techniques for handling missing data (e.g., listwise and pairwise deletion) and because it maximizes statistical power by borrowing information from observed data (Enders, 2010).

**Primary analyses.**

**Structural equation modeling.** Structural equation modeling was utilized to test the present study’s hypothesis. SEM is a comprehensive statistical approach to testing hypotheses about relations among observed and latent variables. In SEM, a hypothesized model of the relations between study variables is compared to the pattern of variances and covariances of observed data (Hoyle, 1995).

**Model specification.** SEM begins with the specification of a model to be tested. In this step, a statement is formally made concerning the relations between study variables and the parameters that will be fixed (i.e., set to zero and not estimated) and free (i.e., estimated) are identified. A structural model, depicting the expected relations between the present study’s latent variables, is depicted in Figure 1 while a measurement model, which specifies the relationships between the study’s latent and observed variables, is provided in Figure 2. A combined structural and measurement model for the present investigation is depicted in Figure 3. The fixed and free parameters for the present project are identified in Figure 4.

**Cross-lagged panel models.** As can be seen from Figures 1-4, the present dissertation tested fully cross-lagged panel models. Cross-lagged panel models are used to examine the structural relations between repeatedly measured constructs and are useful when a research
Figure 1. A structural model depicting the longitudinal relations between maternal depressive symptoms and infant positive emotionality in the first year postpartum.
Figure 2. The initial measurement model for the present study.
Figure 3. An integrated measurement and structural model depicting the longitudinal relations between maternal depressive symptoms and infant positive emotionality in the first year postpartum.

*Note.* Lines representing relations between control variables and latent variables are not depicted for the purpose of clarity.
Figure 4. A figure depicting the fixed and free parameters of the initial model in the present study.

Note. Lines from control variables to latent variables which represent free parameters are not included for clarity.
question concerns the pattern of influence (rather than direction of change), as is the case in the present investigation. Within cross-lagged panel models, an autoregressive effect is defined as the effect of a construct on itself measured at a later point in time (e.g., the effect of X measured at time 1 on X measured at time 2; Selig & Little, 2012). An autoregressive coefficient which is small or zero indicates that there has been a substantial reshuffling of individuals’ standings on a given construct over time whereas a sizeable autoregressive coefficient means that individuals’ standings on the construct have changed very little over time.

A cross-lagged effect in a cross-lagged panel model is defined as the effect of a construct on another, which is measured at a later time (e.g., the effect of X measured at time 1 on Y measured at time 2; Selig & Little, 2012). Cross-lagged effects are estimated controlling for the prior level of the construct being predicted (e.g., the effect of X measured at time 1 on Y measured at time 2 controls for Y at time 1) which allows for one to rule out the possibility that a cross-lagged effect is simply due to the fact that the two constructs were correlated earlier in time. If individuals’ standings on a construct at one point in time (e.g., X1) are related to their standings on another construct at a later time (e.g., Y2), there will be a significant cross-lagged effect.

Results from a cross-lagged panel analysis can be used to determine whether cross-lagged effects occur in only one direction or both directions (i.e., whether X1 predicts Y2 and Y1 predicts X2) and to assess the relative strength of the cross-lagged effects. In the present study, a cross-lagged panel analysis was used to determine whether maternal depressive symptoms predict later infant positive emotionality, whether early infant positive emotionality predicts later
maternal depressive symptoms, or both. Autoregressive effects were examined to inform whether individuals’ standings on primary study variables (i.e., maternal depressive symptoms, infant positive emotionality) were stable or unstable over time.

Model estimation. As recommended by Hoyle and Panter (1995), maximum likelihood estimation (MLE) was utilized to estimate model parameters in the present study. MLE is the most commonly used estimation method and is based on the idea of maximizing the probability that the specific covariance matrix implied by a model is equivalent to the covariance matrix produced by one’s data. MLE is an iterative process; therefore, a series of attempts were made by EQS 6.1 to obtain parameter estimates. The advantages of using MLE are that it does not over- or under-estimate true population values, it produces the most consistent estimates of true population values as compared to other estimation procedures, and it produces estimates that are scale-invariant and scale-free.

Assessment of model fit. Fit statistics indicate the degree to which the pattern of fixed and free parameters specified in a model is consistent with the pattern of variances and covariances from a set of observed data (Hoyle, 1995). In the present investigation, model fit was evaluated through the use of multiple fit indices, following the recommendations of Hoyle and Panter (1995). Specifically, the scaled $\chi^2$ statistic (due to the presence of non-normal data, Satorra & Bentler, 1994), the Root Mean Square Error of Approximation (RMSEA; Steiger & Lind, 1980), and the Standardized Root Mean Square Residual (SRMR) are the absolute fit indices that were evaluated. The $\chi^2$ statistic is a statistical test of the lack of fit resulting from over-identifying restrictions placed on a model, while the RMSEA is an indicator of model fit in relation to degrees of freedom. The SRMR is the standardized difference between the observed covariance
matrix and the predicted covariance matrix. Given that the $\chi^2$ statistic is essentially a “badness of fit” index rather than a goodness-of-fit index, small and non-significant values are desirable. Browne and Cudeck (1993) propose that a value of 0.05 for the RMSEA statistic indicates a close fit of the model in relation to degrees of freedom and that a value of 0.08 or lower indicates adequate model fit. Similarly, a value of 0.08 or lower for the SRMR is considered to indicate good fit (Hu & Bentler, 1999). Two additional indicators of model fit, which are considered incremental fit indices, were utilized in the present study. These are the comparative fit index (CFI; Bentler, 1990) and the non-normed fit index (NNFI; Bentler & Bonett, 1980). The NNFI compares the lack of fit of a target model to that of a baseline model, while the CFI compares the non-central chi-square statistic of a target model with a baseline model. For the NNFI and CFI, values above 0.90 are said to indicate good model fit (Hoyle, 1995; Marsh, Balla, & Hau, 1996).

Model modification. Model modification refers to the process of adjusting a specified and estimated model by: (1) freeing parameters that formerly were fixed, (2) fixing parameters that formerly were free, (3) adding or deleting paths within the model, or (4) adding or deleting observed or latent variables. In the present study, model modification was employed when the fit of the initial model to the data was poor. Model modification, when deemed appropriate, was guided by prior theoretical and empirical work as well as information provided by the EQS program. For example, non-significant pathways of the original model, identified by the EQS program, were deleted, and the fit of the resulting model was compared to the fit of the original model. This was done by comparing the scaled $\chi^2$ statistic of the original model with that of the modified model.
CHAPTER 3

RESULTS

Preliminary Analyses

Descriptive statistics are presented in Table 5. Correlations between study variables are presented in Table 6. Correlations were examined to determine whether the use of latent variables reflecting maternal depression and infant PE was appropriate in the present study. As expected, results indicated that maternal ratings on the BDI-II and PSI Depression subscale were significantly correlated at the 6-month ($r = 0.41, p < .001$), 8-month ($r = 0.48, p < .001$), and 10-month ($r = 0.49, p < .001$) time points. As such, results supported the use of a latent maternal depression variable with two indicators (i.e., ratings on the BDI-II and PSI Depression subscale) at each time point in the structural equation model.

Analyses demonstrated that the three indicators of infant PE (i.e., maternal ratings of infant PE on the IBQ-R, laboratory members’ ratings of infant degree of happiness during laboratory visits, and coding of infant PE observed during the Modified Peek-a-Boo task) were not significantly correlated with each other at the 6-month, 8-month, or 10-month time points. First, correlations between maternal ratings of infant PE on the IBQ-R and infant PE observed during the Modified Peek-a-Boo task at the 6-month ($r = 0.16, p > .05$), 8-month ($r = 0.02, p > .05$), and 10-month ($r = 0.09, p > .05$) laboratory visits were in the expected direction, but were non-significant. Associations between maternal ratings of infant PE on the IBQ-R and laboratory members’ ratings of infant degree of happiness throughout a laboratory visit at the 6-month
Table 5

Descriptive Statistics of Study Variables

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<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Maternal Age</td>
<td>27.60</td>
<td>6.27</td>
<td>17.00 – 42.00</td>
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<tr>
<td>Maternal Years of Education</td>
<td>14.71</td>
<td>2.72</td>
<td>9.00 – 20.00</td>
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<tr>
<td>Cumulative Risk Index</td>
<td>0.83</td>
<td>0.88</td>
<td>0.00 – 3.00</td>
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<td>ATQ Maternal PA</td>
<td>5.10</td>
<td>0.86</td>
<td>1.80 – 6.80</td>
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<tr>
<td>BDI 6 Months</td>
<td>6.19</td>
<td>5.61</td>
<td>0.00 – 36.00</td>
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<td>BDI 8 Months</td>
<td>4.87</td>
<td>4.80</td>
<td>0.00 – 38.00</td>
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<td>BDI 10 Months</td>
<td>4.79</td>
<td>5.05</td>
<td>0.00 – 32.00</td>
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<td>PSI Depression 6 Months</td>
<td>1.88</td>
<td>0.59</td>
<td>1.00 – 4.44</td>
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<tr>
<td>PSI Depression 8 Months</td>
<td>1.86</td>
<td>0.60</td>
<td>1.00 – 3.89</td>
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<tr>
<td>PSI Depression 10 Months</td>
<td>1.78</td>
<td>0.63</td>
<td>1.00 – 3.89</td>
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<tr>
<td>IBQ-R PE 6 Months</td>
<td>29.82</td>
<td>3.68</td>
<td>19.96 – 37.00</td>
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<td>IBQ-R PE 8 Months</td>
<td>31.46</td>
<td>3.77</td>
<td>21.34 – 39.43</td>
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<td>IBQ-R PE 10 Months</td>
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<td>22.42 – 39.77</td>
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<td>PAB Smiling 6 Months</td>
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<td>PAB Smiling 8 Months</td>
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<td>PAB Vocalization 8 Months</td>
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<td>PAB Motor 10 Months</td>
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<td>Post-Visit Degree of Happiness 6 Months</td>
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<td>1.13</td>
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<td>Post-Visit Degree of Happiness 10 Months</td>
<td>5.07</td>
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### Table 6

Correlations between Study Variables

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<td>.80***</td>
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<td>.56***</td>
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<td>-.14</td>
<td>.04</td>
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<td>.25*</td>
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<td>16. IBRS 10 Mos.</td>
<td>-.16</td>
<td>.12</td>
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<td>-.10</td>
<td>.07</td>
<td>.24*</td>
<td>.41***</td>
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*Note.* CRI = Cumulative Risk Index, Mat. = Maternal, PA = Positive Affectivity, SCID MDE = Structured Clinical Interview for DSM-IV-TR Axis I Disorders, History or Current Experience of a Major Depressive Episode, Dep. = Depression, Mos. = Months, IBQ-R = Infant Behavior Questionnaire-Revised, PAB = Peek-a-Boo, IBRS = Infant Behavior Rating Scale

*p = <.05, **p < .01, ***p < .001
(r = 0.01, p > .05), 8-month (r = -0.04, p > .05), and 10-month (r = 0.10, p > .05) time points were consistently small and not always in the anticipated direction. Finally, correlations between observations of infant PE during the Modified Peek-a-Boo task and laboratory members’ ratings of infant degree of happiness at the 6-month (r = 0.12, p > .05), 8-month (r = 0.07, p > .05), and 10-month (r = -0.10, p > .05) time points were non-significant and not always in the anticipated direction. Given that these associations were non-significant, the use of a latent infant PE variable with three indicators at each time point, as was proposed for SEM analyses, was not appropriate for the present study. Because it was inappropriate to proceed with infant PE specified as a latent variable, it was decided that latent variables would not be utilized in the present study and that three separate path models would be tested. The first model examined associations between maternal depression and maternal ratings of infant PE on the IBQ-R over time, while the second model examined associations between maternal depression and observations of infant PE during the Modified Peek-a-Boo task at each time point. The third model examined the associations between maternal depression and laboratory members’ ratings of infant degree of happiness throughout each laboratory visit across the first year postpartum. Given that maternal ratings on the BDI-II and Depression subscale of the PSI were strongly correlated within each time point, it was determined that the maternal depression variable in each of the three newly specified path models would reflect maternal ratings on both questionnaires (i.e., values were standardized and averaged to create a composite variable). The revised structural models, depicting the anticipated associations between variables in the present study, are presented in Figures 5, 6, and 7.
Figure 5. A path diagram depicting the longitudinal relations between maternal depression and maternal report of infant positive emotionality in the first year postpartum.

Note. Paths between covariates and primary study variables are not depicted for clarity.
Figure 6. A path diagram depicting the longitudinal relations between maternal depression and infant positive emotionality observed during the peek-a-boo task in the first year postpartum.

Note. Paths between covariates and primary study variables are not depicted for clarity.
Figure 7. A path diagram depicting the longitudinal relations between maternal depression and infant degree of happiness observed throughout laboratory visits in the first year postpartum.

Note. Paths between covariates and primary study variables are not depicted for clarity.
Because the models were altered to include only observed variables (i.e., the models do not include latent variables), measurement models were not specified and all paths were estimated.

Examination of correlations demonstrated several notable associations between covariates and primary study variables. For example, maternal experience of a MDE, prior to or at the time infants were 4 months of age, was found to be negatively associated with maternal report of infant PE on the IBQ-R when infants were 8 months old \( (r = -0.19, p < .05) \) and positively associated with infant PE as observed during the Peek-a-Boo task when infants were 6 months \( (r = 0.24, p < .05) \) and 8 months \( (r = 0.28, p < .01) \) of age. Significant associations were also found between primary study variables. For example, maternal report of depressive symptoms when infants were 6 months of age was significantly negatively associated with maternal report of infant PE on the IBQ-R when infants were 6 months \( (r = -0.25, p < .01) \), 8 months \( (r = -0.21, p < .05) \), and 10 months old \( (r = -0.22, p < .05) \) and maternal report of depressive symptoms when infants were 8 months old was significantly negatively associated with maternal ratings on the IBQ-R at that same time point \( (r = -0.21, p < .05) \). Surprisingly, maternal report of depressive symptoms when infants were 8 months old was concurrently, positively associated with infant PE as observed during the Peek-a-Boo task \( (r = 0.22, p < .05) \).

**Primary Analyses**

**Infant Behavior Questionnaire–Revised model.** The first model that was tested examined the longitudinal relations between maternal depression, measured through the use of the BDI-II and the PSI Depression subscale, and maternal report of infant PE on the IBQ-R in the first year
of life. The hypothesized model is presented in Figure 5. Initial results can be seen in Figure 8. Results of SEM analysis indicated several significant pathways between covariates and primary study variables. That is, maternal positive affectivity, assessed when infants were 4 months of age, was significantly negatively related to maternal depression two months later ($b^* = -0.27, z = -2.96, p < .01$) while cumulative risk, assessed when infants were 4 months old, was significantly negatively related to maternal depression when infants were 6 months old ($b^* = -0.27, z = -3.24, p < .01$) and significantly positively related to infant PE when infants reached 8 ($b^* = 0.16, z = 2.02, p < .05$) and 10 months ($b^* = 0.18, z = 2.23, p < .05$) of age. Maternal experience of a MDE, at the time infants were 4 months old or at any time prior, was significantly positively associated with the severity of maternal depressive symptoms when infants were 6 ($b^* = 0.74, z = 4.40, p < .001$) and 10 months old ($b^* = 0.27, z = 2.10, p < .05$) and significantly negatively associated with infant PE when infants were 8 months old ($b^* = -0.38, z = -2.19, p < .05$). Surprisingly, all pathways between infant sex and primary study variables were non-significant.

In addition to significant relations between covariates and primary study variables, significant autoregressive effects were observed. Severity of maternal depressive symptoms at the 6-month time point was significantly positively associated with the severity of maternal depressive symptoms at the 8-month ($b^* = 0.92, z = 15.20, p < .001$) and 10-month ($b^* = 0.33, z = 2.54, p < .05$) time points. Maternal depression when infants were 8 months old was also significantly positively associated with maternal depression when infants reached 10 months of age ($b^* = 0.54, z = 5.23, p < .001$). It is noteworthy that the autoregressive effect for the maternal depression variable was largest between the 6-month and 8-month time points, smaller between
Figure 8. Initial results of a model which depicts the longitudinal relations between maternal depression and maternal report of infant positive emotionality in the first year postpartum.

Note. Non-significant paths between covariates and primary study variables are not depicted for clarity.
the 8- and 10-month time points, and smallest between the 6-month and 10-month time points. This suggests both consistency and change with regard to participants’ level of depression across the first year postpartum.

Significant autoregressive effects were also observed for the infant PE variable. Infant PE, rated by mothers when their infants were 6 months of age, was significantly positively related to ratings of infant PE measured two months later \( (b^* = 0.60, z = 7.33, p < .001) \) and maternal report of infant PE when infants were 8 months of age was significantly positively related to maternal report of infant PE when infants were 10 months old \( (b^* = 0.62, z = 7.69, p < .001) \). Notably, the pathway between maternal ratings of infant PE at the 6- and 10-month time points was non-significant. Collectively, these findings indicate high rank-order stability of infant PE, as rated by mothers, across a six-month period in infancy.

Surprisingly, cross-lagged effects were not observed in the model that examined associations between maternal depressive symptoms and maternal report of infant PE in the first year of life. Severity of maternal depressive symptoms when infants were 6 months old was not associated with infant PE when infants were 8 \( (b^* = 0.07, z = 0.68, p > .05) \) or 10 months \( (b^* = -0.10, z = -0.62, p > .05) \) of age. Maternal depressive symptoms when infants were 8 months old was also not associated with infant PE at the 10-month time point \( (b^* = 0.15, z = 1.11, p > .05) \). Infant PE when infants were 6 months old was not significantly related to severity of maternal depressive symptoms when infants reached 8 \( (b^* = 0.04, z = 0.69, p > .05) \) and 10 months \( (b^* = 0.00, z = 0.00, p > .05) \) of age. Infant PE at the 8-month time point was also not related to maternal depression when infants were 10 months old \( (b^* = 0.04, z = 0.54, p > .05) \). Likely due
to small and non-significant cross-lagged effects, the fit of the hypothesized model to the data was poor (see Figure 8, $\chi^2 (6) = 39.34, p < .001$, RMSEA = 0.20, SRMR = 0.11, CFI = 0.93 NNFI = 0.44). In order to improve model fit, non-significant pathways were deleted and the model was re-run.

The final IBQ-R model is presented in Figure 9. Path estimates changed slightly as compared to results of the initial model; three pathways also became non-significant. That is, in the final model, maternal experience of a MDE was not significantly related to the severity of maternal depressive symptoms when infants were 10 months old. Cumulative risk was also no longer significantly associated with maternal report of infant PE on the IBQ-R at the 8- and 10-month time points. The fit of the revised model to the data was adequate ($\chi^2 (24) = 66.80, p < .001$, RMSEA = 0.09, SRMR = 0.11, CFI = 0.94, NNFI = 0.91). The $\chi^2$ difference test was used to compare the fit of the initial and revised models. The $\chi^2$ difference value approached a level of significance ($\chi^2 (18) = 27.47, p < 0.10$). This trend, along with improvements in RMSEA and NNFI values, indicated a notable improvement in model fit with the deletion of non-significant paths.

**Peek-a-boo model.** The second structural equation model that was tested examined the longitudinal relations between maternal depressive symptoms, assessed through the use of two self-report measures, and infant PE as observed during the Modified Peek-a-Boo task at the 6-, 8-, and 10-month laboratory visits. The hypothesized model is presented in Figure 6. Initial results are presented in Figure 10. Results of SEM analysis indicated several significant pathways between control variables and variables of primary interest. That is, maternal positive affectivity, assessed when infants were 4 months old, was significantly negatively related to
Figure 9. The final model which depicts the longitudinal relations between maternal depression and maternal report of infant positive emotionality in the first year postpartum.

Note. Non-significant paths are not depicted.

$\chi^2(24) = 66.80, p < .001$, RMSEA = 0.09, SRMR = 0.11, CFI = 0.94, NNFI = 0.91

$\chi^2$ difference (18) = 27.47, $p > .10$
Figure 10. An initial model which depicts the longitudinal relations between maternal depression and infant positive emotionality observed during the peek-a-boo task in the first year postpartum.

Note. Non-significant paths are not depicted.
severity of maternal depressive symptoms when infants were 6 months of age ($b^* = -0.26, z = -2.91, p < .01$) and significantly positively related to infant PE during the Peek-a-Boo task when infants were 10 months old ($b^* = 0.29, z = 2.98, p < .01$). Cumulative risk was significantly negatively associated with maternal depression at the 6-month time point ($b^* = -0.28, z = -3.24, p < .01$). Maternal experience of a MDE, at the time infants were 4 months old or at any time prior, was significantly related to the severity of maternal depressive symptoms when infants were 6 ($b^* = 0.74, z = 4.40, p < .001$), 8 ($b^* = -0.28, z = -1.96, p < .05$), and 10 months of age ($b^* = 0.29, z = 1.96, p < .05$) and was significantly positively related to infant PE, as observed during the Modified Peek-a-Boo task, when infants were 6 ($b^* = 0.60, z = 2.69, p < .01$) and 8 months old ($b^* = 0.52, z = 2.05, p < .05$).

Significant autoregressive effects were also observed in the Peek-a-Boo model. Severity of maternal depressive symptoms when infants were 6 months old was significantly positively related to severity of maternal depressive symptoms when infants reached 8 ($b^* = 0.92, z = 17.32, p < .001$) and 10 ($b^* = 0.32, z = 2.37, p < .05$) months of age. Maternal depression at the 8-month time point was also significantly positively related to maternal depression at the 10-month time point ($b^* = 0.54, z = 5.14, p < .001$). It is noteworthy that the autoregressive effect for the maternal depression variable was largest between the 6- and 8-month time points, smaller between the 8- and 10-month time points, and smallest between the 6-month and 10-month time points. This suggests both consistency and change with regard to participants’ level of depression across the first year postpartum.

A significant autoregressive effect was also observed for the infant PE variable in the Peek-a-Boo model. Infant PE observed during the Modified Peek-a-Boo task when infants were
8 months of age was significantly positively associated with infant PE observed during the task 2 months later \((b^* = 0.55, z = 6.48, p < .001)\). Notably, infant PE measured at the 6-month time point was not significantly related to infant PE measured at the 8- \((b^* = 0.16, z = 1.76, p > .05)\) or 10- \((b^* = 0.14, z = 1.60, p > .05)\) month time points in this model, which suggests substantial re-shuffling of participants with regard to their level of PE exhibited in response to social stimulation between the time they were 6 and 8 months of age and between the time they were 6 and 10 months of age. The significant autoregressive effect between infant PE observed when infants were 8 and 10 months of age suggests less change during this time period than across other time points in infancy.

Cross-lagged effects were not observed in the model that examined associations between maternal depressive symptoms and infant PE observed during the Peek-a-Boo task in the first year postpartum. Severity of maternal depressive symptoms when infants were 6 months old was not significantly related to infant PE when infants were 8 \((b^* = 0.03, z = 0.22, p > .05)\) or 10 months \((b^* = 0.12, z = 0.59, p > .05)\) of age. Maternal depressive symptoms at the 8-month time point was also not significantly related to infant PE at the 10-month time point \((b^* = 0.07, z = 0.36, p > .05)\). Infant PE when infants were 6 months old was not significantly associated with the severity of maternal depressive symptoms when infants reached 8 \((b^* = 0.07, z = 1.62, p > .05)\) and 10 months \((b^* = -0.03, z = -0.53, p > .05)\) of age. Infant PE at the 8-month time point was also not significantly associated with maternal depression at the 10-month time point \((b^* = -0.01, z = -0.25, p > .05)\). Likely due to small and non-significant cross-lagged effects, the fit of the hypothesized model to the data was poor (see Figure 10, \(\chi^2 (6) = 39.75, p < .001\), RMSEA =
In an attempt to improve model fit, non-significant pathways were deleted and the model was re-run.

The final Peek-a-Boo model is presented in Figure 11. Path estimates changed slightly as compared to results of the initial model and two pathways became non-significant. That is, in the final model, maternal experience of a MDE was not significantly related to the severity of maternal depressive symptoms when infants were 8 or 10 months old. The fit of the revised model to the data was adequate ($\chi^2 (23) = 60.53, p < .001$, RMSEA = 0.09, SRMR = 0.13, CFI = 0.93, NNFI = 0.89). Although the $\chi^2$ difference test was non-significant ($\chi^2 (17) = 20.78, p > 0.25$), substantial improvement was noted in the RMSEA and NNFI values. This suggests the fit of the revised model to the data was an improvement over the initial model and supports the deletion of non-significant pathways.

**Infant Behavior Rating Scale model.** The final model tested the longitudinal relations between the self-reported severity of maternal depressive symptoms and laboratory members’ ratings of infant PE on the IBRS following each visit. The hypothesized model is presented in Figure 7. Initial results are presented in Figure 12. Results of SEM analysis indicated several significant associations between control variables and variables of primary interest. That is, maternal positive affectivity, assessed when infants were 4 months old, was significantly negatively associated with severity of maternal depressive symptoms when infants were 6 months old ($b^* = -0.27, z = -2.98, p < .01$), while cumulative risk was significantly negatively associated with maternal depression at the 6-month time point ($b^* = -0.27, z = -3.23$,
Figure 11. The final model which depicts the longitudinal relations between maternal depression and infant positive emotionality observed during the peek-a-boo task in the first year postpartum.

Note. Non-significant paths are not depicted.
Figure 12. Initial results of a model which depicts the longitudinal relations between maternal depression and infant degree of happiness observed throughout laboratory visits in the first year postpartum.

Note. Non-significant paths between covariates and primary study variables are not depicted for clarity.
Maternal experience of a MDE was significantly positively related to severity of maternal depressive symptoms when infants were 6 months of age ($b^* = 0.73, z = 4.35, p < .01$).

In addition to significant relations between covariates and primary study variables, significant autoregressive effects were observed. Severity of maternal depressive symptoms at the 6-month time point was significantly positively related to severity of maternal depressive symptoms at the 8-month ($b^* = 0.91, z = 17.42, p < .001$) and 10-month ($b^* = 0.38, z = 2.98, p < .05$) time points. Maternal depression when infants were 8 months old was also significantly positively related to maternal depression when infants reached 10 months of age ($b^* = 0.50, z = 4.84, p < .001$). It is noteworthy that the autoregressive effect for the maternal depression variable was largest between the 6- and 8-month time points, smaller between the 8- and 10-month time points, and smallest between the 6- month and 10-month time points. This suggests both consistency and change with regard to participants’ level of depression across the first year postpartum.

Significant autoregressive effects were also observed for the infant PE variable. Ratings of infant PE on the IBRS when infants were 6 months of age was significantly associated with infant PE when infants were 8 months ($b^* = 0.19, z = 2.00, p < .05$) and 10 months old ($b^* = 0.20, z = 2.42, p < .05$). Infant PE at the 8-month time point was also associated with ratings on the IBRS at the 10-month time point ($b^* = 0.37, z = 3.58, p < .001$). The size of the path estimate between the 6- and 8-month time points, as well as between the 6-month and 10-month time points, which was small, suggests both consistency and change in observed infant PE throughout the first year of life. These estimates, in conjunction with the strong association between
observed infant PE at the 8- and 10-month laboratory visits, further suggests that there is less change in observed infant PE between the time infants were 8 and 10 months of age than across other time points in infancy.

Cross-lagged effects were not observed in the model that examined associations between maternal depressive symptoms and ratings of infant PE on the IBRS in the first year of life. Severity of maternal depressive symptoms when infants were 6 months old was not significantly related to infant PE when infants were 8 ($b^* = 0.13, z = 1.02, p > .05$) or 10 months ($b^* = 0.03, z = 0.13, p > .05$) of age. Maternal depressive symptoms when infants were 8 months of age were also not significantly related to infant PE when infants were 10 months old ($b^* = -0.02, z = -0.08, p > .05$). Infant PE when infants were 6 months old was not significantly associated with severity of maternal depressive symptoms when infants reached 8 ($b^* = 0.02, z = 0.37, p > .05$) and 10 months ($b^* = 0.08, z = 1.67, p > .05$) of age. Infant PE at the 8-month time point was also not significantly associated with maternal depression at the 10-month time point ($b^* = -0.03, z = -0.60, p > .05$). Likely due to small and non-significant cross-lagged effects, the fit of the hypothesized model to the data was poor (see Figure 12, $\chi^2(6) = 39.51, p < .001$, RMSEA = 0.20, SRMR = 0.10, CFI = 0.89, NNFI = 0.18). In order to improve model fit, non-significant pathways were deleted and the model was re-run.

The final IBRS model is presented in Figure 13. Path estimates changed slightly as compared to results of the initial model; one pathway became non-significant. That is, in the final model, infant PE when infants were 6 months old was not significantly related to ratings of infant PE on the IBRS two months later. The fit of the revised model to the data was adequate ($\chi^2(25) = 61.03, p < .001$, RMSEA = 0.09, SRMR = 0.12, CFI = 0.92, NNFI = 0.89). The $\chi^2$
Figure 13. The final model which depicts the longitudinal relations between maternal depression and infant degree of happiness observed throughout laboratory visits in the first year postpartum.

Note. Non-significant paths are not depicted.
difference test was used to compare the fit of the data to the initial and revised models and was non-significant ($\chi^2(19) = 21.51, p > 0.25$). However, substantial improvements were noted in the RMSEA and NNFI values, which suggest the revised model is a better fit to the data and supports the deletion of non-significant paths.
CHAPTER 4
DISCUSSION

The present study examined the longitudinal relationship between maternal depressive symptoms and infant temperament in the first year postpartum while addressing several limitations of prior work. Given that prior research has largely focused on associations between “difficult” infant temperament and maternal depressive symptoms or between specific indicators of infant NE and maternal depression, despite research highlighting the importance of infant PE for subsequent child outcomes (e.g., Gartstein & Bateman, 2008; Jacques & Mash, 2004; Lonigan et al., 2003), the present study examined the longitudinal relationship between maternal depressive symptoms and infant PE. The majority of prior studies examining the relationship between maternal depression and infant temperament have relied on maternal report of both constructs while the present study assessed maternal depression and infant PE through the use of multiple methods (i.e., maternal report, laboratory member report, observation). The present project also overcame some limitations of prior research by utilizing structural equation modeling (SEM), a sophisticated and comprehensive approach to testing hypotheses about relations among observed and latent variables, to hypothesize fully cross-lagged panel models which included three time points. The use of SEM and fully cross-lagged panel models allowed for examination of: (1) whether concurrent and/or longitudinal relationships existed between maternal depression and infant PE, (2) the direction of the association between the two variables over time, (3) the timing, pattern, and strength of the relations between maternal depression and
infant PE in the first year postpartum, and (4) the relations between these variables late in infancy while controlling for levels of maternal depressive symptoms and infant PE early in life.

The present study formulated one key hypothesis. That is, it was believed that a reciprocal relationship between severity of maternal depressive symptoms and infant PE would be identified in the first year postpartum. In other words, it was anticipated that higher infant PE early in life would be associated with lower severity of maternal depressive symptoms later in infancy and that higher severity of maternal depressive symptoms early in life would be associated with lower infant PE later in infancy. This hypothesis was formulated based on: (1) prior studies which have suggested that maternal depressive symptoms influence infant temperament and vice versa (Bridgett et al., 2009; Cutrona & Troutman, 1986; Hopkins et al., 1987; Mayberry & Affonso, 1993; Murray et al., 1996; Sugawara et al., 1999), (2) a prior study that provided evidence of reciprocal associations between maternal depression and specific infant temperament characteristics (Sugawara et al., 1999), and (3) theoretical and empirical work concerning depression (Watson, Clark, & Carey, 1988; Watson, Clark, & Tellegen, 1988) and the mechanisms by which parental characteristics and behavior may be transmitted to children (Bandura, 1977; Dix & Meunier, 2009; Doornbos et al., 2009; Hatzimanolis et al., 2013; Sheese et al., 2009).

Despite strong theoretical and empirical support for the present study’s main hypothesis, a reciprocal relationship between maternal depressive symptoms and infant PE in the first year postpartum was not identified. There are a number of possible reasons why the anticipated relations were not supported in the current investigation, which will be discussed below. Attention will also be paid to methodological considerations of the study’s analyses, significant
associations between covariates and primary study variables, and autoregressive effects. Limitations and implications of the present study’s findings for future research will also be discussed.

Methodological Considerations of Analyses

Prior to conducting the study’s primary analyses, data obtained from coding of the Modified Peek-a-Boo task (i.e., intensity of smile and presence versus absence of positive vocalizations, laughter, and movement across the six Peek-a-Boo trials) was combined into a single variable for each time point (i.e., the 6, 8, and 10 month laboratory visits). When creating the Peek-a-Boo composite variable at each visit, it was noted that the laughter variable did not correlate with the other Peek-a-Boo variables in the anticipated manner. That is, across all three time points, non-significant associations were observed between the laughter variable and other Peek-a-Boo variables. Specifically, when infants were 6 months old, the laughter variable was not significantly correlated with intensity of smile, positive vocalizations, or positive movement. At the eight and ten month time points, the laughter variable was not significantly correlated with the positive vocalizations variable.

The non-significant correlations between the laughter variable and other Peek-a-Boo variables (i.e., positive vocalizations, positive movement, intensity of smile) at the 6 month time point may be explained by the low base rate of laughter. That is, only six infants (5.20% of the sample) laughed in response to the Peek-a-Boo game when they were 6 months old. There were more instances of laughter at the eight (13.50% of the sample) and ten month (23%) time points, which may explain, in part, the significant associations between laughter and other Peek-a-Boo variables (i.e., intensity of smile, positive movement) at those times.
The non-significant associations between the laughter and positive vocalization variables at the 8 and 10 month time points may be related to the fact that there were very few instances in which an infant both laughed and made a positive vocalization during the Peek-a-Boo game (i.e., 3 infants at 8 months and 6 infants at 10 months). Certainly there were many instances in which other variables co-occurred, such as when infants both smiled and engaged in positive movement or smiled and made a positive vocalization. It was more unusual for infants to both laugh and make a positive vocalization within a given trial of the Peek-a-Boo game because each trial was only a few seconds long and the two sounds would have needed to be clearly distinct (e.g., separated in time) from one another to both be coded.

In addition to non-significant correlations between some Peek-a-Boo task variables, it was noted that the three variables that were to be used as indicators of an infant PE latent construct in the present study (i.e., maternal report of infant PE on the IBQ-R, observations of infants during the Modified Peek-a-Boo task, and laboratory members’ ratings of infant degree of happiness throughout laboratory visits) were not significantly correlated with each other at the 6-month, 8-month, or 10-month time points. Although correlations between maternal ratings of infant PE on the IBQ-R and infant PE observed during the Modified Peek-a-Boo task were in the expected direction, they were non-significant. Associations between maternal ratings of infant PE on the IBQ-R and laboratory members’ ratings of infant degree of happiness as well as between observations of infant PE during the Modified Peek-a-Boo task and laboratory members’ ratings of infant degree of happiness were non-significant and not always in the anticipated direction.
It may be that the three infant PE variables were not significantly correlated within time because they each assess a distinct aspect of infant PE. First, items comprising the infant PE factor of the IBQ-R reflect maternal perceptions of how often an infant exhibited PE (as indicated by smiling/laughter, activity level, etc.) in everyday situations at home (e.g., feeding, sleeping, bathing/dressing, and playing) within the past week or past two weeks, depending on the question. The Modified Peek-a-Boo game assessed infant pleasure in response to social stimulation across a period of one to two minutes in the laboratory, with individual trials of the task lasting only a few seconds. Laboratory members’ ratings on the IBRS indicated infant degree of happiness throughout a laboratory visit that lasted approximately 1.50 to 2 hours. It is important to note that infant degree of happiness was rated based on observations of infants participating in a variety of tasks, some of which were effective in eliciting fear and frustration. The experience of these emotions and the lengthy time period that infants were expected to participate in laboratory tasks likely impacted the degree of happiness ratings made by laboratory members. Therefore, after examining these measures more closely, it is perhaps not surprising that variables created from the tasks were not significantly correlated as each differed from the others with regard to the context in which PE was assessed and the time period of the observation.

Examining Structural Equation Modeling Pathways Involving Covariates

Although the primary purpose of the present study was to examine the relationship between maternal depression and infant PE across the first year of life, structural equation models identified some noteworthy relationships between covariates and primary study variables that warrant mention. First, it was noted that maternal PA, assessed when infants were four
months old, was significantly negatively related to the severity of maternal depressive symptoms two months later. In other words, greater maternal PA when infants were 4 months of age was significantly associated with lower severity of depressive symptoms when infants were 6 months of age. Although pathways between maternal PA and depressive symptoms measured later in infancy (i.e., at 8 and 10 months postpartum) were non-significant, correlations between these variables were in the anticipated direction and approached the level of significance. These findings are consistent with prior theoretical and empirical work concerning positive affect and depression. The tripartite model of depression (Watson, Clark, & Carey, 1988; Watson, Clark, & Tellegen, 1988), for example, formulates that depression is partially characterized by low levels of positive affect. Relatedly, interventions implemented to reduce depressive symptoms often incorporate a component aimed at increasing PA (e.g., Gortner, Gollan, Dobson, & Jacobsen, 1998; Jacobsen et al., 1996; Lejuez, Hopko, & Hopko, 2001; Martell, Addis, & Jacobsen, 2001). Prior empirical work has also demonstrated that positive affect may serve as a buffer against the experience of depression among the general population (Wichers et al., 2007) and among women in the early postpartum period (Bos et al., 2013; Carver & Gaines, 1987). Therefore, prior work, in conjunction with present study findings, suggests that assessing PA among mothers throughout pregnancy and the early postpartum period may be an additional means by which professionals can identify those in need of early intervention for depression.

In addition to being significantly related to lower severity of depressive symptoms, higher maternal PA when infants were four months old was significantly related to higher infant PE exhibited during the Modified Peek-a-Boo game when infants were 10 months old. This finding is consistent with prior theoretical and empirical work, which suggests that temperament
characteristics are influenced by both biological and environmental factors that interact throughout development (Bridget et al., 2013; Rothbart & Derryberry, 1981; Saudino & Wang, 2012; Shiner et al., 2012). Genetic research has suggested that PE is a moderately heritable characteristic (Carr, 2011) with heritability estimates ranging from 0.20 and 0.60. Research has also linked infant positive emotionality with the COMT gene (Sheese et al., 2009), suggesting that transmission of this gene may have the potential to influence infant PE development.

It is also likely that maternal PA influences the development of infant PE through an early observational learning mechanism (Bandura, 1977). That is, infants of mothers high in PA may develop a greater tendency to display positive emotions as a result of observing similar behavior of their mothers. In support of this theory, prior research has shown that infants, especially toward the end of the first year of life, are capable of learning through observation (Collie & Hayne, 1999; Esseily et al., 2010; Gergely, 2003; Meltzoff, 1988). Also, research involving older children (i.e., 15- to 20-month-olds) has shown that modeling constitutes a mechanism by which emotions (e.g., fear, avoidance) may be acquired early in life (e.g., Gerull & Rapee, 2002).

It is notable that maternal PA was not significantly associated with any indicator of infant PE when infants were six or eight months of age. This may be related to the fact that infant positive emotionality develops significantly across the first year of life (Field et al., 1987; Lin & Green, 2009; Rothbart, 1988; 2007). In other words, it may be that the influence of maternal PA on infant PE may not be identified until infants develop the capacity to express positive emotions through facial expressions, vocalizations, laughter, and movement. At such a time, relations
between maternal and infant positive emotionality would be more easily assessed through both self-report and observational measures.

It is also interesting that maternal PA, measured when infants were 4 months old, was not significantly related to infant PE as reported on the IBQ-R or as rated by laboratory members when infants reached 10 months of age. It is possible that these relations were non-significant given subtle differences between assessments. That is, the Modified Peek-a-Boo task elicits PE from infants through the use of a game-like activity and social stimulation whereas ratings of infant PE on the IBQ-R and IBRS are based on observations of infant PE in daily activities at home (e.g., bathing, dressing, eating) or throughout tasks completed in the laboratory. At home and in the laboratory, attempts to elicit infant PE may not be made. It is possible that a relationship between maternal PA and infant PE may only be identified when attempts to elicit PE (i.e., smiling, vocalizations, laughter, activity) are made.

Also, while examining relations between covariates and primary study variables, it was noted that maternal experience of a MDE, either at the time infants were four months of age or at some time prior, was significantly positively related to the severity of maternal depressive symptoms when infants were six months of age. In other words, a history of maternal depression was significantly associated with increased severity of maternal depressive symptoms early in the first year postpartum. This finding is consistent with prior research which has demonstrated that depression is a recurring condition (e.g., Mueller et al., 1999; Solomon et al., 2000) and that women with a history of depression are at increased risk for experiencing depressive symptoms during the postpartum period (Beck, 2001; Chojenta, Loxton, & Lucke, 2012; Davey, Tough, Adair, & Benzie, 2011; Micali, Simonoff, & Treasure, 2011; Robertson, Grace, Wallington, &
Stewart, 2004). The fact that the severity of depressive symptoms tends to decrease throughout the first year postpartum (Blissett & Farrow, 2007; DiPietro et al., 2008; Wu et al., 2011) may account for the non-significant pathways between history of a MDE and severity of maternal depressive symptoms at eight and ten months postpartum in the present study. Collectively, prior research and current study findings stress the importance of closely monitoring mothers with a history of depression for recurrence of symptoms in the early postpartum period.

Maternal history of clinical depression was also found to be significantly related to infant PE. That is, maternal experience of a MDE, either when infants were four months old or at some time prior, was significantly negatively related to maternal ratings of infant PE on the IBQ-R when infants were eight months of age. In other words, mothers with a history of depression tended to rate their 8 month-old infants as less positive than mothers who had never experienced a MDE. The association between a history of maternal depression and maternal ratings of infant PE on the IBQ-R at the 6-month time point was in the anticipated direction, but was non-significant. These findings are relevant given that prior work has identified only concurrent associations between maternal depression and infant PE (e.g., Forbes et al., 2004; Hart et al., 1999). One study did examine the longitudinal relationship between maternal depression and specific indicators of infant PE (i.e., activity level and approach), but found non-significant relations (Galler et al., 2004). Therefore, this study appears to be the first to identify a longitudinal relationship between maternal depression and infant PE. Although the specific mechanism by which this association occurs cannot be determined presently, prior research points to several possibilities including maternal bias, biological/genetic mechanisms, observational learning, or mediation through parent-infant interactions (Durbin & Wilson, 2012;
Esseily et al., 2010; Sheese et al., 2009). Future research should aim to replicate current study findings and work towards identifying the mechanism by which the relationship between maternal history of depression and infant PE occurs.

It is notable that this finding links maternal depression with broadly-conceptualized PE, which takes into account infant activity level, approach, smiling and laughter, vocal reactivity, high intensity pleasure, and perceptual sensitivity as prior work involving infant PE has used only specific indicators of the construct including activity level and approach (Galler et al., 2004). It is also noteworthy that maternal history of a MDE was related to PE when infants were 8 months of age, but not when they were 10 months old. This finding suggests that a critical period may exist during which time a history of maternal depression has a greater impact on ratings of infant positive emotions than during other time periods.

Maternal experience of a MDE was also related to observations of infant PE in the laboratory. Surprisingly, maternal experience of a MDE was significantly positively associated with infant PE, as observed during the Modified Peek-a-Boo task, when infants were six and eight months of age. In other words, infants of mothers who had experienced depression at some time in their life exhibited greater positive emotionality during Peek-a-Boo games with their mothers when they were 6 and 8 months old than infants of mothers who did not have a history of clinical depression. Although contrary to expectations, this finding may be explained by more closely examining research involving the Peek-a-Boo game.

Peek-a-Boo is a well-known game that allows parents an opportunity to present exaggerated, prototypical expressions of positive emotion (Fernald & O'Neill, 1993; Montague & Walker-Andrews, 2001). Because the game is so well known, parents likely have
preconceived notions of how they should act during the game (i.e., happy, enthusiastic).
Therefore, regardless of depression history, mothers who participate in Peek-a-Boo games tend to express happiness and excitement through their facial expressions and tone of voice (i.e., large smiles, high-pitched voice). In support of this claim, results of the current study indicated non-significant relationships between severity of maternal depressive symptoms and maternal effectiveness during the Modified Peek-a-Boo game. Specifically, this finding indicates that mothers who were experiencing more severe symptoms of depression at each time point were not less positive than mothers experiencing less severe symptoms of depression during the Modified Peek-a-Boo game.

Given that individuals who experience depression typically exhibit flat affect and low energy (Watson, Clark, & Carey, 1988; Watson, Clark, & Tellegen, 1988) and that mothers with a history of depression are at risk for a recurrence of such symptoms in the postpartum period (Beck, 2001; Chojenta et al., 2012; Davey et al., 2011; Micali et al., 2011; Robertson et al., 2004), it may be the case that infants of mothers with a history of depression observe positive affect less often from their mothers. If this were the case, it would be somewhat novel for infants of mothers with a history of depression to observe them exhibiting exaggerated expressions of happiness and excitement. Novelty, then, may be what accounts for increased expression of infant PE during the Modified Peek-a-Boo game in the current study. In other words, infants of mothers with a history of depression may have acted more positive in response to the Peek-a-Boo game in this study because their mothers expressed significant happiness and excitement, which was somewhat novel and unexpected for them to see. In support of this hypothesis, research has shown that the effectiveness of Peek-a-Boo games is attributed to a violation of
expectations and that violation of expectations often elicits positive emotionality among infants (Charlesworth, 1966; Muir & Haines, 1993; Montague et al., 2001; Parrott & Gleitman, 1989; Rochat, Querido, & Striano, 1999).

It is remarkable that maternal history or current experience of a MDE was not significantly positively associated with infant PE during the Modified Peek-a-Boo game when infants reached 10 months of age. There are several potential explanations for this non-significant relationship. First, it may be that by the time infants of mothers with a history or current experience of depression attended the 10-month laboratory visit, the positive behavior exhibited by their mothers was no longer novel or unexpected as the infants had participated in the Modified Peek-a-Boo game several times before. It could also be that infants of mothers with a history or current experience of depression tend to be more emotionally reactive than infants of mothers who have never experienced depression. Early in life this emotional reactivity may not be differentiated into clear expressions of positive or negative emotionality; rather, early in life, infants of depressed mothers may just be more reactive in general. Around the time infants are 10 months old, this may change and infants of mothers with a history of depression may become less positive and more negative, resulting in a non-significant relationship between maternal history of depression and infant PE at the 10-month time point.

Lastly, the non-significant relationship between maternal history of depression and infant PE observed during the Peek-a-Boo task at 10 months of age may be related to the development of object permanence, which occurs around eight months of age (Piaget, 1963). Research has shown that prior to the development of object permanence, infants find enjoyment in Peek-a-Boo games because they believe their mothers have disappeared (i.e., they are no longer there) and
their sudden reappearance is unexpected and pleasant (Montague et al., 2001; Parrott & Gleitman, 1989). Once object permanence develops, a mother’s return in Peek-a-Boo games is no longer unexpected, but the timing of reappearance is unknown and PE is exhibited due to anticipation of the return (Lacey, 2014; Stafford, 2014). Therefore, in the present study, the non-significant relationship between maternal history of a MDE and infant PE exhibited in the Peek-a-Boo task at 10 months may be related to the fact that at this time, infants expressed PE due to anticipation of their mothers’ return rather than due to novelty and violation of expectations. In other words, novelty may be the driving force of the positive relationship between maternal history of depression and infant PE in response to social stimulation in this study.

Examining Structural Equation Modeling Pathways between Variables of Primary Interest

**Autoregressive effects.** An autoregressive effect within a cross-lagged panel model refers to the effect of a construct on itself measured at a later point in time (Selig & Little, 2012). Autoregressive coefficients which are small or zero indicate substantial reshuffling of participants with regard to a given construct over time, whereas sizeable autoregressive coefficients mean that individuals’ standings on the construct changed very little over time.

Results of the current study demonstrated that all autoregressive effects involving the maternal depression variable were significant. That is, severity of maternal depressive symptoms when infants were six months of age was significantly related to severity of depressive symptoms two and four months later. Also, maternal depressive symptoms measured when infants were eight months old was significantly related to depressive symptoms when infants reached 10 months of age. The consistently significant autoregressive effects involving the
maternal depression variable indicate that those mothers who reported high levels of depression at the start of the study tended to report high levels of depression over the course of the next four months. Similarly, mothers who reported minimal symptoms of depression early on tended to report low levels of depression toward the end of the first postpartum year.

Although significant autoregressive effects involving the maternal depression variable suggest stability of the rank-order of participants with regard to the severity of their depression across the first postpartum year, closer examination of the relative strength of these effects also suggests change over time. That is, the pathway between maternal depressive symptoms at the 6-month and 8-month time points was largest ($b^* = 0.84$) while the pathway between the 8- and 10-month time points was smaller ($b^* = 0.46 – 0.49$, depending on the model) and the pathway between the 6-month and 10-month time points was smallest ($b^* = 0.40 – 0.42$, depending on the model). The relative size of these effects suggests that there may be some re-shuffling of participants with regard to the severity of their depressive symptoms throughout the first year postpartum, which may be attributed to a resolution of symptoms, either spontaneously or following intervention. These findings are in line with research which has demonstrated that the severity of postpartum depressive symptoms tends to decrease throughout the first year postpartum (Blissett & Farrow, 2007; DiPietro et al., 2008; Wu et al., 2011) as well as research indicating that women who have more severe depressive symptoms early on in the postnatal period also tend to have more severe depressive symptoms at the end of the first year postpartum (Blissett & Farrow, 2007).

Evidence of significant autoregressive effects involving the infant PE variable depended on the structural equation model examined. In the model which tested relations between maternal
depressive symptoms and infant PE reported by mothers on the IBQ-R, significant autoregressive effects were observed between the 6-month and 8-month time points and between the 8-month and 10-month time points, but not between the 6-month and 10-month time points. These effects indicate high rank-order stability of infant PE observed by mothers in everyday situations at home (e.g., feeding, sleeping, bathing/dressing, and playing) across a six-month period in infancy.

In the model which examined the longitudinal relations between maternal depressive symptoms and infant PE observed during a laboratory Peek-a-Boo task, a significant autoregressive effect was observed between the 8-month and 10-month time points, indicating rank-order stability of PE in response to social stimulation between 8 and 10 months of age. Autoregressive effects were not demonstrated between the 6-month and 8-month time points or between the 6-month and 10-month time points, which suggests substantial development in infant PE exhibited in response to social stimulation prior to 8 months of age.

In the structural equation model testing hypotheses concerning the relations between maternal depressive symptoms and infant PE rated by laboratory members on the IBRS, significant autoregressive effects were evident between the time infants were 8 and 10 months of age and between the time infants were 6 and 10 months of age, but not between the time they were 6 and 8 months old. These findings suggest that PE observed by others throughout laboratory visits, during which various temperament and emotion regulation tasks were completed, develops rapidly between the time an infant is 6 and 8 months of age and is fairly stable later on in infancy.
These findings are all consistent with prior research and theory, which indicates that various indicators of infant PE, including activity level, smiling and laughter, and vocalizations, gradually emerge throughout infancy (Field et al., 1987; Lin & Green, 2009; Rothbart, 1988; 2007). However, present results also suggest that aspects of PE differentially develop. That is, infant PE expressed during daily activities appears to develop steadily between the time infants are 6 and 10 months of age whereas infant PE exhibited during temperament and emotion regulation activities in the laboratory develops most between 6 and 8 months of age and infant PE in response to social stimulation (i.e., throughout the Peek-a-Boo task) develops most between 6 and 8 months of age. The results of each structural equation model, which indicate differences in how PE develops across the first year postpartum, have important implications for future research involving infant PE. It suggests that researchers need to be thoughtful about the context in which they assess infant PE and which measures are most appropriate for that setting.

Cross-lagged effects. Within cross-lagged panel models, a cross-lagged effect is defined as the effect of one construct on another, which is measured at a later time (Selig & Little, 2012). Significant cross-lagged effects indicate the presence of a longitudinal relationship between two constructs.

Despite significant correlations between indicators of maternal depression and infant PE, cross-lagged effects were not observed in any of the structural equation models tested in the current study. In other words, regardless of the method of measurement, maternal depression and infant PE were not found to influence each other in a reciprocal manner during the first year postpartum. Due to the lack of cross-lagged effects, the present study’s main hypothesis was not supported. This finding is surprising given prior theoretical and empirical work, which has
demonstrated concurrent associations between maternal depression and infant PE (Forbes et al., 2004; Hart et al., 1999) as well as longitudinal relationships between maternal depressive symptoms and the negative emotionality and orienting/regulation components of infant temperament (Bridgett et al., 2009; Cutrona & Troutman, 1986; Hopkins et al., 1987; Mayberry & Affonso, 1993; Murray et al., 1996; Sugawara et al., 1999).

Given that present results suggest a longitudinal relationship between maternal history of clinical depression and infant PE, the non-significant cross-lagged effects observed across structural equation models may be attributed to a lack of variability in mothers’ severity of depressive symptoms. Because mothers were recruited to participate in a larger study examining the development of infant temperament and emotion regulation across the first three years of life, they did not need to exhibit symptoms of depression to be eligible. In fact, the majority of mothers did not experience significant depressive symptoms throughout the first year postpartum. Rather, the average severity of maternal depressive symptoms was low at each time point. On the BDI-II, scores can range from zero to 63. Average severity of maternal depressive symptoms was 6.19 when infants were 6 months old, 4.87 at 8 months, and 4.79 when infants reached 10 months of age. On the PSI, scores can range from 0 to 5. The average score for mothers when their infants were six months old was 1.88. When infants reached 8 and 10 months of age, the average score on the PSI was 1.86 and 1.78, respectively. To determine whether a longitudinal or reciprocal relationship exists between maternal depression and infant PE throughout the first year postpartum, future research should examine such associations among a sample of mothers who experience significant depressive symptoms or are diagnosed with a depressive disorder.
An indirect effect of maternal depression on the development of infant PE may also be possible, accounting for the lack of cross-lagged effects. That is, the impact of maternal depression on infant PE may exist through a third variable, such as quality of parent-infant interactions. Previous research has shown that interactions between depressed mothers and their infants are disrupted (Field, 2010). Specifically, mothers experiencing depressive symptoms tend to be less engaged and to exhibit less emotion during interactions with their infants (Kertz et al.; Lovejoy et al., 2000; Radke-Yarrow et al., 1993). They also have been shown to vocalize, smile, imitate, and play games less than non-depressed mothers (Field et al., 2006). Poor-quality mother-infant interactions, in turn, have been proposed to be one of the mechanisms by which depression exerts long-term negative effects on children. One study demonstrated that negative interactions between mothers and their infants were related to later deficits in cognitive performance and that this relationship was overwhelmingly explained by lowered maternal responsiveness during mother-infant interactions (Milgrom et al., 2004). Given that children of depressed mothers are at risk for a variety of negative outcomes including social, academic, and physical health difficulties, cognitive delays, and internalizing and externalizing behavior problems (Beardslee et al., 1998; Downey & Coyne, 1990; Murray et al., 1993; Whiffen & Gotlib, 1989), potentially as a result of characteristics of their interactions with their mothers, it also seems plausible that maternal depression may influence the development of infant temperament characteristics, including infant PE, by means of low quality mother-infant interactions.

The absence of cross-lagged effects in this study could also be related to the time period examined. The present project explored the relationship between maternal depressive symptoms
and infant PE across a four-month period in infancy (i.e., between the time infants were 6 and 10 months of age). It is possible that maternal depression and infant PE do not influence each other during infancy, but during a later developmental time period such as toddlerhood or early childhood. In support of this hypothesis, of the limited work in this area, studies have demonstrated concurrent associations between low PE, maternal history of a mood disorder (Durbin et al., 2005), and current maternal depression (Hayden et al., 2005) in samples of preschoolers. As such, future research should examine the longitudinal and potentially reciprocal relationship between maternal depression and PE using samples of older children, such as preschoolers.

Lastly, it is possible that a secondary caregiver (e.g., fathers) may buffer the impact of maternal depression on the development of infant PE, accounting for the lack of cross-lagged effects in this study. It is well known that the behavior of one parent is influenced by another. Research has also shown that the negative effects of maternal depression can be buffered by a second caregiver (e.g., Hossain et al., 2006; Mezulis, Hyde, & Clark, 2004). Therefore, studies that gather data concerning secondary caregivers (e.g., amount of time spent with the infant, quality of caregiver-infant interactions, mental health history, severity of depressive symptoms, and temperamental positive affectivity) would be beneficial to this area of study. This information could help determine whether a relationship between maternal depression and infant PE exists, but is masked by the positive impact of a secondary caregiver.

Limitations

The present study has several strengths, including: 1) the examination of associations between maternal depression and infant PE, a relatively under-studied aspect of infant
temperament, 2) the assessment of primary variables using multiple methods and measures, 3) the use of structural equation modeling, a sophisticated and comprehensive approach to testing hypotheses about relations among variables, and 4) the specification of fully cross-lagged panel models, which can be used to determine the timing, pattern, direction, and strength of relations between variables. Although this study has numerous strengths, it also had some limitations that should be noted.

First, the sample used in the present study was relatively low risk, which limits generalizability of the study’s findings to other samples. Of the 135 mothers who participated in the present study, only twelve were teen mothers (8.90%) and fourteen (10.40%) had an educational level below high school graduate. Fourteen mothers were considered single mothers (about 14%) and 32 families (23.70%) were living at or below the poverty level at the time of their participation in the project. The maximum cumulative risk index, which took into account the four criteria just listed, was 3 (out of 4) and the mean was 0.83 ($SD = 0.88$). Given the rather low-risk nature of the present study’s sample, future research should attempt to recruit more diverse families for participation in studies examining the relationship between maternal depression and the development of infant positive emotions.

Also, due to the longitudinal nature of this study, some attrition was expected and occurred. Of the 135 families who participated at the 4-month time point, 115 (85.20% of the original sample) returned for a laboratory visit when infants were 6 months old. Once infants reached 8 months of age, 108 families (80% of the original sample) participated and when infants were 10 months old, 102 families remained (75.60% of the original sample). Despite the loss of some families between visits, analyses revealed that data missing due to participant loss
was missing completely at random, which allowed for the use of full information maximum likelihood estimation prior to data analysis.

Finally, although structural equation modeling is a sophisticated statistical technique that has become increasingly popular over the years, it has some limitations. For example, results of an SEM analysis cannot generally be taken as evidence for causality, as is the case with all statistical techniques used in non-experimental designs. It is also impossible to prove a structural equation model is correct as alternative models that fit the data equally well or better are always possible (Tomarken & Waller, 2005). SEM also relies on large sample sizes and assumes multivariate normality (Kline, 2011). Despite these limitations, however, SEM is uniquely able to specify latent variable models that provide separate estimates of relations among latent constructs and their indicators (the measurement model) as well as of the relations among constructs (the structural model). There are also several measures of global fit that can be utilized to determine the appropriateness of complex models and SEM allows researchers to directly test their hypothesis rather than a null hypothesis (Tomarken & Waller, 2005). Therefore, despite its limitations, SEM is a useful and powerful statistical technique.

Implications

Despite the limitations noted above, several findings in the present study have implications for future research in the areas of maternal depression and infant temperament development. First, although the present study sought out to test a very sophisticated structural equation model which included latent constructs of both maternal depression and infant PE, preliminary analyses indicated that the three indicators of infant PE were not significantly correlated at any time point. Although surprising, closer examination of study measures
suggested that the lack of significant correlations may have been due to differences in the context and time in which infant PE was assessed across measures.

Relatedly, examination of autoregressive effects involving infant PE variables suggests that aspects of infant PE differentially develop. That is, infant PE expressed during daily activities appears to develop gradually between the time infants are 6 and 10 months of age while infant PE exhibited during activities in the laboratory, including the Modified Peek-a-Boo task, develops most between 6 and 8 months of age. Together, these findings indicate that there are important differences between assessments of infant PE. Moving forward, researchers will need to be thoughtful about the context in which they wish to assess infant PE and which measures would be most appropriate to use for that setting.

Finally, although cross-lagged effects were not observed in any of the structural equation models tested in the current study, evidence of a longitudinal relationship between maternal depression and infant PE was found, which has not been demonstrated by prior work. Specifically, maternal history of a MDE, either at the time infants were four months old or at some time prior, was significantly negatively related to maternal ratings of infant PE on the IBQ-R when infants were 8 months old. In other words, mothers with a history of depression tended to rate their 8 month-old infants as less positive than mothers who had never experienced a MDE. The association between maternal history of depression and maternal ratings of infant PE on the IBQ-R at the 6-month time point approached the level of significance. The association between these variables at the 10 month time point was in the anticipated direction, but non-significant.
Maternal history of clinical depression was also significantly related to infant PE observed during the Modified Peek-a-Boo game when infants were six and eight months of age, although this relationship was positive. That is, infants of mothers who had experienced depression at some time in their life exhibited greater PE during Peek-a-Boo games with their mothers when they were 6 and 8 months old as compared to infants of mothers who did not have a history of clinical depression.

Collectively, the present study’s findings highlight the ambiguous nature of the relationship between maternal depression and the development of infant positive emotionality in the first year postpartum. Although a significant, positive relationship was identified between a maternal history of a depressive episode and observations of infant PE during a Peek-a-Boo task conducted in the laboratory, relations between other indicators of maternal depression were non-significant and varied in direction. That is, in some cases, non-significant relations between indicators of maternal depression and infant PE were positive and in other cases relations were negative. As such, it will be important for future research to continue to examine the longitudinal relationship between maternal depression and infant PE, particularly among a sample of mothers who exhibit variability with regard to the severity of their depressive symptoms. Future work will also need to give careful consideration to the way in which infant PE is measured given the subtle differences in assessments noted above. Should a longitudinal relationship between maternal depression and infant PE be more consistently demonstrated in future work, researchers could focus on identifying the specific mechanism through which the relationship occurs, whether it be maternal reporting bias, biological/genetic mechanisms, early observational learning, and/or mediated through parent-infant interactions as prior research has suggested.
REFERENCES


APPENDIX A

DEMOGRAPHIC QUESTIONNAIRE (MOTHERS)
Demographic Questionnaire (Mothers)

We would like to ask you some questions about yourself. The questions are about your age, marital status, educational background, and current work. Please answer all questions as completely as possible.

1. What is your partnership status? _____
   1 = Single
   2 = In a relationship
   3 = Living together
   4 = Married
   5 = Divorced
   6 = Separated
   7 = Remarried
   8 = Widowed

2. With which race/ethnicity do you identify most? _____
   1 = Caucasian/European American
   2 = African American/Black
   3 = Asian/Asian American
   4 = Pacific Islander
   5 = Filipino
   6 = Hispanic/Latino
   7 = Native American
   8 = Other: ___________________

3. What is the highest grade you’ve completed?

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Degree earned (if any): __________

4. What is your date of birth? 5. What is your age? __________
   __________ / __________ / __________
   month  day  year

6. What is your gender?
   [ ] Male  [ ] Female

7a. What kind of work are you currently doing (what is your occupation)?
   ____________________________________________________________
   (For example: Electrical engineer, farmer, stock clerk, machinist, etc.)

7b. What are your most important activities or duties?
   ____________________________________________________________
   (For example: selling cars, filing, finishing concrete, etc.)
7c. What kind of industry is this?

________________________________________________________
(For example: retail shoe store, automobile manufacturing, or state labor department, etc.)

8. What was your approximate family income last year? _________________

9. What is your religious affiliation? ________________________________

10. Please check the boxes below if you have previously been diagnosed with any of the following disorders/difficulties:

   □ Depression
   □ Anxiety
   □ ADHD
   □ Substance use/abuse
   □ Behavior problems/delinquency
   □ Other: ________________

11. Please check the boxes below if your biological mother has previously been diagnosed with any of the following disorders/difficulties:

   □ Depression
   □ Anxiety
   □ ADHD
   □ Substance use/abuse
   □ Behavior problems/delinquency
   □ Other: ________________

12. Please check the boxes below if your biological father has previously been diagnosed with any of the following disorders/difficulties:

   □ Depression
   □ Anxiety
   □ ADHD
   □ Substance use/abuse
   □ Behavior problems/delinquency
   □ Other: ________________

13. Please check the boxes below if you have previously been diagnosed with any of the following learning or speech difficulties:

   □ Reading disability/dyslexia
   □ Math disability
   □ Writing disability
   □ Speech impairment
   □ Other: ________________
14. Please check the boxes below if your biological mother has previously been diagnosed with any of the following learning or speech difficulties:

- [ ] Reading disability/dyslexia
- [ ] Math disability
- [ ] Writing disability
- [ ] Speech impairment
- [ ] Other: ____________________________

15. Please check the boxes below if your biological father has previously been diagnosed with any of the following learning or speech difficulties:

- [ ] Reading disability/dyslexia
- [ ] Math disability
- [ ] Writing disability
- [ ] Speech impairment
- [ ] Other: ____________________________

16a. Have you had a history of medical difficulties (for example: heart disease, Alzheimer’s, cancer)?

- [ ] Yes
- [ ] No

16b. If yes, please briefly describe your medical difficulties below:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
APPENDIX B

DEMOGRAPHIC QUESTIONNAIRE (INFANTS)
Demographic Questionnaire (Infants)

These questions specifically ask about your infant. Please answer all questions as completely as possible.

1. What is your infant’s date of birth? ________________

2. How much did your infant weigh at birth? _________ lbs _________ oz

3. How old is your infant today? _________ months _________ days

4. What is your infant’s sex? _________ (1 = female, 2 = male)

5. Is your child adopted? YES NO

6. What race/ethnicity is your child? _________
   
   1 = Caucasian/European American
   2 = Black/African American
   3 = Asian/Asian American
   4 = Pacific Islander
   5 = Filipino
   6 = Hispanic/Latino
   7 = Native American
   0 = Other

7. Is your infant being raised in a bilingual family environment (families in which the caregivers speak more than one language fluently) (circle one)?
   
   YES NO

8. How many older siblings does your infant have? ________________

9. Specify age and gender of each sibling
   (Example: sister, 3 years old)
   ________________________________
   ________________________________
   ________________________________
   ________________________________
   ________________________________
APPENDIX C

ADULT TEMPERAMENT QUESTIONNAIRE SHORT FORM,

POSITIVE AFFECT SUBSCALE
Adult Temperament Questionnaire Short Form, Positive Affect Subscale

**Directions**
On the following pages you will find a series of statements that individuals can use to describe themselves. There are no correct or incorrect responses. All people are unique and different, and it is these differences which we are trying to learn about. Please read each statement carefully and give your best estimate of how well it describes you. Circle the appropriate number below to indicate how well a given statement describes you.

<table>
<thead>
<tr>
<th>circle #:</th>
<th>if the statement is:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>extremely untrue of you</td>
</tr>
<tr>
<td>2</td>
<td>quite untrue of you</td>
</tr>
<tr>
<td>3</td>
<td>slightly untrue of you</td>
</tr>
<tr>
<td>4</td>
<td>neither true nor false</td>
</tr>
<tr>
<td>5</td>
<td>slightly true of you</td>
</tr>
<tr>
<td>6</td>
<td>quite true of you</td>
</tr>
<tr>
<td>7</td>
<td>extremely true of you</td>
</tr>
</tbody>
</table>

If one of the statements does not apply to you (for example, if it involves driving a car and you don’t drive), then circle “X” (not applicable). Check to make sure that you have answered every item.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>extremely true</td>
<td>quite untrue</td>
<td>slightly untrue</td>
<td>neither true nor false</td>
<td>slightly true</td>
<td>quite true</td>
<td>extremely true</td>
<td>not applicable</td>
</tr>
</tbody>
</table>

1. Sometimes minor events cause me to feel intense happiness.
   1 2 3 4 5 6 7 X

2. I sometimes seem to be unable to feel pleasure from events and activities that I should enjoy.
   1 2 3 4 5 6 7 X

3. I rarely ever have days where I don’t at least experience brief moments of intense happiness.
   1 2 3 4 5 6 7 X

4. It doesn’t take much to evoke a happy response in me.
   1 2 3 4 5 6 7 X

5. It takes a lot to make me feel truly happy.
   1 2 3 4 5 6 7 X
APPENDIX D

INFANT BEHAVIOR QUESTIONNAIRE-REVISED,

POSITIVE EMOTIONALITY FACTOR
Infant Behavior Questionnaire-Revised, Positive Emotionality Factor

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.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(X)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
<td>Very</td>
<td>Less Than</td>
<td>Half the</td>
<td>More Than</td>
<td>Almost</td>
<td>Does</td>
</tr>
<tr>
<td></td>
<td>Rarely</td>
<td>Time</td>
<td>the Time</td>
<td>Half the</td>
<td>Time</td>
<td>Always</td>
<td>Not</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Apply</td>
</tr>
</tbody>
</table>

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.

Feeding

During feeding, how often did the baby:

1  2  3  4  5  6  7  X . . .  (1) lie or sit quietly?
1  2  3  4  5  6  7  X . . .  (2) squirm or kick?
1  2  3  4  5  6  7  X . . .  (3) wave arms?
1  2  3  4  5  6  7  X . . .  (4) notice lumpy texture in food (e.g., oatmeal)?

How often did your baby make talking sounds:

1  2  3  4  5  6  7  X . . .  (5) while waiting in a high chair for food?
1  2  3  4  5  6  7  X . . .  (6) when s/he was ready for more food?
Sleeping

During sleep, how often did the baby:

1. wave her/his arms and kick?
2. squirm and/or try to roll away?
3. smile or laugh?
4. coo or vocalize?

Bathing and Dressing

When being dressed or undressed during the last week, how often did the baby:

1. wave her/his arms and kick?
2. squirm and/or try to roll away?
3. smile or laugh?
4. coo or vocalize?

When put into the bath water, how often did the baby:

1. smile?
2. laugh?
3. splash or kick?
4. turn body and/or squirm?

When face was washed, how often did the baby:

1. smile or laugh?
2. coo?

When hair was washed, how often did the baby:

1. smile?
2. vocalize?

Play

How often during the last week did the baby:

1. repeat the same sounds over and over again?
2. laugh aloud in play?
3. smile or laugh after accomplishing something (e.g., stacking blocks, etc.)?
4. smile or laugh when given a toy?
5. smile or laugh when tickled?

How often during the last week did the baby enjoy:

1. being tickled by you or someone else in your family?
2. being involved in rambunctious play?
When tossed around playfully how often did the baby:
1 2 3 4 5 6 7 X . . . (31) smile?
1 2 3 4 5 6 7 X . . . (32) laugh?

During a Peek-a-Boo game, how often did the baby:
1 2 3 4 5 6 7 X . . . (33) smile?
1 2 3 4 5 6 7 X . . . (34) laugh?

How often did your baby enjoy bouncing up and down:
1 2 3 4 5 6 7 X . . . (35) while on your lap?
1 2 3 4 5 6 7 X . . . (36) on an object, such as a bed, bouncer chair, or toy?

How often did the infant look up from playing:
1 2 3 4 5 6 7 X . . . (37) when the telephone rang?
1 2 3 4 5 6 7 X . . . (38) when s/he heard voices in the next room?

When your baby saw a toy s/he wanted, how often did s/he:
1 2 3 4 5 6 7 X . . . (39) get very excited about getting it?
1 2 3 4 5 6 7 X . . . (40) immediately go after it?

When given a new toy, how often did your baby:
1 2 3 4 5 6 7 X . . . (41) get very excited about getting it?
1 2 3 4 5 6 7 X . . . (42) immediately go after it?
1 2 3 4 5 6 7 X . . . (43) seem not to get very excited about it?

**Daily Activities**

How often during the last week did the baby:
1 2 3 4 5 6 7 X . . . (44) appear to listen to even very quiet sounds?
1 2 3 4 5 6 7 X . . . (45) attend to sights or sounds when outdoors (for example, wind chimes or water sprinklers)?
1 2 3 4 5 6 7 X . . . (46) move quickly toward new objects?
1 2 3 4 5 6 7 X . . . (47) show a strong desire for something s/he wanted?
1 2 3 4 5 6 7 X . . . (48) squeal or shout when excited?
1 2 3 4 5 6 7 X . . . (49) imitate the sounds you made?
1 2 3 4 5 6 7 X . . . (50) seem excited when you or other adults acted in an excited manner around him/her?

When placed on his/her back, how often did the baby:
1 2 3 4 5 6 7 X . . . (51) smile or laugh?
1 2 3 4 5 6 7 X . . . (52) wave arms and kick?
1 2 3 4 5 6 7 X . . . (53) squirm and/or turn body?
When placed in an infant seat or car seat, how often did the baby:
1 2 3 4 5 6 7 X . . . (54) wave arms and kick?
1 2 3 4 5 6 7 X . . . (55) squirm and turn body?
1 2 3 4 5 6 7 X . . . (56) lie or sit quietly?

How often did your baby notice:
1 2 3 4 5 6 7 X . . . (57) low-pitched noises, air conditioner, heating system, or refrigerator running or starting up?
1 2 3 4 5 6 7 X . . . (58) sirens from fire trucks or ambulances at a distance?
1 2 3 4 5 6 7 X . . . (59) a change in room temperature?
1 2 3 4 5 6 7 X . . . (60) a change in light when a cloud passed over the sun?
1 2 3 4 5 6 7 X . . . (61) sound of an airplane passing overhead?
1 2 3 4 5 6 7 X . . . (62) a bird or a squirrel up in a tree?

How often did your baby notice:
1 2 3 4 5 6 7 X . . . (63) fabrics with scratchy texture (e.g., wool)?

How often did your baby make talking sounds when:
1 2 3 4 5 6 7 X . . . (64) riding in a car?
1 2 3 4 5 6 7 X . . . (65) riding in a shopping cart?
1 2 3 4 5 6 7 X . . . (66) you talked to her/him?

**Two Week Time Span**

When you returned from having been away and the baby was awake, how often did s/he:
1 2 3 4 5 6 7 X . . . (67) smile or laugh?

When visiting a new place, how often did the baby?
1 2 3 4 5 6 7 X . . . (68) get excited about exploring new surroundings?
1 2 3 4 5 6 7 X . . . (69) move about actively when s/he is exploring new surroundings?

When in a crowd of people, how often did the baby:
1 2 3 4 5 6 7 X . . . (70) seem to enjoy him/herself?

When familiar relatives/friends came to visit, how often did your baby:
1 2 3 4 5 6 7 X . . . (71) get excited?
1 2 3 4 5 6 7 X . . . (72) seem indifferent?
APPENDIX E

INFANT BEHAVIOR RATING SCALE DEGREE OF HAPPINESS
Infant Behavior Rating Scale Degree of Happiness

**Degree of happiness**

1. Child seems unhappy throughout the lab visit.
2. Between 1 and 3.
3. At times rather unhappy, but may respond happily to interesting procedures.
4. Between 3 and 5.
5. Moderately happy or contented; may become upset, but recovers fairly easily.
7. Generally appears to be in a happy state of well-being.
8. Between 7 and 9.
9. Radiates happiness; nothing is upsetting; animated.
APPENDIX F

MODIFIED PEEK-A-BOO GAME
Modified Peek-a-Boo Game

Laboratory Temperament Assessment Battery (Lab-TAB) Pre-Locomotor Version 3.1

The modified Peek-a-Boo game was set up as depicted below:
APPENDIX G

MODIFIED PEEK-A-BOO TASK CODING
Modified Peek-a-Boo Task Coding

ID Number: ____________________

**Trial 1**
Intensity of smiling: Peak intensity of facial joy

- 0 = no smiling at all
- 1 = small smile with lips slightly upturned and no involvement of the cheek or eyes
- 2 = medium smile with lips upturned, perhaps mouth open, slight bulging of cheeks and perhaps some crinkling about the eyes
- 3 = large smile with lips stretched broadly and upturned, perhaps mouth open, definite bulging of the cheeks and noticeable crinkling of eyes

Presence of laughter: Laughter is more intense than positive vocalizations and usually has a rhythmic quality
- 0 = not present
- 1 = present

Presence of positive vocalizations: positively-toned babbling, squealing, etc.
- 0 = not present
- 1 = present

Presence of motor activity: banging hands on table, clapping, waving of arms in excitement, reaching/leaning toward the Peek-a-Boo board, etc.
- 0 = not present
- 1 = present

**Trial 2**
Intensity of smiling: Peak intensity of facial joy

- 0 = no smiling at all
- 1 = small smile with lips slightly upturned and no involvement of the cheek or eyes
- 2 = medium smile with lips upturned, perhaps mouth open, slight bulging of cheeks and perhaps some crinkling about the eyes
- 3 = large smile with lips stretched broadly and upturned, perhaps mouth open, definite bulging of the cheeks and noticeable crinkling of eyes

Presence of laughter: Laughter is more intense than positive vocalizations and usually has a rhythmic quality
- 0 = not present
- 1 = present
Presence of positive vocalizations: positively-toned babbling, squealing, etc. 
0 = not present  
1 = present

Presence of motor activity: banging hands on table, clapping, waving of arms in excitement, reaching/leaning toward the Peek-a-Boo board, etc.  
0 = not present  
1 = present

**Trial 3**

Intensity of smiling: Peak intensity of facial joy  
0 = no smiling at all  
1 = **small smile** with lips slightly upturned and no involvement of the cheek or eyes  
2 = **medium smile** with lips upturned, perhaps mouth open, slight bulging of cheeks and perhaps some crinkling about the eyes  
3 = **large smile** with lips stretched broadly and upturned, perhaps mouth open, definite bulging of the cheeks and noticeable crinkling of eyes

Presence of laughter: Laughter is more intense than positive vocalizations and usually has a rhythmic quality  
0 = not present  
1 = present

Presence of positive vocalizations: positively-toned babbling, squealing, etc. 
0 = not present  
1 = present

Presence of motor activity: banging hands on table, clapping, waving of arms in excitement, reaching/leaning toward the Peek-a-Boo board, etc.  
0 = not present  
1 = present

**Trial 4 (mom hidden)**

Intensity of smiling: Peak intensity of facial joy  
0 = no smiling at all  
1 = **small smile** with lips slightly upturned and no involvement of the cheek or eyes  
2 = **medium smile** with lips upturned, perhaps mouth open, slight bulging of cheeks and perhaps some crinkling about the eyes  
3 = **large smile** with lips stretched broadly and upturned, perhaps mouth open, definite bulging of the cheeks and noticeable crinkling of eyes
Presence of laughter: Laughter is more intense than positive vocalizations and usually has a rhythmic quality
0 = not present
1 = present

Presence of positive vocalizations: positively-toned babbling, squealing, etc. 
0 = not present
1 = present

Presence of motor activity: banging hands on table, clapping, waving of arms in excitement, reaching/leaning toward the Peek-a-Boo board, etc.
0 = not present
1 = present

**Trial 5 (mom hidden)**
Intensity of smiling: Peak intensity of facial joy
0 = no smiling at all
1 = small smile with lips slightly upturned and no involvement of the cheek or eyes
2 = medium smile with lips upturned, perhaps mouth open, slight bulging of cheeks and perhaps some crinkling about the eyes
3 = large smile with lips stretched broadly and upturned, perhaps mouth open, definite bulging of the cheeks and noticeable crinkling of eyes

Presence of laughter: Laughter is more intense than positive vocalizations and usually has a rhythmic quality
0 = not present
1 = present

Presence of positive vocalizations: positively-toned babbling, squealing, etc. 
0 = not present
1 = present

Presence of motor activity: banging hands on table, clapping, waving of arms in excitement, reaching/leaning toward the Peek-a-Boo board, etc.
0 = not present
1 = present

**Trial 6**
Intensity of smiling: Peak intensity of facial joy
0 = no smiling at all
1 = small smile with lips slightly upturned and no involvement of the cheek or eyes
2 = medium smile with lips upturned, perhaps mouth open, slight bulging of cheeks and perhaps some crinkling about the eyes
3 = **large smile** with lips stretched broadly and upturned, perhaps mouth open, definite bulging of the cheeks and noticeable crinkling of eyes

Presence of laughter: Laughter is more intense than positive vocalizations and usually has a rhythmic quality

0 = not present
1 = present

Presence of positive vocalizations: positively-toned babbling, squealing, etc.

0 = not present
1 = present

Presence of motor activity: banging hands on table, clapping, waving of arms in excitement, reaching/leaning toward the Peek-a-Boo board, etc.

0 = not present
1 = present