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Prenatal Exposure to Maternal Depression and Infant Vagal Tone at 3-Months:

The Moderating Role of Maternal Parenting Quality

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Abstract

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This study examined maternal parenting quality and infant cardiac vagal tone at 3-months among 57 mother-infant dyads to test the hypothesis that the quality of the mothers' parenting behaviors with their infants would moderate the association between prenatal depression exposure and infant vulnerability to the later development of depression. All women had a history of major depression and/or anxiety disorder and 40 of them experienced at least a clinically significant level of depression symptoms, if not a diagnosed episode of major depression, during pregnancy. Maternal parenting quality was measured with rating scales that reflected parenting characteristics known to be early life stressors to infants and that also assessed positive affect. Preliminary analyses identified three distinct maternal parenting behavior constructs within the scales: *Sensitivity*, *Intrusiveness*, and *Withdrawal*. Infant vulnerability to the later development of depression was reflected in infant cardiac vagal tone, a psychophysiological measure known to be associated with prenatal exposure to depression and with the development of depression and psychopathology. Electrocardiogram (EKG) recordings were collected during 5-minute *freeplay* dyads, which were also rated for maternal parenting quality. Hierarchical regression analysis showed that while exposure to prenatal depression significantly predicted infant vagal tone at 3-months (although not in the expected direction), maternal parenting quality and the interaction between prenatal depression exposure and maternal parenting quality did not account significantly for additional variance in vagal tone. Results are discussed in terms of implications for future research.

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Table of Contents

1. Descriptive Statistics for Maternal Interactive Quality Rating Scales

2. Correlations Among Rating Scales in the Hypothesized Withdrawal Construct

3. Descriptive Statistics for Sensitivity, Intrusiveness, and Withdrawal Summary Scales; Prenatal Depression Scores (BDI AUC); and Vagal Tone

4. Correlations Among Maternal Parenting Quality Summary Scales, Prenatal Depression Scores (BDI AUC), and Vagal Tone

5. Summary of Hierarchical Regression Analysis for Variables Predicting Vagal Tone

Prenatal Exposure to Maternal Depression and Infant Vagal Tone at 3-Months:

The Moderating Role of Maternal Parenting Quality

The transmission of risk for depression from mother to infant has become a subject of growing importance in developmental psychopathology. Its relevance derives from the prevalence of depression in mothers as well as from an understanding of how prenatal depression may disrupt fetal development of stress-response systems and how postnatal depression interferes with quality parenting needed for healthy infant development. Maternal depression can present prenatally (during pregnancy) and postnatally (after birth), reflecting the possibility of both biological and environmental exposure to depression. Depression at both times appears to increase children's risk for the later development of psychopathology, as a mounting body of research recognizes vulnerabilities in children of prenatally and postnatally depressed mothers (for a review see Goodman, 2007; Goodman & Gotlib, 1999).

Goodman and Gotlib (1999) proposed an integrative, developmentally sensitive model for understanding the relationship between maternal depression and infant outcome. The model specifies four mechanisms through which risk for depression and other psychopathology may pass from mother to infant, and considers both the biological exposure to maternal depression that occurs during pregnancy and the more environmental exposure that often occurs during the postpartum period. Goodman and Gotlib equated mechanisms with statistical mediators (Goodman, 2007), variables that account for or explain the association between an independent and dependent variable (Baron & Kenny, 1986). Thus, the mechanisms identified in the model represent possible pathways through which maternal depression influences infant outcome (Goodman,

2007). They are: (1) heritability of depression; (2) innate dysfunctional neuroregulatory mechanisms; (3) exposure to mother's negative and/or maladaptive cognitions, behaviors, and affect; and (4) exposure to stressful environment. Goodman and Gotlib (1999) also included a number of variables that moderate the transmission of risk, such as the availability and mental health of the father, the timing and course of the mother's depression, and the characteristics of the child. In contrast to a mechanism/mediator, which accounts for the association between two variables, a moderator affects the direction or strength of the association between the independent and dependent variable (Baron & Kenny, 1986).

Of the components included in the Goodman and Gotlib (1999) model, the current study was most concerned with the second and third mechanisms: innate dysfunctional neuroregulatory mechanisms and exposure to mother's negative and/or maladaptive cognitions, behaviors, and affect. The second mechanism suggests that infants of depressed mothers are born with dysfunctional neuroregulatory mechanisms as a direct effect of abnormal fetal development resulting from prenatal depression exposure. Empirical support for this hypothesized mechanism of risk-transmission comes from research on the fetal environment of depressed mothers and research on behavioral evidence for dysfunctional neuroregulatory mechanisms displayed by newborns of depressed mothers (for a review see Goodman & Brand, 2009; Goodman & Tully, 2006). For example, prenatal maternal cortisol levels, which some researchers have found to be associated with depressed mood during pregnancy (Field et al., 2004), have also been associated with fetal and newborn cortisol levels (Glover, Bergman, Sarkar, & O'Connor, 2009; Lundy et al., 1999).

In Goodman and Gotlib's (1999) third mechanism, the mother's depression is associated with negative cognitions, behaviors, and affect that render her an inadequate social partner for her infant. The mother's poor parenting quality is hypothesized to impair the child's social and cognitive development and to influence the child's acquisition of depressotypic cognitions, behaviors, and affect through social learning or through the stressors associated with inadequate parenting. Both effects are expected to increase the child's risk for developing depression. As reviewed by Goodman and Tully (2006), empirical support for this mechanism comes from research identifying depressed mothers' negative parenting qualities during their interactions with their children and research supporting maternal parenting as a mediator between maternal depression and child outcome. Researchers examining the parenting of depressed mothers have observed them to be less positive, more intrusive, and to display more sad affect than controls when interacting with their children (for a review see Goodman & Brand, 2009). Lovejoy, Graczyk, O'Hare, and Neuman's (2000) meta-analytic review of 46 observational studies identified negative parenting (hostile and irritable) as a quality that was associated with depression in mothers ($r = .20$, $p < .01$). Maternal depression was also associated with disengaged parenting, although the correlation was not as strong as it was for negative parenting ($r = .14$, $p < .01$). Further support for this mechanism comes from studies that have identified various characteristics of maternal parenting behavior as mediators of the association between maternal depression and outcomes in children. For example, Murray, Kempton, Woolgar, and Hooper (2006) found that mothers' negative affect as expressed through speech mediated the association between maternal depression and children's cognitive development at 18-months of age.

Given these concerns about qualities of parenting associated with depression in mothers and the role they play in mediating associations between maternal depression and adverse child outcomes, it is not surprising that most of the literature on perinatal depression has focused on postnatal rather than prenatal depression. Yet, prenatal depression occurs just as frequently as postnatal depression (Evans, Heron, Francomb, Oke, & Golding, 2001). Furthermore, prenatal maternal depression is associated with infant vulnerabilities to the later development of depression or other disorders. A growing body of research emphasizes the harmful effects of prenatal depression on the neonate (Field et al., 2004). Researchers have found that newborns of mothers with depressive symptoms during pregnancy have reduced left hemisphere activation (EEG asymmetry), lower scores on the Brazelton Neonatal Behavior Assessment Scale (Jones et al., 1998), decreased activity levels, and greater irritability and depressive-like behavior (Field et al., 2004).

Another infant vulnerability associated with prenatal maternal depression is cardiac vagal tone. Vagal tone measures neural control of the heart and is an index of one's individual stress response and stress vulnerability (Porges, 1992). The autonomic nervous system (ANS) is divided into the parasympathetic nervous system (PNS; the branch of the autonomic nervous system responsible for anabolic processes that conserve energy, rest internal organs, and regulate homeostatic processes in the absence of external challenges) and the sympathetic nervous system (SNS; responsible for increasing metabolic output in response to external threats). When external challenges are present, PNS activity decreases and the SNS is activated. This deactivation of the PNS reflects homeostatic disruption, an event that Porges (1992) proposed be used to define stress.

Thus, stress may be conceptualized as decreased PNS tone in response to external stimuli while stress vulnerability is evident in low PNS tone prior to the threat (Porges, 1992). PNS activity is measured by heart-rate pattern, more specifically by the amplitude of respiratory sinus arrhythmia (RSA; vagal tone), a rhythmic cardio-respiratory process that reflects the efferent influence of the vagus nerve on the heart (Porges, 1992). Higher amplitudes (higher vagal tone) indicate greater heart-rate variability resulting from efficient neural control of the heart. In contrast, lower amplitudes (lower vagal tone) indicate less heart-rate variability and a decreased capacity to self-regulate in reaction to external stimuli (Porges, 1992).

Vagal tone is quantified based on the amplitude of the RSA evident in data from an EKG (Porges, Doussard-Roosevelt, & Maiti, 1994). RSA is also referred to as high frequency (HF) heart-rate variability (HRV), as it represents the high frequency (0.12-0.40 Hz) component of heart-period oscillations (Cacioppo, Uchino, & Berntson, 1994). Reduced vagal tone has been observed in depressed and anxious adults (Lyonfields, Borkovec, & Thayer, 1995; Rechlin, Weis, Spitzer, & Kaschka, 1994; Thayer, Friedman, & Borkovec, 1996; Yergani, et al., 1991; as cited in Beauchaine, Gatzke-Kopp, & Mead, 2007). In addition, Kemp and colleagues' (in press) meta-analytic review of 46 studies found that depressed adults have reduced HRV (HF) as compared to controls ($g = -.29$, $p < .01$) and that HRV decreases with increasing depression severity ($r = -.36$, $p < .01$). Lower HRV has also been observed in depressed and anxious adolescent females (Blom, Olsson, Serlachius, Ericson, & Ingvar, 2010). Moving from adolescents to infants, there is a growing body of research linking perinatal depression with infant vagal tone, as lower vagal tone has also been identified in 3- to 6-month-old infants of currently

depressed mothers (Field et al., 1988; Field, Pickens, Fox, Nawrocki, & Gonzalez, 1995).

Finally, children of prenatally depressed mothers have also been found to exhibit lower

vagal tone than controls within the first 24 hours after birth (Field et al., 2004; Jones et

al., 1998).

In addition to being predicted by exposure to prenatal and concurrent depression,

lower vagal tone in infants is also a particularly strong indicator of infant vulnerability for

the later development of depression, given accumulating evidence supporting vagal tone

as a significant predictor of psychopathology and depression specifically. Lower vagal

tone at 40-weeks has been associated with lower scores on the mental scale of the Bayley

Scales of Mental Development at 8- and 12-months (Fox & Porges, 1985). Additionally,

lower vagal tone at 9-months predicted higher levels of behavioral problems at 3-years of

age (Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). Infant vagal tone

calculated across a 3-week period (33-, 34-, and 35-weeks gestational age) also predicted

social competence in 6-year-olds, suggesting that infant vagal tone may be a marker of

risk for behavioral problems even into the school-age years (Doussard-Roosevelt,

McClenny, & Porges, 2001). Finally, infants with lower vagal tone at 5-months were

found to exhibit concurrently less facial expressivity, specifically less expressed joy and

interest, than infants with higher vagal tone (Stifter, Fox, & Porges, 1989). Given the

links between prenatal depression and lower cardiac vagal tone, early vagal tone

predicting later social competence and behavioral problems, and the association between

lower vagal tone and negative affect and behavior, lower cardiac vagal tone has strong

evidence as an index of vulnerability to the later development of depression that can be

measured in infants of depressed mothers.

Along with prenatal depression exposure, researchers have also considered the potential role of parenting qualities in the prediction of infant vulnerability to depression. This is a particular concern with depressed mothers, given the role of parenting in the Goodman and Gotlib model (1999) and the research showing that depressed mothers display more negative and/or maladaptive parenting behaviors when interacting with their infants than nondepressed mothers. A strong body of research shows that poor maternal parenting behavior is associated with infant vulnerabilities to depression and other problems later on. Researchers have identified a set of parenting characteristics that facilitate healthy infant development or, conversely, may be early life stressors for infants. From the stress perspective, these include low levels of sensitivity and positive affect, as well as intrusiveness, withdrawal, and negative affect. Sensitivity, according to Ainsworth, Bell, and Stayton (1974), involves an awareness and accurate interpretation of the infant's signals, followed by an appropriate and immediate response. Sensitivity is an important component of maternal interactive quality whose absence has been shown to predict insecure attachment (Egeland & Farber, 1984) and impaired acquisition of effective self-regulation skills (Tronick & Gianino, 1999 as cited in Goodman & Gotlib, 1999).

Positive affect, a related construct, is characterized by warmth, stimulation of development, and positive regard for the child (Campbell, 1991). A large body of research has consistently identified depressed mothers of infants as less positive and more negative during mother-infant interactions than nondepressed mothers (for a review see Lovejoy et al., 2000). Maternal positive affect is evident when a mother is attentive, expresses affection, and exhibits behaviors indicating that she clearly takes pleasure in

the child (e.g., smiling or laughing, praising the child). A positive mother will also

provide high-quality stimulation by challenging the child, elaborating on the child's

verbalizations and activities, and labeling the qualities of objects or of the child's

experiences. Such behavior enhances cognitive, linguistic, perceptual, and physical

development (Campbell, 1991). Both maternal sensitivity and positive affective

expression are thought to be critical for infants' development of effective affect

regulation and dyadic communication (Tronick, 1989 as cited in Campbell, Cohn, &

Meyers, 1995).

Cohn and colleagues (1986) and Field, Healy, Goldstein, and Guthertz (1990)

identified two predominant interaction styles, intrusive and withdrawn, in the parenting

behavior of depressed mothers (although depressed mothers may engage in both).

Intrusive parenting is characterized by unwelcomed stimulation that interferes with the

child's activity and emotional state. Intrusive behaviors include loud, rapid verbalizations

or stimulation and unwanted physical contact or closeness (e.g., grabbing toys from the

child or placing them too close to the infants face), and occur despite cues from the infant

that a different activity or pace of interaction is desired (Campbell, 1991). Intrusive

parenting is associated with infant protesting (negative affective states such as fussing

and crying; Field et al., 1990), avoidance (Cohn et al., 1986), and development of an

insecure-ambivalent attachment style (Rosenblum, Mazet, & Bénony, 1997). In addition,

researchers have identified elevated catecholamine and dopamine levels in infants of

intrusive mothers at 3- and 6- months of age (Jones et al., 1997).

In contrast to the overstimulating qualities of the intrusiveness construct,

withdrawn behavior is understimulating (Jones et al., 1997) and is characterized by

emotional uninvolvement and flat affect (Campbell, 1991). Withdrawn behaviors lack animation and fail to demonstrate interest in or awareness of the child. Rosenblum and colleagues (1997) found that 1-year-olds of withdrawn mothers were more likely to show insecure-avoidant attachment styles, and suggested that this style develops as a self-regulatory strategy in the absence of the mother's affective availability. Withdrawn parenting has also been associated with greater relative right frontal EEG asymmetry at 3- and 6- months, lower scores on the Bayley Mental Scale at 1-year, and poorer interactive behaviors (e.g., more gaze aversion) at 3- and 6- months relative to controls (Jones et al., 1997).

Finally, as discussed previously, research also indicates that depressed mothers spend more time in negative affective states than do nondepressed mothers. Negative affect is characterized by negative physical contact (ranging in intensity from abrupt or awkward handling to poking and hitting), an angry or hostile mood, and displeasure, disapproval, or criticism of the child. Anger and displeasure can be reflected in the mother's behaviors, tone of voice, or facial expressions (Clark, 1985). Negative parenting behaviors such as addressing or handling the infant in an angry manner and roughly poking and pulling at the infant are associated with infant protesting (Field et al., 1990) and avoidance (Cohn et al., 1986).

Vulnerable infants, such as those exposed to prenatal depression, may be particularly sensitive to the negative and/or maladaptive parenting that is associated with depression in mothers of infants. Belsky's (1997; 2005; as cited in Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2007) differential-susceptibility hypothesis is an evolutionary theory proposing that some children are more susceptible to both the

adverse effects of negative and/or maladaptive parenting and the favorable effects of

positive and/or adaptive parenting. Differential-susceptibility, also known as the orchid

hypothesis (Ellis & Boyce, 2008), the plasticity hypothesis, and the sensitivity

hypothesis, has only recently begun to be tested. However, differential sensitivity is

becoming a strong and consistent finding in the literature, and is most often connected

with the biological or temperamental characteristics of the child. As reviewed by Belsky

and colleagues (2007), Morrell and Murray (2003) investigated the effects of high infant

emotionality at 4-months (as determined by the number of instances of distress and

irritability divided by the number of tasks the infant completed during a trial period) and

low-quality parenting. Of these infants, only highly negative 4-month-old boys who also

experienced low-quality parenting continued to display evidence of behavioral and

emotional dysregulation at 9-months of age. In addition, infants identified as negative by

parental reports and researcher observation at 1-year of age who also experienced low-

quality parenting across their second and third years of life scored highest on

externalizing problems at 36-months relative to infants who were more positive and to

negative and positive infants who did not experience low-quality parenting

(Belsky, Hsieh, & Crnic, 1998). Especially relevant to the current study is research

addressing maternal sensitivity. Klein Velderman, Bakermans-Kranenburg, Juffer, and

Van Ijzendoorn (2006) found that the security of attachment of 13-month-olds who were

identified by parental reports as being highly negative/reactive at approximately 6-

months of age was more affected by simulated changes in maternal sensitivity than that

of controls.

Belsky and colleagues (2007) contend that the most compelling evidence for the differential-susceptibility hypothesis derives from single-sample studies (a sample of vulnerable infants who are affected by both positive and negative parenting at different times, rather than two or more different samples that vary according to parenting quality) demonstrating that vulnerable children are especially sensitive to both positive and negative parenting. For example, Feldman, Greenbaum, and Yirmiya (1999) found that, of a sample of infants exposed to low levels of observed synchrony during face-to-face interactions with their mothers, the infants who had been identified by maternal report and researcher observation as highly negative (having a difficult temperament) at 9-months of age displayed more noncompliance behaviors at 2-years of age relative to infants who had been rated as less negative. Conversely, the infants who had been identified as negative at 9-months showed greater self-control at 2-years of age than those who had been rated as less negative at 9-months when mother-infant interactions were, in fact, synchronous.

Clearly, an impressive body of research supports the differential-susceptibility hypothesis as it applies to the effects of parenting in relation to temperamental disadvantages in children. Thus, it is important to better understand the nature of infant susceptibility to adverse parenting. Despite the accumulating evidence for temperament qualities as an index of differential-susceptibility, an important unanswered question in the literature concerns the potential role of other vulnerabilities, such as being born to a prenatally depressed mother.

Given the established associations between maternal depression and negative and/or maladaptive parenting behavior and between prenatal depression and infant

vulnerabilities to depression, it is compelling to examine the extent to which infants born to prenatally depressed mothers may be particularly vulnerable to negative parenting. Thus, based on this evidence and the differential-susceptibility hypothesis, we expected the level of mothers' stressful parenting to strengthen or weaken the association between prenatal maternal depression and 3-month-old infants' vagal tone. We expected that lower levels of stressful parenting behavior might serve as a protective factor that minimizes the degree of association between the risk factor of prenatal depression and infants' lower vagal tone. Conversely, higher levels of stressful parenting behavior may aggravate this relationship, strengthening the association between prenatal depression and infant vagal tone.

We chose to focus on 3-month-olds. Notably, the literature on parenting behavior in general often focuses on mothers and their 3-month-olds. Age 3-months may be an especially important time to investigate mother-infant interactions due to developmental advances in the infant's interactive skills that occur at this time, relative to younger and older infants. Feldman (2007) found that face-to-face mother-infant interactions were characterized by a mutual focus (the mother and infant focus on each other) at 3-months, but were more directed towards a joint-focus on objects (e.g., mother and infant both focus on a toy) during the second half of the first year. Lavelli and Fogel (2005) identified a shift in mother-infant interactions from mother-driven communication to a bi-directional system of shared affect, gaze, and social cues that takes place at infant age of 2-months. Thus, at 3-months, the mother-infant interactive system is characterized by recently matured interactive skills yet retains an important mutual focus that is partially lost at later periods.

The specific aim of this study was to investigate the extent to which maternal parenting behavior may serve as a moderator of the association between prenatal maternal depression and infant vagal tone at 3-months of age. It was predicted that the quality of the mothers' parenting behavior with their 3-month-old infants would interact with the level of exposure to prenatal depression in predicting vagal tone at 3-months, either adversely influencing or buffering the effects of prenatal exposure on the infants. For example, prenatal depression exposure may have a smaller effect on infant outcome if the mother is sensitively involved. The current study investigated parenting behavior and vagal tone at 3-months in response to research presented earlier suggesting that infants would likely be more influenced by maternal parenting quality when interacting with the mother at this time, rather than later in development when the focus is more divided between mother and object.

Method

Procedure

This research was part of the *Perinatal Stress and Gene Influences: Pathways to Infant Vulnerability Study*, an ongoing large-scale longitudinal research project investigating the effects of maternal perinatal depression on infants. Participants were recruited from several sources: the referrals of partnered practitioners at local obstetrical practices in response to study advertisements, women referred for clinical evaluation at the Emory University Women's Mental Health Program or the Grady satellite clinic in Atlanta, and women who had been excluded from research studies at the Emory Mood and Anxiety Disorders Program due to a positive pregnancy test. Potential participants completed an initial checklist, a telephone interview, and a Structured Clinical Interview

for the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American

Psychiatric Association, 1994) Axis I Disorders–Patient Edition (SCID-I/P; First, Spitzer,

Gibbon, & Williams, 1995). Following intake into the study, data were collected at

multiple time points during pregnancy and at multiple time points postpartum.

Postpartum data collection included three times (at 3-, 6- and 12-months of age) when

mothers and babies participated in a lab visit and one time (at 6-month of age) when

researchers accompanied the mother and baby on the baby's routine pediatrician visit. Of

the postpartum lab visits, the 3-month data collection provided the data for this study.

The women completed a battery of measures, including the SCID and the Beck

Depression Inventory-First Edition (BDI-I; Beck, Ward, Mendelson, Mock, & Erbaugh,

1961), at each data-collection point during pregnancy. The BDI was also administered at

multiple time points in the first 3 months postpartum. These measures were administered

in order to determine whether the women were currently in a depressive episode and to

assess the severity of depressive symptoms.

During the 3-month postpartum visit, the mothers completed questionnaires and

then were video-recorded interacting with their infants during *baseline*, *feeding*, and

freeplay segments. Infants were connected to EEG and EKG devices during all three

segments to collect brain wave and heart-rate data. The current study focused on the

mother-infant interaction and the heart-rate data collected during the 5-minute *freeplay*

segment of the 3-month visit, during which mothers were instructed to play with their

child as they would normally. This segment was selected for use in the study because it

allows for maternal parenting qualities to be observed concurrently with the vagal tone

measure and, unlike the *feeding* and *baseline* segments, is entirely focused on face-to-

face mother-infant interaction. The infant was placed in a seat and positioned so that mother and child were facing each other. A split-screen camera recorded the mother and infant simultaneously and the recorded *freeplay* segment was later uploaded onto a computer in a digital file. The mothers were provided with a box of age-appropriate toys (which included stuffed animals, rattles, and a toy phone) with which to engage their infants.

Participants

Participants consisted of 56 mothers (57 mother-infants dyads in total as the sample included one pair of twins) who were enrolled within their first 16 weeks of pregnancy. This number reflected the number of mothers who met the inclusion and exclusion criteria and also had available data on parenting quality and vagal tone. Inclusion criteria included being between 18- and 45- years of age and having fulfilled DSM-IV criteria for past major depressive disorder, postpartum depression, obsessive-compulsive disorder, generalized anxiety disorder, or post-traumatic stress disorder. Additional inclusion criteria consisted of fluency in English, the ability to give informed consent, and the ability to identify the child's biological father. Exclusion criteria included active suicidality or homicidality, psychotic symptoms, a diagnosis of schizophrenia, bipolar disorder, substance use disorder, eating disorder, or various medical illnesses or thyroid problems. The participants included African-American women (8.8%), Caucasian women (75.4%), Asian-American women (1.8%), Native American women (3.5%), and 10.5% of unknown ethnicity, with an average age at delivery of 34.28 (SD = 3.84) years. Of the women who participated in the study, 49 (85.9%) were married, four (7.0%) were divorced, one (1.8%) was living with her spouse

but had never married, and one (1.8%) was never partnered. The marital status for two

women (3.5%) was unavailable. Of the women who participated in the study, 78.9% were

college graduates, 87.7% were living with a husband or partner, and 68.4% had a full- or

part-time job outside of the home. Finally, 52.6% of the women had taken antidepressant

medications at some point during pregnancy, while 40.4% were on antidepressant

medications for the entire length of pregnancy. In addition, 54.4% of the women had

taken antidepressant medications at some point during the first 3 months postpartum, and

45.6% were currently taking antidepressant medications at the time of the 3-month lab

visit. Of the 57 infants who participated in the study, 24 (42.1%) were female and 33

(57.9%) were male.

Prenatal Depression Measures

Structured Clinical Interview for DSM-IV Axis I Disorders–Patient Edition

(SCID-I/P; First et al., 1995). The SCID is a semi-structured interview used to diagnose

Axis I Disorders of the DSM-IV. The SCID was administered by trained research

assistants during the initial screening and subsequent visits. Reliability of the interviews

was ensured by a senior psychiatric nurse who independently scored the audiotapes of

each interview. The interview was used to determine whether the mother had a previous

history of major depressive disorder or other disorders, or if she met criteria for

depression currently.

Beck Depression Inventory-First Edition (BDI-I; Beck et al., 1961). The BDI

is a self-report measure of depression with well-established reliability and validity. The

measure has been found to have especially strong internal consistency, concurrent

validity, discriminant validity, and construct validity (Beck, Steer, & Garbin, 1988). The

questionnaire includes 21 items, each of which corresponds to a specific symptom of depression. Respondents rate each item on a 4-point scale (0-3) based on their emotional experiences over the past week. Total scores indicative of the respondent's current depression severity were computed by summing the ratings on all items. Based on work by the developers of the scale, depression scores ranging from 0-9 were interpreted to indicate no depression, while scores from 10-18 indicated mild to moderate depression, from 19-29 indicated moderate to severe depression, and from 30-63 indicated severe depression.

The BDI was administered to participants multiple times throughout pregnancy. A BDI area under the curve (BDI AUC) score, an index that reflects both the chronicity (amount of time the mother was depressed) and the severity (the most severe level of depression) of the mother's depression during pregnancy, was calculated across BDI scores for each mother to measure her prenatal depression and adjusted for the length of pregnancy. The BDI was also administered multiple times during the first 3 months postpartum and similar scores were calculated from this data.

Parenting Quality Measure

Maternal Interactive Quality Ratings. A trained team of research assistants rated the digital video-recorded *freeplay* segments using the Maternal Interactive Quality Ratings, 14 rating scales taken from the standardized rating scales of Ainsworth (Ainsworth, Blehar, Waters, & Wall, 1978), Clark (1985), and Campbell (1991). This set of scales was selected to assess the quality of the mother's interactive behavior with her child, and specifically, to assess the behaviors that may be especially stressful to infants. Consistent with the literature, the scales reflected parenting characteristics known to be

early life stressors to infants and also assessed positive affect, which may be present

despite the occurrence of aspects of stressful parenting. The five categories of interactive

quality included 1) Insensitive Parenting, 2) Intrusiveness, 3) Withdrawal, 4) Positive

Affect, and 5) Negative Affect. Insensitive Parenting was measured with two scales from

Campbell: *sensitivity/responsiveness to distress* and *sensitivity/responsiveness to*

nondistress. Intrusiveness was also measured with two scales: Campbell's *intrusiveness*

and Ainsworth and colleagues' *cooperation vs. interference*. Withdrawal was measured

with *detachment/disengagement* and *flatness of affect* and Positive Affect was measured

with *positive regard for the child*, *warmth,* and *stimulation of development*—all from

Campbell. Two more scales from Clark, *quality of verbalizations* and *structures and*

mediates environment, were added to measure Positive Affect following the initial

compilation of the rating scales. Finally, Negative Affect was measured using three scales

from Clark. They included *quality and amount of physical contact: negative*; *angry,*

hostile mood; and *displeasure, disapproval, criticism*. For a full description of the scales,

see Appendix. Scores for each of the scales were based upon a 4- or 5-point Likert scale,

and took into consideration both the quality and quantity or intensity of the behavior

measured in the scale. For most of the scales, raters assigned a score based on whether

the behavior was 'characteristic' or 'not characteristic' of the mother (or some gradient in

between).

Raters were undergraduate research assistants who had been extensively trained

on the rating scales prior to the rating period. Training involved each member of the

rating team independently rating *freeplay* segments from a previous study and then

discussing the segment with a senior clinical psychologist until the group reached a

consensus. The rating period began once the team members consistently demonstrated high inter-rater reliability in their rating of the segments (disagreeing by no more than one point on no more than a few scales). Raters were blind to the past and current depression status of the mothers they observed. Each week a subset of segments was randomly selected to also be rated by another team member in order to assess reliability throughout the study. A total of 23.8% of the segments were selected to be rated a second time. Segment assignments were designed so that each team member was paired with each of the other team members an equal number of times, and so that each member served as the primary and reliability rater equally often. The group met weekly to discuss the segments that had been rated for reliability, and to discuss any questions they had regarding the segments they had rated independently. This meeting was designed to maintain the team's skills and overall reliability throughout the rating period.

Vagal tone index. Infant EKGs were recorded from disposable electrodes during the entire lab visit. Event markers were used to separate the resulting file into the different conditions (*baseline*, *freeplay*, and *feeding*). The infant EKG recordings from the *freeplay* segment were edited by trained research assistants using CardioEdit (Brain-Body Center, 2006-2007) software in order to extract 3- to 5-minutes of fully analyzable EKG. Following procedures developed by Porges (1985), a cardiac vagal tone index was computed for the *freeplay* segment using CardioBatch (Brain-Body Center, 2006-2007) software. This technique uses time-domain filters to extract the RSA and calculate the amplitude (variance) of the pattern (Porges et al., 1994).

Results

Missing Data

Of the 127 participating women whose babies had reached age 3-months to date,

usable *freeplay* segment footage and heart-rate data were available for 60. Data for four

women were later excluded from analyses because the mothers had not completed the

BDI three or more times during pregnancy, which was the minimum needed to yield a

sufficient BDI AUC score. Thus, the current study included a total sample of 56 mothers

and 57 infants (for a total of 57 mother-infant dyads).

Preliminary Analysis and Descriptive Statistics

Maternal Interactive Quality Ratings. Preliminary analysis of the 14 rating

scales was conducted on the 84 segments that had been rated by the rating team to date,

and therefore included data that were excluded from hypothesis testing because of

unavailable heart-rate or prenatal depression data. Descriptive information for the

frequency distributions of the scales (see Table 1) was examined in order to identify

skewness or limited distribution of scores. With the exception of two scales, the

distributions and range of scores for the rating scales indicated that the original data for

each variable could be used for analysis. However, a limited range of scores (only scores

of 3-5 were observed) for *angry, hostile mood* indicated that this parenting quality was

not observed in the parenting behaviors of this sample. In addition, a limited range (3-5)

of scores for *displeasure, disapproval, criticism* indicated that this parenting quality was

also rarely observed. Both scales, therefore, were excluded from further analyses.

Correlational patterns among the 12 remaining scales indicated the presence of

three distinct parenting constructs within the range of possible behaviors reflected by the

scales. The constructs were labeled *Sensitivity*, *Intrusiveness*, and *Withdrawal* to reflect

the primary constructs of theoretical interest that had been identified in previous studies

and meta-analysis. As expected, the two Insensitive Parenting scales,

sensitivity/responsiveness to distress and *sensitivity/responsiveness to nondistress* were

significantly and moderately correlated ($r = .46$, $p < .01$), suggesting that the two scales

may be combined to form a single *Sensitivity* construct. Both *sensitivity/responsiveness to*

distress and *sensitivity/responsiveness to nondistress* were measured on 4-point Likert

scales that were scored in the same direction (1 = low sensitivity to 4 = high sensitivity).

Thus, we created a comprehensive *Sensitivity* scale with higher scores indicating greater

sensitivity by computing the mean of the original scores on the two rating scales.

The two scales conceptualized as measuring Intrusiveness *(intrusiveness* and

cooperation vs. interference) were significantly and highly intercorrelated with each

other ($r = -.52$, $p < .01$). In addition, both Intrusiveness scales were significantly and

moderately to highly correlated with *quality and amount of physical contact: negative* (*r*

$= -.51$, $p < .01$; $r = .43$, $p < .01$), the only remaining Negative Affect scale following the

exclusion of *angry, hostile mood* and *displeasure, disapproval, criticism*. Therefore, we

decided to combine the three scales to form a broader *Intrusiveness* construct. The

original *intrusiveness* scale was recoded so that it was scored in the same direction as the

other two scales (1 = high intrusiveness to 4 = low intrusiveness). Although *cooperation*

vs. interference and *quality and amount of physical contact: negative* were scored on 5-

point Likert scales, we made the decision to compute the mean of the three scales, rather

than compute standardized *z*-scores, in order to preserve the interpretability of the final

score. Thus, a comprehensive *Intrusiveness* scale was formed by computing the mean of the three scales, with higher scores indicating less intrusiveness.

The scales measuring the *Withdrawal* construct (*detachment/disengagement* and *flatness of affect*) and the Positive Affect construct (*positive regard for the child*, *warmth*, *stimulation of development*, *quality of verbalizations*, and *structures and mediates environment*) were all significantly correlated within and across constructs with all but one effect size ranging from moderate to large (see Table 2). Therefore, we decided to combine the seven scales to form a broader parenting construct. This construct was conceptualized as a single *Withdrawal* scale, as mothers who are high on withdrawal display little or weak interactive behaviors, including the animated and affectionate behaviors that contribute to Positive Affect. *Detachment/disengagement* and *flatness of affect* were both recoded so that higher scores indicated less withdrawal and greater animation and so that all seven scales were scored in the same direction (with higher scores indicating higher quality parenting). Although the seven scales varied on whether they were measured using a 4- or 5-point Likert scale, we again made the decision to compute the mean of the scales rather than compute standardized z-scores. Thus, a comprehensive *Withdrawal* scale was formed by computing the mean of the seven scales, with higher scores indicating lower levels of withdrawal and higher levels of positive affect. Descriptive statistics were examined for the *Sensitivity*, *Intrusiveness*, and *Withdrawal* summary scales ($N = 57$) and the distributions and range of scores for each indicated that the data could be used for analysis (see Table 3). The three scales were used in hypothesis testing as our measures of maternal parenting quality.

Prenatal depression symptom level. As the BDI was administered multiple times during pregnancy, prenatal depression symptom level was reflected in three different scores: the mean BDI score across all administrations, each participant's peak (highest) BDI score, and the BDI AUC score. In order to minimize the number of analyses conducted and in an effort to choose a single score that might best capture women's experience of depression symptoms across pregnancy, we identified the pregnancy BDI AUC as the most comprehensive measure of prenatal depression, as it incorporated both the timing and the severity of depression as measured by multiple BDI administrations across pregnancy. The pregnancy BDI AUC scores ($N = 57$) were used in hypothesis testing as our measure of prenatal depression symptom level, and descriptive statistics for the scale were examined (see Table 3). The BDI AUC scores did not correlate significantly with any of the maternal parenting quality summary scales (see Table 4). However, the association between BDI AUC and *Sensitivity* had a small effect size of -.13, with higher levels of prenatal depression symptoms associated with lower maternal sensitivity, albeit not significant.

Descriptive statistics were also examined for the 57 available mean pregnancy BDI scores ($M = 9.32$, $SD = 6.68$) and the 55 available peak pregnancy BDI scores ($M = 15.53$, $SD = 10.27$). As the BDI was also administered multiple times during the first three months postpartum, postnatal depression symptom level was again reflected in three different scores ($n = 43$ for all three): mean postpartum BDI score ($M = 9.03$, $SD = 7.85$), peak postpartum BDI score ($M = 11.98$, $SD = 9.44$), and BDI AUC ($M = 112.11$, $SD = 94.74$).

According to data from the peak pregnancy BDI scores and using the standard cut scores established by the developers of the scale, 15 women (27.3%) experienced no depression during pregnancy, 22 women (40% experienced) mild to moderate depression at least once during pregnancy, 11 women (20%) experienced moderate to severe depression at least once during pregnancy, and 7 women (12.7%) experienced severe depression at least once during pregnancy. Peak pregnancy BDI scores were not available for two of the mothers.

Vagal tone. Descriptive information for the vagal tone data ($N = 57$) is shown in Table 3. Prenatal depression symptom levels (BDI AUC) predicted infant vagal tone with a moderate effect size ($r = .30, p = .02$), although not in the expected direction as higher scores on the BDI AUC predicted higher vagal tone (See Table 4 for all correlations among variables used in hypothesis testing). Infant vagal tone was not significantly correlated with any of the three maternal parenting quality means. However, the correlation between vagal tone and the *Withdrawal* summary scale had a small effect size of .16, with higher infant vagal tone associated with less maternal withdrawal, albeit not significant.

The correlations between vagal tone and the other prenatal depression variables and the postpartum depression variables were also examined. While higher mean pregnancy BDI was significantly associated with higher infant vagal tone with a small effect size ($r = .29, p = .03$), the correlation between peak pregnancy BDI scores and vagal tone was not significant but had a small effect size of .21. As was the case with the pregnancy BDI AUC scores, the associations between vagal tone and the two other prenatal depression scores were not in the expected direction. None of the correlations

between vagal tone and mean postpartum BDI, peak postpartum BDI, and postpartum

BDI AUC were significant, yet all three associations had small effect sizes of .22, .28,

and .25, respectively. These associations were in the opposite direction of what would be

expected, given previous research on concurrent depression and infant vagal tone.

Reliability. Inter-rater reliability on the Maternal Interactive Quality Ratings was

calculated based on the total number of segments that had been rated by the rating team

to date. Of the 84 total rated *freeplay* segments, 20 (23.8%) were also rated by a

reliability rater. Reliability was assessed at the level that the scales were used in the

hypothesis testing. Specifically, intraclass correlations were calculated for each of the

three summary scales (*Sensitivity*, *Intrusiveness*, and *Withdrawal*) between the scores

given by the primary rater and the reliability rater. The intraclass correlations for

Sensitivity, ICC(2,1) =.84, $p < .01$, *Intrusiveness*, ICC(2,1) = .67, $p < .01$, and

Withdrawal, ICC(2,1) = .94, $p < .01$, indicated strong inter-rater reliability on all three

scales. Overall, therefore, ratings for maternal parenting quality demonstrated strong

inter-rater reliability.

Hypothesis Testing

A hierarchical regression analysis (see Table 5) was conducted to test the

hypothesis that the quality of the mothers' parenting behavior with their 3-month-old

infants would interact with the level of exposure to prenatal depression in predicting

vagal tone at 3-months. At Step 1, pregnancy BDI AUC significantly predicted vagal

tone, accounting for 8.9% of the variance (R^2 = .089, p = .024). The inclusion of the three

maternal parenting quality summary scales at Step 2 accounted for an additional 1.7% of

the variance, although this change was not significant (R^2 = .115). Three interaction

variables were created to reflect the interaction between pregnancy BDI AUC and each of the maternal parenting quality summary scales. After the addition of the interaction scales to the regression at Step 3 ($\Delta R^2 = .036$), the total variance in vagal tone explained by the model as a whole was 14.1%, $F(7,49) = 1.149$. Contrary to the hypothesis, this level of change was not significant and none of the interaction terms significantly predicted vagal tone.

Discussion

This study applies vagal and differential-susceptibility theory to explore the consequences of prenatal depression, a subject that has often been overlooked in the perinatal depression research relative to postpartum depression. While the results indicated that prenatal depression significantly predicts infant cardiac vagal tone with a moderate effect size, maternal parenting quality and the interaction between prenatal depression and maternal parenting quality did not significantly predict infant vagal tone. Thus, the findings do not support the hypothesis that maternal parenting quality would moderate the relationship between prenatal depression exposure and infant vagal tone at 3-months. Nonetheless, the study has a number of strengths and raises some intriguing questions—two aspects suggesting that the current subject deserves further research.

The finding that higher adjusted area under the curve depression symptom levels across pregnancy were significantly correlated with 3-month-old infants' higher vagal tone is, perhaps, the most surprising outcome of the study. Notably, the BDI has a long history of reliability and validity in measuring depression symptom levels. Furthermore, the other pregnancy BDI scores (mean and peak) were also associated with vagal tone in the unexpected direction, which suggests that the hypothesis test results were not affected

by the decision to measure prenatal depression symptom levels with the BDI or the BDI

AUC score specifically. In addition, the mean and standard deviation of the vagal tone

data ($M = 3.11$, $SD = 1.08$) are comparable with those found in a sample of 73 five-

month-olds ($M = 3.02$, $SD = 0.71$; Fracasso, Porges, Lamb, & Rosenberg, 1994) and 86

three-month-olds ($M = 2.53$, $SD = 0.80$; Izard et al., 1991). Data were collected from both

samples at baseline (with the infant sitting quietly on the mother's lap) and both samples

had a similar demographic composition to the current sample. The vagal tone descriptive

statistics are also comparable to those collected in a sample of 41 three-month-olds

during an interaction period with the researchers ($M = 3.77$, $SD = 1.00$; Bazhenova,

Plonskaia, & Porges, 2001). Thus, the consistencies between the vagal tone data and

those found in similar research suggest that the unexpected findings of the current study

should not be attributed to errors in heart-rate data recording or in the computation of the

vagal tone index.

Previous research on prenatal depression and infant vagal tone (Field et al., 2004;

Jones et al., 1998) has identified an association between prenatal depression and lower

vagal tone in newborns. No published studies were found to have tested the association

between prenatal depression and infant vagal tone at later infant ages. Thus, until our

findings are replicated on a larger sample, the question of how prenatal depression

exposure may relate to infant vagal tone beyond the neonatal period (e.g., at 3-months of

age) still remains unanswered.

Further studies are needed to test whether prenatal depression might be related

differently to infant vagal tone at later ages. A 10-month longitudinal study (Izard et al.,

1991) identified age-related increases in vagal tone as infants developed through their

first year. Specifically, infants' vagal tone at 3-months significantly increased between

ages 3- and 13-months, $F(4, 96) = 12.86$ ($p < .01$). The possibility of developmental

increases in vagal tone and the lack of previous research identifying an association

between prenatal depression and lower vagal tone in infants beyond the neonatal period

together suggest that prenatal depression may be related to vagal tone differently

depending on the infant age at the time of the vagal tone measurement. Other important

questions to examine are whether prenatal depression relates in more of the hypothesized

direction with other measures of infant vulnerability to depression, such as EEG

asymmetry, and whether use of these measures would support the application of the

differential-susceptibility hypothesis to infants of prenatally depressed mothers.

      Although the results of the hypothesis test were not significant, correlations

among the Maternal Interactive Quality Ratings yielded interesting findings. Correlations

among the two Intrusiveness scales and *quality and amount of physical contact: negative*

(the only Negative Affect scale used in analyses) suggested that the three scales be

combined to form a more comprehensive *Intrusiveness* construct. Correlations within and

across the Withdrawal and Positive Affect scales suggested that these scales also be

combined to form one comprehensive *Withdrawal* construct. Cohn and colleagues (1986)

and Field and colleagues (1990) identified withdrawal and intrusiveness as two

predominant interaction styles among depressed mothers with their infants. The

Intrusiveness construct identified in the current study is similar to the intrusiveness style

identified in the two previous studies, which was conceptualized as an *anger/poke*

behavior characterized by both intrusiveness and negative physical contact. The

Withdrawal construct is also similar to that of Cohn and colleagues and Field and

colleagues, as withdrawn mothers inevitably lack an animated and warm affect. Unlike

the two previous studies, however, the current study identified three predominant

behaviors among mothers interacting with their infants, as a correlation between the two

Insensitive Parenting scales suggested that they be combined to form a comprehensive

Sensitivity construct. This difference might be explained by the fact that the current

sample contained participants with widely ranging levels of current depression (including

no current depression). Regardless, the identification of three distinct parenting behavior

constructs and subsequent reorganization of the Maternal Interactive Quality Ratings

necessitate replication of the findings and further research on the characteristics of

maternal parenting quality (in depressed samples and in general).

In addition to identifying three scales that might adequately describe and measure

parenting behavior in depressed mothers, the current study also attests to the reliability of

the Maternal Interactive Quality Ratings. The high inter-rater-reliability achieved on the

scales is a particular strength of this study, as it supports the use of this measure in future

research. These scales might serve as an especially useful measure of maternal parenting

quality in future studies on prenatal depression and differential-susceptibility.

This study was also limited by several factors that might help explain the

nonsignificant and unexpected findings. First, the lack of available heart-rate data for

some of the infants and the lack of available prenatal depression data for even more of the

mothers resulted in a much smaller sample than the 84 mother-infant dyads that were

rated for maternal parenting quality. Furthermore, a clear majority of the mothers

(67.3%) either experienced no depression during pregnancy or reached only mild to

moderate levels of depression symptoms during pregnancy. An increased number of

mothers experiencing more significant levels of depression would be ideal for a study on the consequences of prenatal depression. Furthermore, many of the mothers in this study were taking antidepressant medications, and future studies need to test the role of these medications in the associations studied here. These limitations, therefore, might help explain the nonsignificant findings—especially those that conflict with previous research—and suggest that future research on the subject include a larger sample.

Clearly, the current study highlights many unanswered questions and various areas for future research. As discussed previously, the preliminary findings among the Maternal Interactive Quality Ratings suggest that future studies use the scales as a measure of maternal parenting quality in order to replicate findings and further establish the scales as a reliable and valid measure. In addition, this study did not investigate the effects of infant gender, the timing of the exposure to the mother's depression (whether it occurred early in pregnancy or later on), or the relative contribution of concurrent depression to maternal parenting quality and infant vagal tone. Future research should address these variables. Finally, the positive correlation between prenatal depression symptom level and infant vagal tone requires further investigation for two purposes. First, the correlation contradicts a large body of previous research that has identified an inverse relationship between maternal depression and vagal tone in infants. Therefore, an accurate understanding of this psychophysiological measure is an essential component in understanding the transmission of depression from mother to infant, one that can only be achieved through continued investigation in this area. Secondly, the findings need to be compared to other indices of infant vulnerability to depression, and the possible effects of developmental increases in vagal tone need to be assessed. Thus, it remains entirely

possible that the differential-susceptibility hypothesis does, in fact, apply to infants of prenatally depressed mothers, and that maternal parenting quality serves as a moderator in this relationship. The results of the current study, therefore, point to further research within the current study design and further research on maternal depression and infant vagal tone in general.

As stipulated in the method section, mother-infant *freeplay* segments and EKG recordings were collected at 3-, 6- and 12-months postpartum. In addition, EKG recordings were also collected during *baseline* and *feeding* segments. Thus, a large amount of available data for the current research design remains uninvestigated. Furthermore, data collection is ongoing, such that the eventual sample size of even 3-month-olds will double that which was available here. The logical steps following this study will be to incorporate multiple measures of infant vulnerability to depression that are closely linked to prenatal depression exposure and also to include the expanded dataset once it is available. While the findings failed to support the predicted hypothesis, this study successfully identified and emphasized various avenues for future research, created an empirically- and theory-based set of maternal parenting quality scales that can be reliably measured, and established the application of the differential-susceptibility hypothesis to infants of prenatally depressed mothers as a subject worthy of future empirical attention.

References

Ainsworth, M. D., Bell, S. M., & Stayton, D. J. (1974). Infant-mother attachment and

social development: Socialisation as a product of reciprocal responsiveness to

signals. In M. P. Richards (Ed.), *The Integration of a Child Into a Social World*

(pp. 99-135). London: Cambridge University Press.

Ainsworth, M. D., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of Attachment:*

A Psychological Study of the Strange Situation. Hillsdale: Lawrence Erlbaum

Associates.

American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental*

Disorders (4th ed.). Washington, DC: American Psychiatric Association.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in

social psychological research: conceptual, strategic, and statistical considerations.

Journal of Personality and Social Psychology, 51(6), 1173-1182.

Bazhenova, O. V., Plonskaia, O., & Porges, S. W. (2001). Vagal reactivity and affective

adjustment in infants during interaction challenges. *Child Development, 72*(5),

1314-1326.

Beauchaine, T. P., Gatzke-Kopp, L., & Mead, H. K. (2007). Polyvagal theory and

developmental psychopathology: Emotion regulation and conduct problems from

preschool to adolescence. *Biological Psychology, 74*(2), 174-184.

Beck, A. T., Steer, R. A., & Garbin, M. G. (1988). Psychometric properties of the Beck

Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology*

Review, 8, 77-100.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory

    for measuring depression. *Archives of General Psychiatry, 4*, 561-571.

Belsky, J., Bakermans-Kranenburg, M. J., & van Ijzendoorn, M. H. (2007). For better and

    for worse: Differential susceptibility to environmental influences. *Current*

    Directions in Psychological Science, 16, 300-304.

Belsky, J., Hsieh, K., & Crnic, K. (1998). Mothering, fathering, and infant negativity as

    antecedents of boys' externalizing problems and inhibition at 3 years: Differential

    susceptibility to rearing experience? *Development and Psychopathology, 10*, 301-

    319.

Blom, E. H., Olsson, E. M., Serlachius, E., Ericson, M., & Ingvar, M. (2010). Heart rate

    variability (HRV) in adolescent females with anxiety disorders and major

    depressive disorder. *Acta Paediatrica, 99*(4), 604-611.

Brain-Body Center, U. o. I. a. C. (2006-2007). CardioBatch (Version 3): Brain-Body

    Center, University of Illinois at Chicago.

Cacioppo, J. T., Uchino, B. N., & Berntson, G. G. (1994). Individual differences in the

    autonomic origins of heart rate reactivity: The psychometrics of respiratory sinus

    arrhythmia and preejection period. *Psychophysiology, 31*, 412-419.

Campbell, S. B. (1991). *Coding manual for videotaped mother-infant interaction. In*

    NICHD Study of Early Child Care. manuscript.

Campbell, S. B., Cohn, J. F., & Meyers, T. (1995). Depression in first-time mothers:

    Mother-infant interaction and depression chronicity. *Developmental Psychology,*

    31(3), 349-357.

Clark, R. (1985). *The Parent-Child Early Relational Assessment: Instrument and Manual*. Madison: University of Wisconsin Medical School, Department of Psychiatry.

Cohn, J. F., Matias, R., Tronick, E. Z., Connell, D., & Lyons-Ruth, K. (1986). Face-to-face interactions of depressed mothers and their infants. In E. Z. Tronick & T. Field (Eds.), *Maternal Depression and Infant Disturbance* (pp. 31-45). San Francisco: Jossey-Bass.

Doussard-Roosevelt, J. A., McClenny, B. D., & Porges, S. W. (2001). Neonatal cardiac vagal tone and school-age developmental outcome in very low birth weight infants. *Developmental Psychobiology, 38*(1), 56-66. doi: 10.1002/1098-2302(2001)38:1<56::AID-DEV5>3.0.CO;2-K [pii]

Egeland, B., & Farber, E. A. (1984). Infant-mother attachment: Factors related to its development and changes over time. *Child Development, 55*, 753-771.

Ellis, B. J., & Boyce, T. W. (2008). Biological sensitivity to context. *Current Directions in Psychological Science, 17*(3), 183-187.

Evans, J., Heron, J., Francomb, H., Oke, S., & Golding, J. (2001). Cohort study of depressed mood during pregnancy and after childbirth. *BMJ, 323*, 257-260.

Feldman, R. (2007). Parent-infant synchrony and the construction of shared timing; physiological precursors, developmental outcomes, and risk conditions. *Journal of Child Psychology and Psychiatry, 48*(3-4), 329-354. doi: JCPP1701 [pii] 10.1111/j.1469-7610.2006.01701.x

Feldman, R., Greenbaum, C. W., & Yirmiya, N. (1999). Mother-infant affect synchrony as an antecedent of the emergence of self-control. *Developmental Psychology, 35*(5), 223-231.

Field, T., Diego, M. A., Dieter, J., Hernandez-Reif, M., Schanberg, S., Kuhn, C., et al. (2004). Prenatal depression effects on the fetus and the newborn. *Infant Behavior and Development, 24*, 216-229. doi: 10.1016/j.infbeh.2003.09.010

Field, T., Healy, B., Goldstein, S., & Guthertz, M. (1990). Behavior-state matching and synchrony in mother-infant interactions of nondepressed versus depressed dyads. *Developmental Psychology, 26*(1), 7-14.

Field, T., Healy, B., Goldstein, S., Perry, S., Bendell, D., Schanberg, S., et al. (1988). Infants of depressed mothers show "depressed" behavior even with nondepressed adults. *Child Development, 59*(6), 1569-1579.

Field, T., Pickens, J., Fox, N. A., Nawrocki, T., & Gonzalez, J. (1995). Vagal tone in infants of depressed mothers. *Development and Psychopathology, 7*(2), 227-231.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. (1995). *Structured Clinical Interview for DSM-IV Axis I Disorders, Patient Edition (SCID-I/P)*. New York: New York State Psychiatric Institute Biometrics Research.

Fox, N. A., & Porges, S. W. (1985). The relation between neonatal heart period patterns and developmental outcome. *Child Development, 56*, 28-37.

Fracasso, M. P., Porges, S. W., Lamb, M. E., & Rosenberg, A. A. (1994). Cardiac activity in infancy: Reliability and stability of individual differences. *Infant Behavior and Development, 17*(277-284).

Glover, V., Bergman, K., Sarkar, P., & O'Connor, T. G. (2009). Association between

    maternal and amniotic fluid cortisol is moderated by maternal anxiety.

    Psychoneuroendocrinology, 34, 430-435. doi: 10.1016/j.psyneuen.2008.10.005

Goodman, S. H. (2007). Depression in mothers. *Annual Review of Clinical Psychology,*

    3, 107-135. doi: 10.1146/annurev.clinpsy.3.022806.091401

Goodman, S. H., & Brand, S. R. (2009). Infants of depressed mothers: Vulnerabilities,

    risk factors, and protective factors for the later development of psychopathology.

    In C. Zeanah (Ed.), *Handbook of Infant Mental Health* (3rd ed.). New York: The

    Guilford Press.

Goodman, S. H., & Gotlib, I. H. (1999). Risk for psychopathology in the children of

    depressed mothers: a developmental model for understanding mechanisms of

    transmission. *Psychological Review, 106*(3), 458-490.

Goodman, S. H., & Tully, E. (2006). Depression in women who are mothers: An

    integrative model of risk for the development of psychopathology in their sons

    and daughters. In C. L. M. Keyes & S. H. Goodman (Eds.), *Women and*

    Depression: A Handbook for the Social, Behavioral, and Biomedical Sciences.

    Cambridge: Cambridge University Press.

Izard, C. E., Porges, S. W., Simons, R. F., Haynes, O. M., Hyde, C., Parisi, M., et al.

    (1991). Infant cardiac activity: Developmental changes and relations with

    attachment. *Developmental Psychology, 27*(3), 432-439.

Jones, N. A., Field, T., Fox, N. A., Davalos, M., Lundy, B., & Hart, S. (1998). Newborns

    of mothers with depressive symptoms are physiologically less developed. *Infant*

    Behavior and Development, 21(3), 537-541.

Jones, N. A., Field, T., Fox, N. A., Davalos, M., Malphurs, J., Carraway, K., et al. (1997). Infants of intrusive and withdrawn mothers. *Infant Behavior and Development, 20*(2), 175-186.

Kemp, A. H., Quintana, D. S., Gray, M. A., Felmingham, K. L., Brown, K., & Gatt, J. (in press). Impact of depression and antidepressant treatment on heart rate variability: A review and meta-analysis. *Society of Biological Psychiatry*. doi: 10.1016/j.biopsych.2009.12.012

Klein Velderman, M., Bakermans-Kranenburg, M. J., Juffer, F., & van Ijzendoorn, M. H. (2006). Effects of attachment-based interventions on maternal sensitivity and infant attachment: Differential susceptibility of highly reactive infants. *Journal of Family Psychology, 20*(2), 266-274. doi: 10.1037/0893-3200.20.2.266

Lavelli, M., & Fogel, A. (2005). Developmental changes in the relationship between the infant's attention and emotion during early face-to-face communication: The 2-month transition. *Developmental Psychology, 41*(1), 265-280. doi: 10.1037/0012-1649.41.1.265

Lovejoy, M. C., Graczyk, P. A., O'Hare, E., & Neuman, G. (2000). Maternal depression and parenting behavior: A meta-analytic review. *Clinical Psychology Review, 20*(5), 561-592.

Lundy, B. L., Jones, N. A., Field, T., Nearing, G., Davalos, M., Pietro, P. A., et al. (1999). Prenatal depression effects on neonates. *Infant Behavior and Development, 22*(1), 119-129.

Morrell, J., & Murray, L. (2003). Parenting and the development of conduct disorder and hyperactive symptoms in childhood: A prospective longitudinal study from 2 months to 8 years. *Journal of Child Psychology and Psychiatry, 44*(4), 489-508.

Murray, L., Kempton, C., Woolgar, M., & Hooper, R. (2006). Depressed mothers' speech to their infants and its relation to infant gender and cognitive development. *Journal of Child Psychology and Psychiatry, 34*(7), 1083-1101. doi: 10.1111/j.1469-7610.1993.tb01775.x

Porges, S. W. (1985). Method and apparatus for evaluating rhythmic oscillations in aperiodic physiological response systems. US patent, 4,510,944.

Porges, S. W. (1992). Vagal tone: a physiologic marker of stress vulnerability. *Pediatrics, 90*(3), 498-504.

Porges, S. W., Doussard-Roosevelt, J., & Maiti, A. K. (1994). Vagal tone and the physiological regulation of emotion. *Monographs of the Society for Research in Child Development, 59*(2/3), 167-186.

Porges, S. W., Doussard-Roosevelt, J. A., Portales, A. L., & Greenspan, S. I. (1996). Infant regulation of the vagal "brake" predicts child behavior problems: a psychobiological model of social behavior. *Developmental Psychobiology, 29*(8), 697-712.

Rosenblum, O., Mazet, P., & Bénony, H. (1997). Mother and infant affective involvement states and maternal depression. *Infant Mental Health Journal, 18*(4), 350-363.

Stifter, C. A., Fox, N. A., & Porges, S. W. (1989). Facial expressivity and vagal tone in 5- and 10-month-old infants. *Infant Behavior and Development, 12*, 127-137.

Appendix

Maternal Interactive Quality Ratings

Participant ID: _____

First Name, Last Initial: _____

Session Date: _____

Baby's Age: **3**   **6**   **12**
(circle one)

Condition: **Feeding**   **Play**
(circle one)   **(F)**   **(P)**

Coder: _____

Type of Coding: **Primary**   **Reliability**
(circle one)

Date Coded: _____

SPSS entered by: _____

SPSS entered date: _____

Start Time: _____

Stop Time: _____

Feeding Type: **1 = Breast**
(circle one)

2 = Bottle or Cup

3 = Finger or Spoon

Comments:

I.   Sensitivity

1.   Sensitivity/responsiveness to distress

2.   Sensitivity/responsiveness to nondistress

II.   Intrusiveness

3.   Intrusiveness

4.   Cooperation vs. Interference

III.   Withdrawal

5.   Detachment/disengagement

6.   Flatness of affect

IV. Positive Affect

7.   Positive Regard for the child

8.   Warmth

9.   Stimulation of Development

V. Negative Affect

10. Quality and Amount of Physical Contact: Negative

11. Angry, Hostile Mood

12. Displeasure, Disapproval, Criticism

13. Quality of Verbalizations

14. Structures and Mediates Environment

Maternal Interactive Quality Ratings

I.   Insensitive Parenting

1.   *Sensitivity/responsiveness to distress*

- Proportion of distress signals responded to. Responds to all signals.
- Latency of response. Responds promptly. Mild fussiness does not require as quick a response than acute distress.
- Appropriateness of response. Effective in soothing the child. For example, speaking to the child, switching positions, offering or changing toys, patting, holding close, etc. All attempts to soothe should be acknowledged.
- The decision of a 2 vs. a 3 would be made on the basis of the overall percentage of signals (greater than 1/2 responded to being given a 3; fewer than 1/2 given a 2) and the relation between degree of distress and responsiveness.
- If the mother's first response to the distressed infant does not soothe the child, the episode should be judged as insensitive/unresponsive (even if the response was immediate) **unless** the mother proceeds to offer a "fuller" response (i.e., more proximal soothing behaviors).

1 = **Not at all characteristic.** Mother's behavior is extremely insensitive. Either no response or only responds when infant becomes very demanding. **A rating of 1 should be given for those mothers who are so unresponsive, delayed, and inappropriate in their responding that it could be considered problematic.**

2 = **Minimally characteristic.** Mother displays infrequent/weak response. Responds slowly and ineffectively. If the clear majority of responses were inappropriate/ineffective even though immediate, the rating should be a 2.

3 = **Moderately characteristic.** Mother is predominantly sensitive/responsive, but there is some time in which the infant's signal does not receive a response or the response is delayed. If only the milder fusses are the ignored signals, even if fussing represents more than half of the distress signals emitted, then the observation would be coded 3.

4 = **Highly characteristic.   Mother is exceptionally sensitive and responsive to distress.** A rating of 4 should be given to those mothers who exhibit immediate and exceptionally sensitive appropriate responses.

9 = **No opportunity to observe.** No instances of child distress were observed.

Comments:		
Distress Signals		
Weak	Strong	Effectiveness of Response

2. *Sensitivity/responsiveness to nondistress*

- The mother is tuned to the child and manifests awareness of the child's needs, moods, interests, and capabilities, and allows this awareness to guide his/her interaction.
- The mother provides stimulation that is situationally appropriate and takes an active interest in the child's activities (i.e. makes comments and embellishments when child loses interests).
- The mother is not overstimulating/intrusive and the interactions are well timed and paced to the child's responses.

1 = **Not at all characteristic.** Mother is predominately intrusive or detached. No signs of sensitivity.

2 = **Minimally characteristic.** Mother displays infrequent or weak sensitivity/responsiveness

3 = **Moderately characteristic.** Mother is predominately sensitive/responsive. Sometimes (at least twice) neglects to give a fuller response or a well-timed or appropriate response.

4 = **Highly characteristic. <u>Mother is exceptionally sensitive and responsive.</u>**

<div align="center">Score ____</div>

II.   Intrusiveness

3.   *Intrusiveness*

- The mother imposes her agenda on the child despite signals that a different activity, level, or pace of interaction is needed.
- If the child responds positively with sustained interest **<u>and</u>** is not engaging in defensive behaviors then intrusiveness is not occurring; however, intrusiveness is evident when the child averts his/her gaze, turns away, or expresses negative affect and the mother continues or escalates his/her activity.
- For example, (a) speaking too loudly or being extremely close to the child physically or with a toy; (b) offering a continuous barrage of stimulation, food, or toys; (c) persisting to demonstrate toys long after the child's interest has been gained and he/she wants to manipulate the toy him/herself; (d) overwhelming the child with a rapid succession of toys or approaches and not allowing him/her time to react to one before another occurs.

1 = **Not at all characteristic.** This rating should be given to mothers who display almost no sign of intrusive behavior. A mother may show two instances of mildly intrusive behavior and still receive a 1 if the baby does not respond defensively in any way.

2 = **Minimally characteristic**. This rating should be given to mothers who display minimal intrusiveness. There is some evidence of intrusiveness, but it is not typical. The mother may initiate interactions with and offer suggestions to the child which occasionally are not welcomed. The mother sometimes continues his/her activity after the child engages in defensive behavior, but does not escalate the activity.

3 = **Moderately characteristic.** This rating should be given to mothers who are regularly intrusive. Mother intrusiveness occurs with moderate frequency.

4 = **Highly characteristic**. **This rating should be given to mothers who are so intrusive that it is worrisome**. The mother is consistently and typically intrusive. Most of the observation period is marked by the mother

completely controlling the interaction, allowing the child little self-direction in his/her activities.

<div align="center">Score ____</div>

4. *Cooperation vs. Interference*

- This scale is concerned with the extent to which the mother's interactions interrupt the baby's ongoing activity rather then being concerned with the timing and the baby's state, mood, and current interests.

- Some examples of interference are: (a) not allowing the child to influence the pace or focus of play, interaction, or feeding; (b) taking away objects or food while the child still appears interested; (c) not allowing the child to handle toys he/she reaches for; (d) insisting that the child do something (play, eat, interact) in which he/she is not interested; and (e) not allowing the child to make choices.

- Some examples of cooperation are: (a) delaying interference until a natural break in the child's activity occurs; (b) gradually diverting the child from what he or she is doing to move toward a more desirable activity; (c) responding to the child's vocalizations and/or initiations of play; (d) shifting an approach when the child does not respond; and (e) being spontaneous according to the child's mood and the situation (i.e. talking softly when the baby appears tired and irritable).

1 = **Highly interfering**. This rating should be given to mothers who "are conspicuous for the direct, physical, forcefulness of their interruptions or restraints. Others are conspicuous for the extreme frequency of interruption of the baby's activity-in-progress so that they seem 'at' the baby most of the time – instructing, training, eliciting, directing, and controlling. But the "1" mother tends to combine both types of interference, even though she may emphasize one type more than the other. Regardless of the balance between physical man-handling and milder interruptions, these mothers have in common an extreme lack of respect for the baby's autonomy, and an obtrusiveness which permits them to break into what the baby is doing without any need to explain to others or even to justify to themselves the reason for the interruption."

2 = **Interfering.** Like "1" mothers, these mothers display either direct, forceful, physical interference or frequent milder interference or both. But the "2" mother "has some kind of rationale for her actions which is perceivable to the observer (even though it may seem far from desirable); the interference is not obviously arbitrary. For example, the mother may be more focused on attempting to "shape the baby" to her way of doing things or she may be trying to focus on a specific routine.

3 = **Mildly interfering**. The "3" mother tends to issue more verbal commands and prohibitions to control the baby from a distance rather than being direct, abrupt, and physically forceful, making her interference milder than mothers with lower ratings. Compared to mothers with higher ratings, the "3" mother "pays less attention to mood-setting and to other techniques which aid smooth transitions from one activity to another". She tends to switch to certain activities (nap, feeding, etc.) without regard to the baby's ongoing activity.

4 = **Cooperative.** The mother is predominately cooperative and non-interfering. The "4" mother tends to give more verbal commands and prohibitions that the "5" mother; however she attempts to avoid interference and "rarely, if ever, intervenes in direct, abrupt, physical ways."

5 = **Conspicuously cooperative**. This mother "avoids interrupting an activity the baby has in progress. When it is desirable to intervene for a routine or to shift she truly engages his cooperation, by mood-setting, by inviting him, by diverting him, and by engaging him in reciprocal activity of some sort, often enough vocalization or play." Except in emergency situations, the mother never interferes abruptly.

<div align="center">Score ____</div>

III. Withdrawal

5. *Detachment/disengagement*

- The mother appears emotionally uninvolved or disengaged, and unaware of the child's needs for appropriate interaction to facilitate involvement with objects or people.
- Detachment can be marked by (a) putting the child so he/she faces away from the mother, without attempts to visually "check in"; (b) presenting toys without first engaging the child or showing him/her how to manipulate them;(c) rarely making eye contact or rarely talking to the child; (d) not responding to the child's vocalizations. smiles, or reaches for toys; (e) an unawareness of the child's capabilities and appropriate activities; (f) positioning the child so that he/she cannot reach or manipulate a toy; (g) cleaning the child, rocking, diapering, or feeding in a mechanical, detached, distant way (h) ignoring the interesting things the child does; (i) letting the child play unsupervised without checking in; and (j) continually calling the child "baby" instead of using his/her name.
- The mother is more focused on the toy than the child.

1 = **Not at all characteristic.** This rating should be given to mothers who display **almost no signs** of detachment or underinvolvement. When interacting with the child. The mother is clearly emotionally involved. These mothers can be sensitive or intrusive.

2 = **Minimally characteristic.** This rating should be given to mothers who display minimal detachment. While the mother is sometimes noninvolved, he/she is clearly more involved than not.

3 = **Moderately characteristic.** This rating should be given to mothers who are predominantly detached. The mother is relatively more noninvolved than involved, but the detachment is not so prevalent that it is problematic.

4 = **Highly characteristic. This rating should be given to mothers who are so detached that it is worrisome.** In the minimal instances of involvement, the mother's behaviors are simple, mechanical, stereotyped, repetitive, and perfunctory. The mother is clearly not emotionally involved with the child, and appears to be "just going through the motions."

<div align="center">Score ____</div>

6. *Flatness of affect*

- This scale measures how animated the mother is. Flat affect may reflect boredom, depression, fatigue, or distraction.
- Flatness is exhibited by blank, impassive facial expression, and flat tone in vocal expression. It is marked by a lack of animation. If the mother is watching the child with interest (eyes "bright"), it is a sign that the mother's affect is not flat.

1 = **Not at all characteristic.** This rating should be given to mothers who exhibit **almost no flatness**. There is consistent animation in the mother's demeanor and behavior

2 = **Minimally characteristic.** This rating should be given to mothers who exhibit some flatness. The mother is usually animated, but there is some time when facial expression is blank and impassive.

3 = **Moderately characteristic.** This rating should be given to mothers who are predominantly flat. Some periods of animation alternate with more clear periods of flatness than observed for a score of 2. Flat affect predominates.

4 = **Highly characteristic**. **This rating should be given to mothers who are so flat that it is worrisome.** There is consistent absence of animation.   Score _____

IV. Positive Affect

7. *Positive Regard for the child*

- Ratings on this scale are based on both quality and quantity of positive regard.
- Positive feelings are shown by (a) speaking in a warm tone of voice; (b) hugging or other expressions of physical affection; (c) an expressive face; (d) smiling; (e) laughing with the child; (f) enthusiasm about the child; (g) praising the child; and (h) general enjoyment of the child. Positive regard is evident when the mother listens, watches attentively, looks into the child's face when talking to him/her, has affectionate physical contact, and is playful.

1 = **Not at all characteristic. This rating should be given to mothers who display so little positive regard that it is worrisome**. This rating can also be used for positive expressions (laughing, smiling) that appear to be inappropriate to the situation or an inaccurate reflection of the mother's feelings. The mother may be expressionless or flat, or negative.

2 = **Minimally characteristic.** This rating should be given to mothers who display infrequent or weak signals of positive regard. The intensity and frequency of behavioral indicators are both low.

3 = **Moderately characteristic.** This rating should be given to mothers who predominantly display positive regard. More frequent and intense positive affect is shown than in the 2 rating, but the mother is not as strongly or consistently positive as those scored as a 4.

4 = **Very characteristic.** This rating should be given to mothers who are exceptionally positive in terms of facial and vocal expressiveness and behavior. Affect is positive and spontaneous.

The mother shows a range of expressions and behaviors, which are all clearly positive. He/she clearly "delights" in the child.

<div align="center">Score_____</div>

8. *Warmth*

- This scale reflects the quality of Mother's affection toward Baby; it includes the extent to which Mother expresses affection toward Baby in a pleasurable way. Warmth may be apparent in vocal affect or content, expression, or handling.

1 = **None.** M's behavior consistently fails to convey warmth; interactions generally lack tenderness, caring and affection

2 = **Little**

3 = **Some**. M's behavior usually expresses some warmth, but on some or many occasions, her behavior lacks tenderness, caring, and affection.

4 = **Much**

5 = **Very much.** M's behavior always expresses warmth. Her behavior is very tender, caring and affectionate.

Score ____

9. Stimulation of Development

- This scale focuses on the amount and quality of activities that may ultimately enhance perceptual, cognitive, linguistic, and physical development. All qualitative judgments must be considered in relation to the quantity of stimulation provided by the mother: How many of the available opportunities for stimulation were taken advantage of?

- Behaviors characterizing stimulation include (a) attempting to focus the child on an object or task; (b) focusing the child's attention on the perceptual qualities (sounds, colors, movement, etc.) of objects; (c) verbally responding to or expanding on the child's verbalizations or vocalizations; and (d) encouraging the child to actively participate in activities.

- Higher scores should be reserved for those mothers who (a) describe or label toys or objects, or demonstrate how they work; (b) read or recite to the child; (c) challenge the child to try something new; (d) present activities in an organized sequence of steps; (e) teach the child or give him/her an opportunity to experiment with materials that illustrate or teach concepts; (f) label and interpret the child's experiences, (e.g. "you think that's funny"); and so on.

1= Not at all characteristic. **This rating should be given to mothers who provide so little stimulation that it is worrisome.** The mother makes almost no attempts to teach the child anything. The mother may ignore the child's activities and never does more than offer toys in a perfunctory, mechanical manner. She is typically silent.

2= Minimally characteristic. This rating should be given to mothers who provide infrequent or weak stimulation. The mother's conscious and purposeful attempts to engage the child in development fostering experiences are limited. He/she may label or demonstrate materials, but does so perfunctorily and with minimal elaboration. If a mother spends a very brief portion of the time in high-quality interactions with a child and provides that child with no stimulation for the remainder of the time, he/she would receive a rating of 2. **A mother might also receive a 2 if stimulation is continuous but minimally advantageous.**

3= Moderately characteristic. This rating should be given to mothers who provide adequate stimulation but could reasonably be expected to provide more and higher-quality stimulation. The mother does make some effort to provide stimulation, but does not consistently take advantage of opportunities to do so. Stimulation is not the main agenda. The mother may find some new ways to engage the child with toys, for example, but, actions are likely to be simply repeated rather than thoughtfully varied. **Mothers who provide a rich linguistic environment but do not demonstrate the potential of toys or objects would receive this rating as well as mothers who demonstrate toys in a stimulating but non-vocal manner.**

4= Very characteristic. This rating should be given to the mother who is consistently stimulating and takes advantage of many activities to stimulate. The mother provides frequent stimulation through "lessons," explanations, activities, or toys. Teaching or fostering development is a primary intent. The mother thoughtfully varies and elaborates on these activities, providing numerous opportunities, **which are exceptionally advantageous to the child**.

9= Feeding Scale: NR

Score ____

V.   Negative Affect

10. Quality and Amount of Physical Contact: Negative

- This variable assesses the **quality** and **amount** of negative physical contact experienced by child. This may range from awkward, abrupt, disruptive and/or insensitive handling to intense tickling and/or rough-and-tumble play to physical restraint, slapping, pinching, and/or hitting.

1 = Characteristic; frequent negative contact or restraint of child.

2 = Considerable. Not characteristic.

3 = Moderate amount of negative contact or restraint of child.

4 = Slight instances.

5 = No instances of negative contact or restraint of child.

<div align="center">Score _____</div>

11.   Angry, Hostile Mood

- This may be reflected in hostile, irritable or angry *behavior* and/or *facial expressions*; annoyance or irritability; *tone of voice*; *content* of vocalizations; *posture*. Consider intensity and duration of expressed affect over the five-minute segment.

1 = Extremely or characteristically hostile or angry mood, i.e. attitude and affect

2 = Marked expression of anger and hostility; some modulation in intensity and duration. Angry mood not quite characteristic.

3 = Moderately angry, irritable or hostile. Quality of anger, irritability or hostility is not intense.

4 = Slight annoyance, irritability, hostility or brief, fleeting episode of anger. Pervasive mood w/o anger.

5 = No anger displayed.

<div align="center">Score ____</div>

12.   Displeasure, Disapproval, Criticism

- This may be evidenced in mild expressions of displeasure to extreme amounts of criticism and/or negativity including harsh tone of voice, cynical, nasty and/or taunting remarks.
- Criticism may be expressed vocally, facially, or through gestures toward the child. Does not need to be blatant displeasure; could be cynical or sarcastic. Examples of criticism: "You can't do that" "No, don't do it that way" "Why are you doing this" "You ain't paying attention."

1 = Characteristically negative; critical; may include attributing negative characteristics to child; abusive remarks or behavior.

2 = Considerable negativity; critical much of the time

3 = Moderately displeased, disapproving and/or critical.

4 = Slight displeasure, disapproval, and/or criticism

5 = No evidence of displeasure, disapproval, or criticism.

<div align="center">Score ____</div>

13. *Quality of Verbalizations*

- The quality of the parent's verbalizations to or about the child with the emphasis on whether or not language is used as communication; the verbal aspect of the parent-child dialogue.
- Optimal includes imitating and extending infant vocalizations or child's verbalizations, Questioning and answering child, elaborating on child's verbalizations, commenting on child's activities, etc. with very young infants verbalization may be used to help the infant regulate (note cadence in parent's voice, 'motherese').
- The rater should consider the quality of developmental appropriateness of the verbalizations, not necessarily the number of times parent speaks to the child.

1 = No instances of communicative verbalizations or facilitation of child's language

2 = Few instances of communicative verbalizations or meaningful communication. Only a few high quality verbalizations or the parent doesn't talk very much, but when does talk – high quality

3 = Moderate amount of quality of verbalizations or meaningful communication.   Half of the verbalizations were high quality or talked half of the time and those were high quality

4 = Many. Some breaks in dialogue, most verbalizations were high.

5 = Most verbalizations (90%) are of high quality or characterized by meaningful communication

9 = NR

Score ____

14. *Structures and Mediates Environment*

- This variable attempts to assess the parent as the child's first or auxiliary ego, i.e. a parent's demonstrated capacity to take the role of an adult caretaker as appropriate to the child's needs and to the task. This includes modulating affect and stimulation as well as facilitating the child's acquisition of skills and mastery of age-appropriate tasks.
- This can be measured by looking at the amount and the way in which s/he *gains, helps to focus, and sustains* the child's attention to the relevant aspects of the situation.
- The *scaffolding* provided by the parent may, with a younger infant, be manifested by good, protective caretaking.
- With an older child, this may include a quality of assistance such as teaching, demonstrating, clear statements of expectations, and limit setting with an awareness of where the child is affectively and cognitively.
- Quality includes effectiveness of parent's efforts.

1= no instances of providing structure or mediation of environment; efforts to structure or mediate are completely ineffective

2 = a few attempts to structure/mediate; efforts to structure or mediate are usually ineffective

3 = moderate amount or effectiveness of structuring/mediating

4 = on most occasions takes role of adult caretaker where this is appropriate. Efforts to structure are usually effective. Mediates well in terms of keeping the child from getting upset, but doesn't structure or high quality structuring but less strong scaffolding

5 = characteristically takes role of adult caretaker. Efforts to structure are almost always effective. Both structuring (and mediating) and scaffolding – effective in sustaining and maintaining the child's attention, engaging the child in play/feeding/other activity.

9 = NR

Score ____

Table 1

Descriptive Statistics for Maternal Interactive Quality Rating Scales

Variable	*M*	*SD*	*Range*
Sensitivity/Responsiveness to distress	2.85	0.79	1-4
Sensitivity/Responsiveness to nondistress	3.00	0.72	2-4
Intrusiveness	1.95	0.82	1-4
Cooperation vs. Interference*	3.29	0.84	1-5
Detachment/Disengagement	1.50	0.75	1-4
Flatness of Affect	1.86	0.85	1-4
Positive Regard for the Child	3.18	0.75	1-4
Warmth*	3.77	0.81	2-5
Stimulation of Development	2.56	0.75	1-4
Quality and Amount of Physical Contact: Negative*	4.64	0.61	2-5
Angry, Hostile Mood*	4.92	0.32	3-5
Displeasure, Disapproval, Criticism*	4.67	0.50	3-5
Quality of Verbalizations*	3.13	1.14	1-5
Structures and Mediates Environment*	3.10	0.99	1-5

Note. Variables marked with an asterisk were scored on a 5-point scale. All others were scored on a 4-point scale.

Intrusiveness, *detachment/disengagement*, and *flatness of affect* were reverse scored scales.

Table 2

Correlations Among Rating Scales in the Hypothesized Withdrawal Construct

Variable	1	2	3	4	5	6	7
1. Detachment/Disengagement	__	.64	-.63	-.64	-.42	-.50	-.52
2. Flatness of Affect	__	__	-.72	-.64	-.29	-.43	-.37
3. Positive Regard for the Child	__	__	__	.70	.47	.58	.58
4. Warmth	__	__	__	__	.35	.45	.55
5. Stimulation of Development	__	__	__	__	__	.69	.64
6. Quality of Verbalizations	__	__	__	__	__	__	.56
7. Structures and Mediates Environment	__	__	__	__	__	__	__

Note . p < .01 for all correlations. Detachment/disengagement and *flatness of affect* were reverse scored scales.

Table 3

Descriptive Statistics for Sensitivity, Intrusiveness, and Withdrawal Summary Scales;

Prenatal Depression Scores (BDI AUC); and Vagal Tone

Variable	*M*	*SD*	*Range*
Sensitivity	2.99	0.64	2.00-4.00
Intrusiveness	3.66	0.63	2.00-4.67
Withdrawal	3.33	0.58	1.86-4.43
BDI AUC	398.06	272.71	35.64-1207.82
Vagal Tone	3.11	1.08	-1.67-5.44

Table 4

Correlations Among Maternal Parenting Quality Summary Scales, Prenatal Depression

Scores (BDI AUC), and Vagal Tone

Variable	1		2		3		4		5	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
1. Sensitivity	____		.43**	.01	.62**	.01	-.13	.33	.07	.57
2. Intrusiveness	____		____		.22	.10	.05	.74	.01	.95
3. Withdrawal	____		____		____		.08	.54	.16	.24
4. BDI AUC	____		____		____		____		.30*	.02
5. Vagal Tone	____		____		____		____		____	

p < .05. **p < .01.

Table 5

Summary of Hierarchical Regression Analysis for Variables Predicting Vagal Tone

Variable	*B*	*SE B*	β
Step 1			
BDI AUC	0.001	> 0.001	0.300*
Step 2			
BDI AUC	0.001	0.001	0.310*
Sensitivity	0.161	0.306	0.102
Intrusiveness	-0.105	0.249	-0.062
Withdrawal	0.084	0.300	0.050
Step 3			
BDI AUC	0.008	0.005	2.011
Sensitivity	-0.098	0.623	-0.062
Intrusiveness	0.312	0.535	0.183
Withdrawal	0.646	0.592	0.382
BDI AUC X Sensitivity	0.001	0.001	0.444
BDI AUC X Intrusiveness	-0.001	0.001	-0.847
BDI AUC X Withdrawal	-0.002	0.001	-1.402

Note. R^2 = .089 for Step 1; ΔR^2 = .017 for Step 2; ΔR^2 = .036 for Step 3

*p < .05