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Positive Affect in Middle Childhood:

Associations with Mothers' History of Depression

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Positive Affect in Middle Childhood:

Associations with Mothers' History of Depression

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Abstract

Positive Affect in Middle Childhood:
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By Katherine A. Cullum

Children of mothers with a history of depression are at elevated risk for depression. Reduced positive affect (PA) may represent a vulnerability to depression. The rate of depression increases in adolescence, albeit specifically for females. Thus, middle childhood may be an important developmental period for understanding PA as a vulnerability to depression. Forbes and Dahl (2005) proposed a model in which PA is characterized by four features: behavioral, hedonic, motivational, and physiologic. Yet most studies have examined only one or two of these features of PA in relation to childhood risk for depression. The current study built upon the literature by examining all four features of PA. We investigated the extent to which a sample of 131 8 to 10 year-old children with and without a maternal history of depression differed in terms of each feature of PA. We expected that children of mothers with a history of depression would show lower PA across features relative to controls. We further expected that associations between maternal depression history and PA would be stronger for females than for males. Lastly, we explored the extent to which mothers' current depressive symptom level accounted for additional variance in PA. To test these hypotheses, we took a multi-method approach that included: self-reports, observed affect coding, performance on a behavioral monetary reward task, and physiologic measures (EEG and RSA). Analyses failed to support the hypothesis that mothers' history of depression would be associated with child PA or that the association would be stronger for females. Females reported higher hedonic PA, although there were no other significant sex differences. Mothers' current symptom levels did not contribute to the prediction of child PA beyond other variables in the model. Results are discussed in terms of potential methodological and developmental implications as well as directions for future research.

Keywords: positive affect, middle childhood, maternal depression

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Positive Affect in Middle Childhood: Associations with Mothers' History of Depression

Approximately 7.5 million parents in the United States are affected by depression each year, leaving at least 15 million children at risk for various adverse developmental outcomes associated with depression in parents, including risk for the development of depression (for a review, see Goodman & Gotlib, 1999; National Research Council and Institute of Medicine, 2009). The manifestation of depression in children of depressed parents is, on average, associated with an earlier onset relative to that in children of non-depressed probands; this is particularly concerning given the impairments in cognitive, behavioral, interpersonal, and neuroendocrine functioning associated with early-onset depression (for a review, see Beardslee, Versage, & Gladstone, 1998; Wilcox & Anthony, 2004). Although depression in both parents is concerning, depression in women is three times more prevalent than in men (Kessler, 2006), and women are the primary caregiver to most children (National Alliance for Caregiving and AARP, "Caregiving in the U.S. National Alliance for Caregiving," 2009). Based on consistent evidence over several decades, depression in mothers is considered an established risk for the development of depression in their offspring. Even prior to the onset of depression, children of depressed mothers show problems in affective, behavioral, cognitive, and biological functioning, which may reflect underlying vulnerabilities and could serve as early markers of risk for the later development of depression (Klein, Kujawa, Black, & Pennock, 2013). The current study seeks to further explore one such possible marker of vulnerability, low positive affect (PA).

Positive affect plays a central role in depression, with diminished interest and/or pleasure (known as anhedonia) being a hallmark diagnostic criterion. The tripartite model

of depression and anxiety clarifies that while high *negative* affect (NA; which reflects anger, sadness, fear, anxiety, or frustration) characterizes both depression and anxiety, low PA is specific to depression (Klein et al., 2013). In addition to the understanding of the role of PA in depression, researchers have begun to consider whether and to what extent differences in PA may precede the onset of depression. This question is particularly compelling to ask of children who have mothers with past or current depression (typically during the child's lifetime) and, thus, are at increased risk for depression.

Middle Childhood

Examining vulnerabilities to depression during middle childhood may be of particular importance relative to other periods in development. Starting around the age of 11, the onset and prevalence of depression begins a sharp and steady increase that continues into early adulthood, albeit specifically in females (Costello, Copeland, & Angold, 2011; Hankin et al., 1998). As such, the period directly *prior to* adolescence maybe when vulnerabilities to depression emerge and, thus, is of particular relevance for understanding the later development of depression, with implications for primary prevention (Costello et al., 2011).

PA as a Vulnerability to Depression

Definition. PA refers to positively-valenced cognitions, moods, and emotions (for a review, see Forbes & Dahl, 2005; Ramsey & Gentzler, 2015). Although PA is variously referred to as positive emotionality and positive affectivity, we use the term positive affect and the abbreviation PA. In contrast with NA, PA taps into the experience and expression of pleasure, excitement, or joy. Although PA and NA may be thought to exist

on opposite ends of a spectrum, evidence from across the lifespan supports them being orthogonal constructs (for a review, see Belsky, Hsieh, & Crnic, 1996; Ramsey & Gentzler, 2015).

Features of PA. Proposing a framework of PA encompassing both developmental psychopathology and affective neuroscience perspectives, Forbes and Dahl (2005) conceptualize PA as a system made up of behavioral, hedonic, motivational, and physiologic features. Together, these features organize to facilitate the pursuit and enjoyment of rewards, including and importantly within social context. Their framework extends previous models considering affect dysregulation generally, specifying a set of positive affective processes that may be altered in association with depression. The framework thus enables a more nuanced understanding of PA than had been available in the past and the potential to reveal that particular features of PA may represent a vulnerability to depression, rather than the broader construct of PA.

PA as a Vulnerability to Depression. In several studies, researchers have conducted cross-sectional comparisons of currently depressed and non-depressed adults and youth and, in comparison to controls, found depression to be associated with lower positive mood states (e.g., Clark & Watson, 1991; Joiner et al., 1996), reduced reward anticipation (Sherdell, Waugh, & Gotlib, 2012), and fewer responses and monetary earnings during a progressive ratio reinforcement task (Hughes, Pleasants, & Pickens, 1985). In addition to these findings on PA features in currently depressed adults or youth, Forbes and Dahl (2005) posit that alterations to PA may represent a *vulnerability* to depression. Researchers have begun testing this premise, examining PA features as vulnerabilities to depression. Despite the knowledge gained from such studies, they are

limited in being restricted to only one or two of the features of PA in isolation (e.g., behavioral PA), which precludes the potential benefits of interpreting findings within the multi-feature framework put forth by Forbes and Dahl. In the next sections, we review findings on each feature of PA related to risk for depression, with a focus on studies of children in middle childhood where the literature allowed.

Behavioral feature of PA. Most typically, researchers study the behavioral feature of child PA through observations of affective behavior during parent-child interactions. Evidence for the importance of this index of behavioral PA in normative samples, albeit specific to young children, is a finding from Hayden et al. (2006) in which 3 to 4 year-olds' observed lower facial, physical, and verbal PA was found to predict their higher interpersonal helplessness and decreased processing of positive self-relevant descriptors 3 to 4 years later (Hayden, Klein, Durbin, & Olino, 2006).

Researchers provide support for the behavioral feature of PA, measured from observations, being lower in children of mothers with a history of depression relative to controls. For example, 3 to 8 year-old children of mothers with childhood-onset depression showed lower observed PA (i.e., physical gestures such as hugging or kissing mother, facial expressions and verbal comments that were positive in both content and tone) during an emotion regulation task, relative to children of mothers with a lifetime free of any major psychiatric disorder (Shaw et al., 2006). In a longitudinal study of changes in observed PA across childhood (from late infancy to 9 years of age), Olino and colleagues (2011) found low observed PA (as indexed by facial, verbal content and tone, and physical expression) in children of mothers with a history of depression across development, relative to controls, with an average ES of .20. Findings were not presented

separately for males and females. Two studies that sampled broad age ranges spanning middle childhood and adolescence drew similar conclusions. In the first study, 8- to 17 year-olds whose mothers had a history of major depressive disorder (MDD) were observed to have lower PA than controls (e.g., Dietz et al., 2008). In the second study, 9- to 14-year old never depressed children of mothers with a history of MDD, compared to children of mothers with no lifetime history of psychiatric disorder, showed lower PA, both in a context primed for positivity and one primed for conflict in mother-child interactions (McMakin et al., 2011). Overall, findings from these studies support as association between maternal history of depression and lower observed PA in children, including prior to the age when rates of depression increase. Further, consideration of child sex in relation to this association is needed.

In addition to mothers' history of depression, mothers' current depressive symptom levels could account for offspring's behavioral (observed) PA. Durbin, Klein, Hayden, Buckley, and Moerk (2005) found that current maternal depression was associated with lower levels of child PA. Consistent with this idea, Olino et al. (2011) found that elevated current maternal depression predicted their offspring's lower observed PA; however, this relationship was true only for mothers with depression comorbid with anxiety. On these bases, we examined the role of mothers' current depressive symptom level in predicting child observed PA beyond the variance accounted for by mothers' history of depression.

Hedonic features of PA. The hedonic features of PA refer to the momentary experience of pleasure and reflect the experience of enjoyment in relation to positive outcomes (Heller et al., 2013). Paul Meehl was amongst the first to posit hedonic

capacity as one probably pathway, or precursor, to depression (Meehl, 1975). Low hedonic tone is believed to increase risk of depression by lowering reactivity to external, rewarding experiences and by lowering the positive cognitive bias that is typical of children (Hayden, Klein, Durbin, & Olino, 2006; Forbes, Shaw, & Dahl, 2007). Meehl posited that, if low hedonic capacity is indeed a precursor of depression, then this should be more evident in populations at elevated risk for clinical depression compared to those at low risk for this outcome.

We found only one study of hedonic PA in children of mothers with a history of depression. Among 8 to 17 year-old children, levels of hedonic PA were assessed multiple times via self-report using ecological momentary assessment (EMA) outside of the school day. They found no significant differences on hedonic PA between children of mothers with or without a history of depression (Olino et al., 2014). Given that the collection of EMA data was restricted to outside the school day, when have the opportunity to seek out environments that they enjoy, the authors posit that their failure to find a significant group difference on this assessment of PA likely reflects a lack of distinction between high and low risk groups specifically in enjoyable environments. Thus, we examined this feature using the same measure as Olino et al., but in the standardized context of a lab visit.

Motivational features of PA. According to Forbes and Dahl (2005), the motivational feature of PA is involved in reward anticipation and reward-seeking behavior. We found a few studies that examined reward motivation as it relates to risk for depression in childhood. Supporting a role of reward motivation in depression in childhood, Forbes, Shaw, and Dahl (2007) found that reduced reward-seeking (i.e., the

failure to choose an option with a high probability of returning a high magnitude, monetary reward) not only characterized recently depressed 11-year old boys but also predicted their self-reported depression a year later. Building on this evidence of altered reward functioning in currently depressed children, other researchers examined the extent to which altered reward functioning also characterizes children at risk for developing depression.

Olino et al. (2014) found that 8 to 17-year-old youth (*M* age = 15.72) at high familial risk for depression demonstrated reduced striatal response during reward anticipation, relative to their low risk peers, even after controlling for youths' self-reported current depressive symptoms. Olino et al. (2014) did not present findings separately for males and females. This finding suggests that a disturbance of reward anticipation may be a marker of vulnerability to the development of depression. Moreover, this finding is consistent with evidence of reduced reward-related striatal activation in 10- to 14-year old never-depressed girls of mothers with a history of depression during their daughters' lifetime, even after controlling for girls' anhedonic symptoms (compared to their peers with no maternal history of psychopathology; Gotlib et al., 2010).

In contrast to these two studies examining reward at the neural level, the one study we found to report on *behavioral* responses to reward did not find an association with risk for depression. In this study, Luking, Pagliaccio, Luby, and Barch (2015) found no differences in approach behavior in 7-10 year-old children with and without a maternal history of depression during a gain feedback condition (where the reward was a piece of candy). However, in post hoc analyses, among children of depressed mothers,

number of maternal depressive episodes was associated with loss avoidance behavior, suggesting the importance of increased risk related to severity of maternal depression. In the current study, we pursue this idea by examining the role of mothers' current depression symptom levels beyond variance in PA explained by mothers' history of depression.

Physiologic features of PA. Physiologic features of PA refer to processes involved with the enhancement or dampening of positive affect, and, thus, in the achievement of goals related to affect regulation and affect expression. The two most commonly studied indices of the physiological feature of PA are frontal electroencephalogram (EEG) asymmetry and respiratory sinus arrhythmia (RSA). Studies of EEG asymmetry and RSA at baseline and in response to laboratory stressors have facilitated understandings of neural and autonomic nervous system (ANS) activity, respectively, associated with PA.

Although the relation between cerebral asymmetry and affective valence has been debated (Harmon-Jones, 2003), greater relative left frontal EEG activation is thought to be one neurobiological marker of approach behavior, and, thus, related to PA, whereas greater right frontal activation is thought to index withdrawal behavior (relating to negative affect) (Davidson & Fox, 1982; Forbes, May, et al., 2006; Fox, 1991; Müller, Kühn-Popp, Meinhardt, Sodian, & Paulus, 2015). Consistent with this understanding, greater right frontal EEG asymmetry has been found to be a marker of vulnerability to depression (for a meta-analysis, see Peltola et al., 2014). Yet despite several studies having found an association between depression risk and frontal EEG asymmetry in infants, young children, and early adolescents (Ashman, Dawson, & Panagiotides, 2008;

Jones et al., 1998; Tomarken, Dichter, Garber, & Simien, 2004), few studies were found to have examined associations between right frontal EEG asymmetry and risk for depression in children during middle childhood. Moreover, findings from those studies are equivocal (for a review, see Peltola et al., 2014). In a study that included children from preschool age to middle childhood (ages 3 to 9 years), frontal EEG asymmetry did not differ between those at high familial risk for depression and their peers without a familial history of depression (Forbes, Fox, Cohn, Galles, & Kovacs, 2006). Given the opportunity to be gained from a focus on the middle childhood period, further investigation of the association between the EEG asymmetry and childhood risk for depression is warranted, including consideration of the potential role played by current maternal depressive symptom level.

Another physiological measure relevant to the study of PA is respiratory sinus arrhythmia (RSA), which reflects the variations of heart rate across the respiration cycle (Beauchaine, 2015). Higher resting RSA is considered to be more adaptive in that it reflects emotion regulation capacity and physiological flexibility (Porges, 2007). Higher baseline RSA in children has been found to relate to more positive affect (Calkins, 1997) and less emotion dysregulation (Blandon, Calkins, Keane, & O'Brien, 2008). Several studies have found support for lower resting RSA in infants and young children of mothers with a history of depression relative to those with no maternal history of depression (e.g., Jones et al., 1998). In one study that extended the study of resting RSA into middle childhood (age 10), differences in resting RSA between children with and without a maternal history of depression were significant (Gentzler, Rottenberg, Kovacs, George, & Morey, 2012). Moreover, this difference in resting RSA was not associated

with the child's own history of a mood disorder. Given the well-established association between maternal depression and lower resting RSA in infancy, further investigation of the association between the resting RSA and risk for depression in middle childhood is warranted. Furthermore, by examining RSA in middle childhood, a time posited to be near an upswing in the significance of RSA, further light could be shed on the role played by current maternal depressive symptom level and child sex.

Summary. Across multiple studies, researchers have examined differences in each of the features of PA between children with and without an increased risk for depression, with risk typically defined as children having a mother with a history of depression. Relating to the *behavioral* feature of PA, offspring of mothers with a history of depression demonstrated lower levels of PA, relative to control peers, during interactions designed to elicit affect. In terms of *hedonic* PA, children of mothers with a history of depression do not report lower self-reported PA relative to children on non-depressed mothers when EMA assessment is used. In terms of *motivational* features of PA, children of mothers with a history of depression, relative to controls, showed reduced motivation in terms of reward seeking. Relating to the *physiologic* features of PA, childhood risk for depression has been linked to atypical EEG asymmetry and resting RSA; although findings for both indices have been inconsistent and warrant further examination, including consideration of the role of current maternal depression in resting EEG asymmetry. Given our understanding regarding vulnerabilities to depression that may be specific to females, child sex may moderate the association between maternal depression and child PA. In addition to maternal *history* of depression, current maternal depressive symptom level may influence child expression of PA.

Current Study

This study adds to the literature on PA and risk for the development of depression by examining the extent to which PA, across the features as delineated by Forbes and Dahl, differs in middle childhood in relation to children's risk for the development of depression, defined as their mothers having a history of depression during the child's lifetime. Although many studies have examined one or two of the features of PA, we found no published study to have examined all four features of PA within one sample in relation to maternal history of depression. Studying all four features of PA within a sample of youth at low and high risk for depression provides the opportunity to evaluate Forbes and Dahl's conceptual model of PA. By including groups with and without increased risk for the development of depression, we can evaluate the extent to which this established risk factor for depression (i.e., a history of depression) is associated with indices of each of these features in their offspring during middle childhood along with the potential role of mothers' current depression symptom levels and child sex. We studied children between the ages of 8 and 10 years old (i.e., in middle childhood) because this period directly precedes the increase in depression rates occurring in early adolescence, especially in females (Costello et al., 2011; Hankin et al., 1998).

The current study had several aims. The first aim was to compare children with and without a maternal history of depression across indices of each of the four features of PA. Specifically, we hypothesized that children of mothers with a history of depression during the child's lifetime, relative to their control peers, would: exhibit lower levels of observed PA, report lower levels of hedonic PA, show reduced reward motivation, and

would not significantly differ in terms of physiologic measures of PA (i.e., RSA and EEG).

We tested the hypothesis that maternal depression history would be associated with each feature of child PA with a series of regression equations, the first step of which was entering the dichotomous variable of maternal depression history. Given the understanding that vulnerabilities to depression may be particular to females, our second aim was to test the prediction that girls would be lower on each feature of PA than boys and that the association between maternal history of depression and each feature of child PA would be stronger for girls than for boys (a moderated relationship). Our third and final aim was to explore current maternal depressive symptom level as a predictor of each feature of child PA, beyond variance explained by maternal history of depression, child sex, and maternal history moderated by sex.

Method

Recruitment

We recruited women and their children between the ages of 8 and 10 years from two sites - Emory University and Vanderbilt University. At Emory, we recruited women from the Emory University Child Study Center database and Kaiser Permanente-Georgia. At Vanderbilt, participants were recruited through the Vanderbilt University research listserv, referrals, and a birth record database.

Eligibility was determined by a phone screen during which a trained research assistant administered a modified Structural Clinical Interview for DSM-IV (*SCID*; First, Gibbon, Spitzer, & Williams, 2002). Eligible dyads were mothers who, during their child's lifetime, either met diagnostic criteria for a depressive disorder or had no history

of depression. Participants were excluded if the mother reported current suicidality, psychosis, or substance abuse, or had ever been diagnosed with bipolar I disorder or schizophrenia. Additional exclusion criteria were the child having a pervasive developmental disorder, intellectual disability, psychosis, autism, bipolar disorder, or had ever met criteria for MDD or DYS. Monolingual, non-English speaking children were excluded. If multiple children in a family were eligible, we randomly selected one child in order to avoid non-independent data.

Participants

A total of 131 women and their 8 to 10-year old children were enrolled in the study. This included 65 children with a maternal history of a depressive disorder and 66 controls. About half (53%; n = 70) of children were female. On average, mothers were 40 years old (SD= 6 years) and children were 9 years old (SD= 0.85). Approximately 55% of the mothers were Caucasian, 31% African American, 4% Asian American, 1% Hispanic or Latino, and 9% did not specify their ethnicity. Forty-four percent of mothers had at least completed a graduate or professional degree. Seventy-nine percent of mothers were married, with a median household income of between $90,000 and $100,000.

Procedure

Prior to coming to the lab, mothers were sent a link to an online survey and asked to complete a series of questionnaires. In the lab, the protocol began with a 10-minute mother-child play session, with the instruction to engage in some activities together using Legos and crafts that were provided. Following the interaction, the mothers left the room and children completed a series of self-report questionnaires with the experimenter reading the questions and the children entering their responses on the computer. During

this time, the experimenters fit the children with an EEG cap and fastened electrodes to their chest and rib cage for the acquisition of EEG and RSA data.

Next, children participated in a mood induction procedure. They were seated in front of a video monitor and instructed to listen to or watch a series of six 4-minute segments, in the following order: resting baseline audio, negative affect video (e.g. Lion King), neutral affect video, positive affect video (e.g. Happy Feet), neutral affect video, and neutral affect audio clip. Clips were selected from child-appropriate films, with the order of presented clips determined for each participant using block randomization stratified by sex. Children were instructed to focus on their feelings as they listened to/watched the subsequent clip, after which they were asked to rate their mood.

Next, children completed a computerized reward motivation task, which assesses changes in effort involved in the pursuit of a reward of fixed value (Forbes, personal communication, May 17, 2016). Specifically, the task involves pressing a key on a keyboard an increasing number of times in return for earning a quarter. Following the completion of the reward motivation task, children were given the money they earned.

RSA and EEG recordings were collected throughout the mood induction procedure and motivation task, with resting baseline segments used for the current study. EEG was recorded from left and right frontal and parietal locations. Eye movements were recorded to facilitate artifact removal during editing.

At the end of the visit, the research assistant gave the mother a small amount of money and gave a small toy to the child.

Measures

Mother Measures. ***History of Depression.*** Maternal history of depression was determined via screening using the SCID-IV (refer to Participants for exclusion and inclusion criteria). Children whose mothers met diagnostic criteria for a depressive disorder during their child's lifetime were considered to have a maternal history of depression. The control group consisted of children whose mothers had no history of depression during the child's lifetime.

Current Level of Depression. The *Center for Epidemiologic Studies - Depression Scale* (CES-D; Radloff, 1977) is a 20-item, self-report questionnaire designed to assess depressive symptoms in the past two weeks. The CES-D was used to determine the mothers' current level of depressive symptoms (Radloff, 1977). Participants rated symptoms along a 4-point Likert scale, with response categories ranging from "Rarely or none of the time (<1 Day)" to "Most or all of the time (5-7 days)." Responses across all items were summed to create the final score, with a score of 16 or above being the cut-off for depression (Radloff, 1977). In our sample, 5% of women had a score of 16 or above. The CES-D has well established validity and reliability (Radloff, 1977).

Child Measures. ***Behavioral (Observed) PA***. Second-by-second observed affect was coded according to a 7-point scheme based on well-established rubrics (e.g., Dougherty et al., 2010) that had been used with adults and young children. We improved on some rubrics (e.g. Olino et al., 2011) by having the coding schema take into consideration not only affect valence but also affect intensity. Child affect was coded continuously on a scale ranging from +4, indicating high intensity positive affect (e.g., outward laughter) to -4, indicating high intensity negative affect (e.g., screaming), with a code of 1 indicating neutral affect. Coding decisions reflect the intensity of child affective

displays based on facial expressions (e.g., smiling or laughing), physical gestures (e.g., open or engaged posture), and tone of voice (e.g., warm) (Dougherty, Klein, Durbin, Hayden, & Olino, 2010; Olino et al., 2011) (see Appendix). Two additional codes were used to categorize seconds in which affect was not coded, such as if the child was out of view or a researcher entered the room.

Each 10-minute, mother-child interaction segment was split in half (i.e., into 2 videos) prior to coding, with each video segment approximately five minutes in duration.[1] The coding yielded a score for the proportion of the observed time that the child spent in positive affect across the 2 segments, which was considered to be a measure of behavioral (observed) PA. Raters were undergraduate research assistants who had been extensively trained but were unaware of the other information collected on the mother and child, such as maternal depression history. Using Interact-9 (Mangold, 2015), coders watched their assigned segment once through fully, then rated the child in terms of second-by-second affect (the Interact system records the time when each affect change is noted) and, finally, reviewed the coding file and refined the timing of individual codes as needed.

Training involved each member of the rating team independently rating practice segments from a pilot study and then discussing any disagreements with the lead graduate student until the group reached a consensus. The rating period began once the team member consistently demonstrated high inter-rater reliability (kappa above .80 for four consecutive segments). Each week, a subset of segments was randomly selected to be rated in order to assess reliability regularly throughout the study and prevent rater drift. A randomly selected 19% of video segments (n = 50) were coded by two team members

who were unaware that the segment had been selected for reliability checks. For those segments, reliability was found to be high, with a kappa of .82.

Hedonic PA. The Positive and Negative Affect Schedule *(PANAS-C;* Laurent et al., 1999*)* is a 30-item child self-report measure of PA and NA. The state version of the PANAS-C assesses the extent to which children feel each adjective at the present moment. The PANAS-C state positive scale consists of 15 items, with response options on a 5-point Likert scale (ranging from 1 = Not much or not at all to 5 = A lot). The PANAS-C yields a score that is the sum of items of that scale. Higher scores indicate higher levels of hedonic (self-reported) positive affect. Laurent et al. (2009) found that the PANAS-C yielded high internal consistency as well as good convergent and divergent validity. For the current sample, internal consistency was high, with a Cronbach's alpha of .90.

Effort Discounting Task. The effort discounting task (EDT), developed by Forbes, is a progressive ratio scheduled task that measures reward motivation, operationalized as the willingness to expend increasingly greater effort to obtain a set value reward. The reward in the task was quarters, which the child earned and was told that they would keep. The task was programmed and administered in E-Prime 2.0. The child sat in front of a computer and was instructed to hit a key 10 times and then an additional 10 times each trial. After each trial, they had the chance to receive a set monetary reward of 25 cents. The highest ratio completed and mean response time were the scores used.

Physiology. *Frontal EEG Asymmetry*. Children's EEG was recorded during a resting segment, during which children were asked to listen to an audio story. EEG was

recorded with a stretch cap (Electro-Cap, Inc., Eaton, OH) with electrodes in the 10/20 system pattern. EEG recordings were made from 16 left and right scalp sites, including: frontal pole (Fp1, Fp2), medial frontal (F3, F4), lateral frontal (F7, F8), central (C3, C4), anterior temporal (T7, T8), mid-parietal (P3, P4), and occipital (O1, O2), referenced to the site at the vertex (Cz). Asymmetry at the mid-frontal sites (F3/F4) was the focus of analyses, but asymmetry was also computed for other sites. The cap was placed on the child's head and a small amount of abrasive gel was placed into each site, followed by conductive gel. Electrode impedance was brought down to less than 20 K ohms.

EEG data were examined and analyzed using EEG Analysis System software developed by James Long Company (Caroga Lake, NY). First, the data were re-referenced to an average reference configuration, which weighted all sites equally and eliminated the need for a non-cephalic reference. The average reference configuration requires a sufficient number of electrodes be sampled and that these electrodes be evenly distributed across the scalp. Despite a lack of current agreement regarding the appropriate number of electrodes, the 10/20 configuration satisfies the requirement of an even scalp distribution. EEG data were inspected visually and scored for artifact (e.g., due to eye blinking or movement), which was manually removed using Fp1 and Fp2 (Myslobodsky et al., 1989), with a peak-to-peak criterion of 100 mV or greater. Artifact associated with gross motor movements over 200 mV peak-to-peak was also scored. The depressed and control groups did not differ in the quantity of artifact-edited data ($F(1, 59) = 1.79$, $p = .20$). The EEG data were quantified with discrete Fourier transformation (DFT), using a Hanning window of 1-s wide and with 50% overlap. The frequency range of interest was the alpha band, which is considered to be inversely related to brain activation

(Pfurtscheller, Stancak, & Neuper, 1996). Based on developmental findings on EEG (Marshall, Bar-Haim, & Fox, 2002), average power in the 8-11 Hz band was taken as an index of average power. EEG values were averaged within the first resting segment. Asymmetry scores were computed as the difference of transformed power scores for the medial frontal leads (lnF4–lnF3). Positive scores reflect greater relative left frontal activity, whereas negative scores reflect greater relative right frontal activity.

RSA. Child ECGs were recorded from disposable electrodes during each segment. Event markers were used to separate the resulting file into different segments (e.g., resting, negative, etc.) ECG signals were edited by trained research assistants using CardioEdit and RSA was computed using CardioBatch (Brain-Body Center, 2007). Average RSA across the first resting segment was used as the index of resting heart rate.

Data Analytic Strategy

Following previous research, preliminary analyses tested the degree of association between demographic variables and PA variables (e.g., child age and RSA) (Bar-Haim, Marshall, & Fox, 2000; Forbes, Fox, Cohn, Galles, & Kovacs, 2006), in order to determine whether to control for these variables. Preliminary analyses were conducted to compare the groups (children with and without a maternal history of depression) in terms of demographic characteristics and mothers' scores on current depressive symptoms.

Main analyses tested hypotheses regarding PA variables and maternal depression history, child sex, the interaction of maternal depression history and child sex, and current maternal depressive symptom level. First, t-tests were conducted to compare children with and without a maternal history of depression in terms of each PA variable, including: observed PA (% time spent in PA), PANAS-C State, EDT, resting RSA, and

resting frontal EEG asymmetry. Maternal history of depression, child sex, and the interaction between the two were entered into the regression model in separate steps to test the extent to which they contributed to the explanation of child PA. The relations between current maternal depressive symptom level and child PA were first examined by generating Pearson's correlations. Second, level of current maternal depressive symptoms was entered in the regression models in the last step to examine the extent to which mothers' current depression symptom level contributed to the variance in each feature of child PA, above and beyond maternal history of depression, child sex, and maternal history moderated by sex. Effect sizes were calculated using Cohen's d.

Results

Preliminary Analyses

Before testing hypotheses, preliminary analyses were conducted to test for outliers and to check the distribution of scores. The pattern of missing data was as follows, with the n's indicating the number of participants missing each score: behavioral (observed) PA (n = 2), hedonic PA (n = 2), motivational PA (n = 7, and physiologic PA (RSA: n = 17; EEG: n = 72). EEG data was only available for half of the study sample. One-way ANOVAs and chi-square tests were conducted to compare demographic characteristics between groups (i.e., high risk vs. control; for descriptive and test statistics, see Table 1). There were no significant differences between groups in terms of child sex, age, or maternal education level. However, there were significant differences between groups in terms of child ethnicity, X^2 (1, N = 131) = 4.04, p = .03; 63.6% of children in the control group identified as White/Caucasian versus 46.2% of children of mothers with a history of depression. There was also a significant difference between

groups in maternal marital status, $X^2(1, N = 129) = 7.17$, $p = .01$; more control mothers than mothers with a history of depression were married (89.2% vs. 70.3%, respectively). As expected, mothers with a history of depression reported a significantly higher current depressive symptom level than did mothers in the control group, $F(1, 127) = 36.15$, $p < .01$.

Pearson's correlations were conducted to investigate relationships between demographic variables (e.g., child's age) and each of the scores from the PA variables, to determine whether any of these factors needed to be controlled for in subsequent analyses. Only one significant association was found: child age was significantly correlated with children's performance on the reward motivation task; older children completed a higher ratio of trials and earned more money on the EDT relative to younger children (highest ratio completed: $r = .224$, p=.01; total money earned: $r = .25$, p = .01).

Hypothesis Testing

Maternal history of depression. For descriptive purposes, the results of each independent samples t-test are shown in Table 2. The t-tests revealed no significant differences in any of the scores from any of the child PA features between groups (i.e., children whose mothers had or had not experienced depression in the child's lifetime). A series of regression analyses were conducted to test the hypothesized association between history of depression in mothers and each feature of child PA. Contrary to the hypotheses, these regressions yielded no significant results, $p > .05$ and small effect sizes (see Table 4).

Child sex. Next, we report on the results from the regression analyses when we added child sex to the model after accounting for maternal depression history and,

subsequently, the interaction term for child sex and maternal history of depression added into the model with the main effects. After accounting for maternal history of depression, analyses revealed a significant main effect of child sex on one feature of PA - child hedonic PA (scores on the PANAS-C), $\Delta R^2 = .07$, $F(2, 126) = 4.84$, $p = .01$. However, contrary to the hypothesis, females reported higher levels of hedonic PA than males. Contrary to the hypothesis, we found no significant main effects of child sex for other PA variables (see Table 4). Also contrary to the hypothesized moderating role of child sex in the association between maternal history of depression and child PA, we found no significant interaction between child sex and maternal depression history in the prediction of any child PA variable, $p > .05$ and all small effect sizes.

Current depression and child PA. For descriptive purposes, Pearson's correlations were run to examine the relations between current maternal depressive symptom level (i.e., scores on the CES-D) and each measure of child PA. Across the sample as a whole, a higher level of current maternal depressive symptoms was associated with one of the scores on child PA, lower behavioral (observed) child PA, $r(129) = -.19$, $p = .03$). Given the understanding that vulnerabilities may be particular to female offspring, correlations between current maternal depressive symptom level and child PA were run separately by child sex. For females, there was a significant negative correlation between current maternal depressive symptom level and observed PA, where higher levels of maternal depressive symptoms were associated with lower observed PA, $r(69) = -.25$, $p = .04$. However, for males, level of current maternal depressive symptoms was not associated with observed PA nor any other PA variable.

To test the extent to which current maternal depressive symptom level predicted child PA (above and beyond maternal history of depression, child sex, and history moderated by sex), current maternal depression level was added to each regression model. The results of the regressions indicated that level of current maternal depressive symptoms did not account for additional variance in any of the PA variables and effect sizes in all cases were small (see Table 4).

Discussion

Low PA has been posited to serve as a vulnerability for depression. Accumulating research has found support for children of depressed mothers to score lower on behavioral PA than children whose mothers had not been depressed (Durbin et al., 2005; Olino et al., 2011). Other studies have sought to differentiate these groups in terms of approach activation (e.g., Gotlib et al., 2010) and hedonic PA (Olino et al., 2014). The current study extended this work by examining PA within the framework put forth by Forbes and Dahl, including behavioral, hedonic, motivational, and physiologic features of PA in the same sample. Using this framework, the current study sought to: clarify the extent to which disruptions in PA are associated with children being at high risk for developing depression, test whether PA was lower in females than in males, test whether the association was stronger for females than males, and examine the influence of current maternal depressive symptoms on child PA.

Contrary to our hypotheses, mothers' history of depression during the child's lifetime was not associated with any of the features of PA. This failure to differentiate between groups according to maternal depression may reflect a few considerations. First,

we take into consideration our measurement of each feature of PA. Concerning our findings on behavioral (observed) PA, the lack of significant difference between the groups according to maternal history of depression was surprising. In our study, observed PA was assessed in the context of an unstructured mother-child interaction. In published studies that found significant differences in observed PA between similarly aged children with and without depressed mothers, mother-child interactions were structured around either a problem-solving task (Dietz et al., 2008) or other situation designed to stimulate negative or positive affect (e.g., McMakin et al., 2011). While it could be argued that the less structured interaction context within the current study would generalize well to mother-child interactions outside of the laboratory, it may not have been a strong enough situation to elicit such differences in affect expression.

Concerning the motivational feature of PA, findings in support of lower reward motivation in at-risk children operationalized motivation in terms of performance on or neural activation during neuroimaging tasks with monetary rewards (e.g., Gotlib et al., 2010). Using a behavioral task that also involves monetary reward, we did not find a significant difference between groups according to maternal depression history. However, as Luking et al. (2016) suggested, risk for depression may be more strongly associated with reduced sensitivity to *loss* as opposed to motivation to pursue a reward; in this case, using a task involving both gain and loss of reward may distinguish between groups in terms of reward responsiveness.

Consistent with some previous research that compared risk groups in terms of resting physiology, no differences between groups in resting RSA or EEG asymmetry

were detected. Ashman et al. (2008) also found no difference between children of depressed and non-depressed mothers in terms of resting RSA; however, they did find differences in RSA reactivity, which is another index of heart rate variability. Additionally, children of chronically depressed mothers had higher RSA reactivity than children of mothers with stable mild depression. Future studies should examine expand investigations of RSA to include considerations of RSA reactivity differing between children of mothers with and without a history of depression. Concerning EEG asymmetry, the consistency of children's asymmetry across other mood inductions, such as when watching happy and sad videos, has also been suggested as an early marker of vulnerability for depression (Feng et al., 2012). Further consideration of RSA reactivity as well as EEG asymmetry during mood inductions may facilitate understandings of the extent to which these groups differ during middle childhood.

The lack of association between current maternal depressive symptom level and features of child PA may also reflect differences between the current study and previous studies that found such an association. In previous research, having a mother with higher levels of current depressive symptoms was associated with children demonstrating lower observed PA (Durbin et al., 2005). However, in the study done by Olino et al. (2011), current maternal depression was only found to be associated with observed PA when comorbid with anxiety. As current maternal anxiety was not assessed in the current study, we cannot rule out the role that it may play in the relationship between current depression and child PA. The current study also failed to detect significant effects of current maternal depressive symptoms on motivational and physiologic features of PA. Previous research on these motivational (Luking et al., 2015) and physiologic (Ashman et al.,

2008) features has suggested the importance of considering the role of depression chronicity, or number of previous episodes of depression, on PA over and above symptom severity (Ashman et al., 2008; Luking et al., 2015). Lastly, beyond mothers' own symptoms of depression, children's symptoms of anhedonia may be a promising avenue for examination within the current dataset. In support of this notion, Luking et al. (2015) found that gain approach behavior was associated with children's higher level of anhedonic symptoms. A more nuanced consideration of maternal depression, considering chronicity and severity of symptoms, as well as child anhedonia may contribute to our understanding of differences within this population.

The current study's failure to detect differences in features of PA within this sample may also reflect a larger developmental consideration. According to Cauffman et al. (2010), the exploration of responsiveness to reward is particular noteworthy during *adolescence*, when the natural inclination to seek reward increases. Thus, the dampening effect of exposure to maternal depressive symptoms on reward-seeking behavior during middle childhood may not be as strong as it is in the context of increased approach orientation during adolescence (Fussner, Luebbe, & Bell, 2015). The lack of association between maternal depression and children's performance on the EDT, for example, may thus suggest that distinctions within this feature of PA do not emerge until later in development.

It is essential to interpret our findings in the context of certain limitations. First, our sample consisted of a highly-educated mothers, with 44% of mothers having completed at least a graduate or professional degree. According to Carneiro, Meghir, and

Parey (2013), lower maternal education level is associated with greater financial strain, which is in turn associated with elevated risk for depression (Zimmerman & Katon, 2005). The current study might underestimate associations between maternal depression and child PA, perhaps in relation to families having more resources and thus less additional strain. Overall, our findings can only be generalized to families with highly educated mothers. Second, the range of current maternal depressive symptoms in our sample was restricted, with an overall mean of 8.12 (*SD* = 4.22), although women with history of depression scored significantly higher (*M* = 10.11, *SD* = 4.95) relative to women with no history of depression. Only 5% of mothers exceeded the established cutoff for clinically significant levels of depression on the CES-D. The association between observed PA and current maternal depressive symptom level in females may reflect the importance of current exposure to maternal depressive symptoms to children's expression of PA. In support of this possibility, previous work has demonstrated how concurrent or recent maternal depression predicts more negative child outcomes than depression occurring earlier in the child's life (Luoma et al., 2001; Sinclair & Murray, 1998). On the other hand, maternal depression early in the child's life may interferes with the development of offspring self-regulatory skills important to the physiologic features of PA. Third, we were unable to quantify chronicity of the mothers' depression history and, thus, unable to attempt to replicate findings that, for children of mothers with a history of depression, the number of episodes mattered whereas the history per se did not.

Despite the null findings and the limitations of our study design, our findings have implications for next steps in this line of research. First, it is important to understand how mothers with a history of depression (and/or current depression) socialize their children

with regards to PA. Examining this question would likely require consideration of context in that such socialization may differ depending on the context in which the mother and child are interacting (i.e., neutral contexts as well as those eliciting positivity or negativity, such as a conflict discussion task). Second, our findings - in combination with the findings of previous studies - suggest the need for longitudinal study designs to delineate how and at what point(s) these features of PA emerge during development in relation to the development of depression in the offspring. Third, future studies might also take into consideration mothers' qualities of parenting. For example, maternal involvement and child positivity likely represent reciprocal processes that reinforce adaptive or maladaptive interaction styles (Dietz, 2008). Findings from all of these suggested studies have the potential to inform the development of effective programs to prevent the development of depression in children at elevated risk.

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Footnotes

[1] This was done because, in other parts of the study not included here, there were 5-minute segments and we did not want coders to distinguish between segments of different lengths in their coding.

Table 1

Demographic Characteristics According to Maternal Depression History

	Group		
	Maternal History of Depression	No Maternal History of Depression	Statistic
Child sex (% female)	56.9	50.0	$X^2(1, 131) = 0.63$
Child age (in years), mean (SD)	9.26 (0.82)	9.44 (0.88)	$F(1, 129) = 1.53$
Child ethnicity, % Black, African American, Asian, Hispanic, or Other	53.8	36.4	$X^2 (1, 131) = 4.04$ *
Maternal education, highest grade completed, mean (SD)	6.32 (1.73)	6.65 (1.65)	$t(126) = 1.09$
Maternal marital status, % married	70.3	89.2	$X^2(1, N = 129) = 7.17$ **
Maternal current depressive symptoms, CES-D, mean (SD)	10.11 (4.95)	6.15 (1.90)	$F(1, 127) = 36.15$ **

Note. CES-D = Center for Epidemiologic Studies - Depression Scale

*$p < .05$

**$p<.01$

Table 2

Mean Scores, Standard Deviations, and t-tests for the Differences between Children With and Without a Maternal History of Depression on Features of Child PA

Variable	Group				95% CI	*t*	*df*	ES
	Maternal History of Depression		Control					
	M (SD)	*n*	M (SD)	*n*				
Observed	52	65	55	66	-0.03, 0.09	0.90	129.00	0.16
PANAS	43.48 (13.50)	65	43.56 (11.69)	66	-4.28, 4.45	0.04	125.87	0.01
EDT: HRC	147.10 (43.05)	62	137.23 (52.25)	65	-26.65, 6.91	-1.16	122.45	-0.21
TME	3.65 (1.09)	62	3.44 (1.31)	65	-63.64, 20.69	-1.01	122.72	-0.18
Resting RSA	6.59 (1.20)	60	6.49 (1.17)	56	-0.53, 0.34	-.45	114	-0.08
EEG	0.07 (0.19)	32	0.03 (0.17)	29	-0.13, 0.05	-0.89	59	-0.23

Note. PANAS = Positive and Negative Affect Schedule, Child Version; EDT = Effort Discounting Task; HRC = Highest ratio completed; TME = Total money earned; RSA = Respiratory sinus arrhythmia; EEG = Electroencephalogram asymmetry; Satterthwaite approximation employed for scores on the PANAS-C (State Positive) and Effort Discounting Task (EDT); both highest ratio completed and total money earned) due to unequal group variances.

* $p < .05$.

Table 3

Associations between Current Maternal Depression Symptoms And Child PA Variables

Variables	1.	2.	3.	4.	5.	6.	7.
1. CES-D	-	-.190*	-.050	.041	.038	-.008	.073
2. Observed PA	-.190*	-	-.20	.024	.027	-.153	-.190*
3. PANAS-C	-.04	-.20	-	-.01	-.01	-.05	-.04
4. EDT - HRC	.041	.024	-.016	-	.991**	-.175	.157
5. EDT - TME	.038	.027	-.012	.991**	-	-.156	.161
6. Frontal EEG Asymmetry	-.008	-.153	.033	-.175	-.156	-	-.063
7. Resting RSA	.073	-.190*	-.042	.157	.161	-.063	-

Note. CES-D = Center for Epidemiologic Studies - Depression Scale; PANAS-C = Positive and Negative Affect Schedule, Child Version, State PA; EDT = Effort Discounting Task; HRC = Highest ratio completed; TME = Total money earned; RSA = Respiratory Sinus Arrythmia; EEG = electroencephalogram

*p<.05

**p<.01

Table 4

Results of Multiple Moderated Regression Analysis

Variable	ΔR^2	R^2	β	B	*95% CI*		*p*
					LB	*UB*	
Observed PA							
Overall Model							
Maternal History of Depression	.01	.04	-.08	-.028	-.09	-.03	.38
Child Sex	.01	.11	-.09	-.03	-.09	-.10	.32
Maternal History x Child Sex	.00	.13	-.11	-.04	-.17	-.08	.50
Current Maternal Depression	.03	.21	-.18	-.01	-.02	-.19	.07
PANAS-C							
Overall Model							
Maternal History of Depression	.00	.00	.03	.69	-4.10	5.47	.78
Child Sex	.07	.07	.27	7.29	2.63	11.94	.01
Maternal History x Child Sex	.00	.07	.01	.41	-8.93	9.75	.93
Current Maternal Depression	.01	.29	-.12	-.38	-1.01	.255	.24
EDT - HRC							
Overall Model							
Maternal History of Depression	.01	.01	.11	10.64	-6.40	27.69	.22
Child Sex	.01	.02	.10	9.95	-7.13	27.04	.25
Maternal History x Child Sex	.00	.02	-.01	-1.22	-35.54	33.10	.94
Current Maternal Depression	.00	.02	-.03	-.38	-2.71	1.95	.74
EDT - TME							
Overall Model							
Maternal History of Depression	.01	.01	.10	23.37	-19.46	66.19	.28
Child Sex	.01	.02	.11	26.75	-16.12	69.62	.22
Maternal History x Child Sex	.00	.02	-.01	-2.34	-88.48	83.80	.96
Current Maternal Depression	.08	.02	-.03	-.85	-6.70	4.99	.77

Resting RSA							
Overall Model							
Maternal History of Depression	.01	.01	.08	.18	-.24	.60	.40
Child Sex	.00	.01	.00	.00	-.42	.43	.98
Maternal History x Child Sex	.02	.17	.27	.66	-.19	1.51	.13
Current Maternal Depression	.00	.17	.04	.01	-.04	.07	.72
Resting EEG Asymmetry							
Overall Model							
Maternal History of Depression	.01	.01	.08	.03	-.07	.12	.54
Child Sex	.06	.07	-.25	-.09	-.18	.00	.06
Maternal History x Child Sex	.00	.07	.06	.02	-.16	.21	.80
Current Maternal Depression	.00	.07	.02	.00	-.01	.01	.89

Note. Maternal depression history, child sex, and the interaction term of the two were each added into the model successively, followed by current maternal depressive symptom level; PANAS-C = Positive and Negative Affect Schedule, Child Version, State Positive Affect; EDT = Effort Discounting Task; HRC = Highest ratio completed; TME = Total money earned; RSA = Respiratory Sinus Arrythmia; EEG = electroencephalogram;

Appendix

Observed Affect Coding Rubric

Positive Affect*

***Bolded = necessary and sufficient. If there is more than one bolded descriptor within a mode, only one needs to be present to meet criteria for a particular level of affect.**

+4	**High Intensity Positive Affect**

Face	**Outward laughter** or **giggling** (Inward contained chuckles should not be scored as + 4)
Voice	Very enthusiastic and excited. Highly animated, pitched, positive/sing-songy tone. May talk at a markedly rapid rate or loud volume in a pleasant/excited manner.
Body	Behavioral indicators of excitement/joy (e.g., jumping, clapping, and cheering). Or display of physical affection stronger than a +3 (e.g. hug, kiss, etc.) Animated gestures.

+3	**Moderate Intensity Positive Affect**

Face	**Smiles with any eye involvement (sparkle or crinkles), or smiles with raised eyebrows.** May include bright eyes and/or affectionate gaze. Includes **chuckles** – inward, briefer, and more contained than laughter.
Voice	May include somewhat high pitched, warm/pleasant/soft, or enthusiastic/moderately excited tone of voice. May talk at moderately rapid rate or louder volume in a pleasant/excited manner.
Body	Moderate physical affection (touch, pat on back). Somewhat animated gestures. Nodding. May include open body posture and leaning in.

+2	**Low Intensity Positive Affect**

Face	Slight smile without eye involvement. Includes brief, ambiguous mouth or facial movements (i.e. smirks, twitches, broadening of the mouth, or other clear expressions that are not clearly smiles). Expressions of surprise (i.e. open mouth with raised eyebrows).
Voice	May include expressing interest through a slightly high pitched, warm/pleasant/soft tone of voice even in the absence of a clear smile. Includes humming.
Body*	Body should be somewhat engaged and not withdrawn or tense. May include leaning in or nodding.

* Body alone would not be sufficient

Neutral Affect

1 = None/Neutral Affect

No indicators of positive or negative affect. Neutral face, voice, and body. Includes coughs, sneezes, and yawns.

Rate "1" if you cannot tell if an expression is positive or negative.

Rule: May be making good eye contact but if no smile or warm/pleasant/upbeat tone of voice then rate as "1".

Negative Affect*

***For all levels of NA, must show evidence of either anger or sadness or anxiety.**

-2 Low Intensity Negative Affect

Face	Anger	Slight or vague look of anger. Brows slightly slanted or furrowed. Eyelids appear slightly tense, and/or eyes appear slightly hard or blank. Mouth may be straight, pursed, or slightly open as if gritting teeth.
	Sadness	Slight or vague look of sadness. Inside of the eyebrows are raised slightly. Lower eyelid may be slightly raised and eyes may appear slightly downcast and/or droopy. Lip corners may be turned down slightly.
	Anxiety	Slight or vague look of being uncomfortable, anxious, worried, or concerned. Eyebrows are approximately straight and somewhat raised, and the inner corners of the brow are drawn together. Eyes may appear somewhat more open than normal, and tense (the upper eyelid is raised and the lower lid is tense)

		Mild look of worry or concern. Mouth may be slightly open and the lips may be tense and drawn back, or may include ambiguous mouth movements May include lip biting and pressed lips.
Voice	Anger	Slightly hostile, sarcastic, tense, or otherwise moderately negative tone of voice.
	Sadness	Slightly sad tone of voice. Soft tone of voice. Mild whining or sighing.
	Anxiety	Slightly concerned/worried tone of voice.
Body	Anger	Slight body tensing or crossed arms.
	Sadness	Slight body sadness (e.g., slight angling down of head or slump of shoulders).
	Anxiety	Slight body anxiety (e.g., minor fidgeting).

*Regarding "sarcasm", if tone of voice and face are suggesting -2 – then go with that.

-3 Moderate Intensity Negative Affect

Face	Anger	Moderate look of anger. Same as for -2, but higher in intensity. May include raised cheeks or rolling eyes. Grimaces (gritted smiles with furrowed brow) and sneers also included.
	Sadness	Moderate look of sadness. Same as for -2, but higher in intensity. Inner corners of eyebrows raised and may be drawn together. Eyes may crinkle with lower lid raised. May include bottom lip protruding as if pouting.
	Anxiety	Moderate look of anxiety. Same as for -2, but higher in intensity. May include: tightening of lips, grimacing, or tense/non-angry mouth.
Voice	Anger	Same as for -2 but higher in intensity. May include frustrated sighs or raised voice (as indicated by increased volume paired with forcefulness).
	Sadness	Same as for -2 but higher in intensity.
	Anxiety	Same as for -2 but higher in intensity.
Body	Anger	Same as for -2 but higher in intensity. May include: moderate body tensing (balled fists, tight gripping, little raise of the shoulders, neck tensing), head shaking, or frustrated gestures.
	Sadness	Same as for -2 but higher in intensity (e.g., noticeable drop of head or slump in shoulders)
	Anxiety	Same as for -2 but higher in intensity. May include: tense or rigid posture. Rapid and repetitive movements (e.g., jiggling foot). Trembling hands, lips, or mouth.

-4	**High Intensity Negative Affect**	
Face	Anger	Marked look of anger. Same as for -3, but higher in intensity. Brows are slanted or furrowed and cheeks may be raised, likely includes some bulging or wrinkling around the brows.
	Sadness	Marked look of sadness. Same as for -3, but higher in intensity. Lip corners are distinctly turned down and cheek area droops down. May include bottom lip shaking or crying.
	Anxiety	Marked look of anxiety or fear. Same as for -3, but higher in intensity. Marked look of worry, fear, or concern.
Voice	Anger	Same as for -3, but higher in intensity. May include: yelling, loud "guff", screaming, or otherwise high negativity.
	Sadness	Same as for -3, but higher in intensity. May include: voice quavering or crying, very soft, slow, monotone, depressed voice, or intense whining or sighing.
	Anxiety	Same as for -3, but higher in intensity. Markedly anxious or fearful tone of voice. May include: elevated voice tone, very frantic and rapid speech, or extreme stuttering or difficulty in speaking.
Body	Anger	Same as for -3, but higher in intensity. May include: Banging of fists, kicking, stomping, throwing/forceful tossing of objects/ materials, hitting self/mom, or forceful, threatening gestures.
	Sadness	Same as for -3, but higher in intensity. May include: putting head down, in hands, or on table in a manner that conveys sadness. Obvious slump of body/shoulders.
	Anxiety	Same as for -3, but higher in intensity. May include: tightening of lips, intense biting of the lip(s), putting hand to mouth, excessive fidgeting/restlessness, hard swallowing. Extreme cowering or flight behaviors.

<u>Ratings for uncodeable or not rateable segments</u>

Uncodeable (U)	Face is partially or completely out of view due to face angle in the camera or hair in the face. Use this only when the child is out of view or looks away so the coder cannot see her face or any affect or clear, obvious bodily indicators (e.g., noticeably tense shoulder may be enough to support a negative code) AND you have no vocal cues to the emotion for at least 3 seconds. Includes being under the table. Uncodeable would end as soon as a codeable emotion (e.g., expression or tone) is observed. One should not try to guess state if

	face is partially or completely out of view due to face angle (i.e., less than profile – at least 1 eye and ½ of mouth) in the camera or hair in the face – UNLESS there is a clear expression (e.g., pronounced cheek raise)
Not Rateable (XX)	Use this when there are circumstances that violate the standards for the particular situation you are observing, such as when there are other people in the room or the child/mother pair is not following the essential instructions or any other ways in which the protocol is not being followed. Includes intentional facial obstruction (e.g., child uses prop to cover face) from camera. Also to be used in the case of any consumption - food or drink – when the item is making contact with the child's face or if the child is still engaged in the act of consumption (e.g., chewing).

Guidelines

- Watch the entire interaction clip once before coding to get a feel for the interaction.
- Start and stop times for each video segment will be provided to you. Be sure to strictly adhere to these times in your coding.
- As you code, make notes of any questions or concerns you have about the coding. Bring these notes to the weekly coding meetings and let us know about them so we can discuss them.
- Always code with headphones. The sound is much clearer.
- Please don't consult with or discuss your coding file with another RA. Coding needs to be done independently to maintain the integrity of the process.
- Do not do all of your coding (i.e., more than one video) in one sitting.
- If face, tone of voice, and behavior would suggest different codes, code with priority given to facial expression and tone of voice, then *secondarily* behavior or verbal content.
    - Behavior and content can be used to *clarify/support* a code, but defer to facial expression and tone when inconsistent with behavior and content. For example, if a child is smiling and criticizing mom in a playful tone, this would be coded as a +2/3.
    - Behavior can be used to choose between codes of the same valence but different intensity (e.g., -2 or -3) OR when the face and tone are neutral [e.g., face/tone would indicate 1, but paired with intense behavior that would suggest a different code (+/-)].
- For NA, code based on appropriateness of intensity for any of the emotions listed (i.e., lip biting with no eye movement or vocal indicators would be -2) – emotion categories are listed only for ease in identification and organization.
- When the child temporarily goes out of view for longer than 3 second – code as U <u>unless</u> you can accurately rate an emotion by other indicators (e.g., you can see strong

emotion in part of the body or you can hear strong emotion in the voice) – then code affect accordingly.

- When you are finished coding, review all of your coding to make sure there are no gaps or other errors. To detect gaps, look to see that the start time on each line immediately follows the stop time on the previous line. This is an essential last step in your coding of each segment.

*In the rare case of a child whose natural resting mouth appears upturned (do not confuse this with someone who smiles most of the time), look for instances when the corners of the mouth are turned up in an even more pronounced manner to determine when she/he is smiling. On the other hand, if a child is smiling much of the time, all of those times count as smiling.

*In the rare case of a child whose natural eyebrow shape appears furrowed (do not confuse this with someone who furrows their brows most of the time), look for instances when the brows are turned in an even more pronounced manner to determine when they are furrowing their brow. As with smiles, if a child truly has furrowed brows much of the time, all of those times count as having furrowed brow.