BEHAVIORAL EXPRESSIONS OF JEALOUSY ACROSS THE FIRST TWO YEARS OF LIFE: ASSOCIATIONS WITH EEG ASYMMETRY, CORTISOL REACTIVITY AND ATTACHMENT SECURITY

by

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ABSTRACT

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Jealousy is understood as a system of physiological, behavioral, and emotional responses, yet few studies have examined these aspects of jealousy simultaneously in infants. Further, jealousy paradigms have not been examined as a potential stressor in infancy and thus typical cortisol reactivity and regulation patterns in response to jealousy paradigms have not been observed. In addition, the contribution of attachment security to infant expressions of jealousy has been vastly understudied. The present study seeks to fill the current gaps in the infant jealousy literature by investigating quantitative and qualitative changes in infant jealousy across the first two years of life. Data was collected longitudinally and mother- infant dyads were asked to participate when infants were 12-months and 24-months of age. Associations between behavioral jealousy responses, baseline EEG activity, stress reactivity and attachment security were examined. Differences in approach behaviors and behavioral arousal were found across conditions

and were consistent with previous studies (Hart & Carrington, 2002; Mize & Jones, 2012). Findings relating to EEG activity pointed to a relationship between left EEG asymmetry and global approach behaviors across time. Cortisol reactivity was found to be associated with attachment security but reactive cortisol concentrations compared to baseline cortisol concentrations do not indicate that the paradigm was an effective stressor. Attachment security was found to be associated with proximity behaviors in 12-month olds but not 24-month olds. Finally, a linear regression revealed that attachment security, EEG asymmetry, and cortisol reactivity at 12-months are significant predictors of behavioral jealousy responses at 24-months. Changes in behavioral and physiological measures across time indicate that jealousy continues to develop during the second year of life but may have different underlying processes than the processes that contribute to jealousy expression in 12-month-olds.

DEDICATION

For my grandmother, Marta A. Pineda, who was one of the “good ones”.

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I. INTRODUCTION

Infant Jealousy

Jealousy has been described as a combination of behavioral, physiological and affective responses to a perceived threat to a social bond (Maner & Shackelford, 2008). Jealousy responses are theorized to be adaptive in that they are activated in an attempt to preserve a valued relationship. In romantic relationships, attempts to thwart emotional and/or sexual infidelity promote inclusive fitness by minimizing paternity uncertainty and the risk of resources going to a third person outside of the relationship (Harris, 2004). In childhood, jealous responses to maternal differential treatment toward a sibling or peer serve the function of redirecting maternal resources (i.e. warmth, protection and food) toward the self, thereby promoting survival (Dillon, 2013).

The construct of jealousy in early childhood and infancy has been difficult to define in previous research. One of the problems in recognizing infants' ability to express jealousy is that jealousy can be thought of as a primary or secondary emotion. Primary emotions, which include sadness, fear, anger and joy, are observed shortly after birth and are closely connected to the development of the nervous system (Panskepp, 2013). Primary emotions involve little cognitive processing and are independent of representations of the self and of social relationships (Baumringer, 2013). Secondary emotions, on the other hand, require at least the cognitive ability to distinguish the self from others- an ability that has been proposed to develop between the ages of 15 to 24 months of age (Lewis, 2010). For those who maintain that jealousy is a secondary

emotion, jealousy responses observed in infants under the age of 15 months have been described as proto-typical jealousy or precursors to jealousy. However, recent research on infant jealousy has proposed that jealousy expressions in infancy represent a combination of several primary emotions such as interest, sadness, anger and love (Hart, 2010). Jealousy paradigms have been used to assess jealousy expressions in infants as young as 3 months of age.

Most studies assessing infant jealousy have used a lifelike doll as a social rival and a book as a non-social rival. Mothers are asked to ignore their infants as they interact with each. In studies with 6-month-olds, infants have been observed to demonstrate greater negative affect (i.e. sadness and anger) and greater levels of mother-directed gaze during the social rival conditions than the non-social rival conditions (Hart & Carrington, 2002; Hart, Carrington, Tronick & Carroll, 2004). While some may argue that infants are responding to maternal inattention and are not responding to their mothers' differential treatment, infant negative and approach responses have been shown to be greater during social rival conditions than other conditions of maternal unresponsiveness such as the still face procedure (Hart, Carrington, Tronick & Carroll, 2004). With age, infant jealousy responses have been shown to increase in complexity and intensity. In addition to negative affective responses to jealousy evocation, which has been observed in younger infants, 12-month old infants also demonstrate increased proximity to their mothers, more reach toward their mothers, less play and more protest vocalizations (Hart, Field, Del Valle & Letourneu, 1998).

Although general protest and approach responses have largely been observed as typical jealousy responses in infants, more specific patterns of jealousy protest have also

been identified. Extreme anger, inconsolable crying or aggression toward the self, the mother or the social rival are atypical jealousy responses that fall out of typical jealousy response patterns (Hart, 2001, 2015). Infants with disinhibited jealousy patterns are quick to react to jealousy evocation and typically respond with high levels of approach and anger. Infants with organized jealousy patterns demonstrate a mix of anger, sadness, fear and self-comforting. Finally, infants with inhibited jealousy patterns have the longest latency to react to the social rival condition and demonstrate high levels of interest in the interaction between their mothers and the social rival.

Infants of depressed mothers do not seem to fit into any of those jealousy profiles. Twelve-month-old infants of depressed mothers have been shown to demonstrate less protest during the social rival condition compared to non-depressed mothers (Hart, Field, Letourneu & Del Valle, 1998) and have also been shown to engage in more distancing and withdrawal behaviors such as increasing their proximity from their mothers and playing with toys (Hart, Jones & Field, 2003). The present longitudinal study will examine jealousy responses of infants at 12 months and 24 months of age. Changes in the intensity of jealousy expressions are expected as infants develop increased mobility, verbal communication skills and self-regulatory mechanisms throughout the first two years of life.

Mother-Infant Attachment

Mother-infant attachment relationships represent the first of many social relationships that children will participate in throughout their development. It has been proposed that these first affectionate ties prepare children for future social relationships by introducing them to positive social experiences, by providing experience with

reciprocal interactions, and by reinforcing self-efficacy perceptions relating to social skills (Thompson, 2006). Attachment has been described as an evolved mechanism in which attachment behaviors (i.e. clinging, crying, following, etc.) serve to maintain proximity between infants and their primary caregivers. Over time and context, attachment behaviors may change but attachment between a dyad remains an enduring and stable bond (Ainsworth, 1969).

Given the value of attachment relationships, threats to the mother-infant bond stemming from positive interactions between mothers and a social rival may produce jealousy responses in infants. The current study aims to investigate infant jealousy across the first two years of life with data collection occurring when infants are 12 months and then again at 24 months of age. Specifically, associations between behavioral jealousy responses, baseline EEG activity, stress reactivity and attachment security will be examined. The primary goal of the study is to examine quantitative and qualitative changes in infant jealousy responses across time. The following section will review attachment theory and will discuss the development of attachment, methodologies used in attachment theory, consequences of attachment patterns, and the association between attachment and jealousy behaviors. Next, a review of previous infant jealousy research will be discussed followed by a review of EEG and cortisol research and a brief overview of the physiology of jealousy. Finally, a longitudinal study will be proposed which aims to fulfill many of the current gaps in the infant jealousy literature.

Attachment Development

The development of attachment is believed to occur in phases (Ainsworth, 1967). According to attachment theorists, newborn infants respond similarly to social

responsiveness from any source- regardless of whether it originates from their primary caregiver or an unfamiliar person. Between 7 and 11 weeks of age, infants begin to demonstrate differential smiling and vocalizations towards their primary caregiver who is typically their mother. Discriminative behavior, separation distress, and negative responses to non-attachment figures increase in intensity from 11 to 39 weeks of age. At 40 weeks, infants can be observed to follow their mothers upon noticing her impending departure, approach and greet their mothers upon her return, and use her as a secure base for exploration in her presence. At around age 3 to 4 years of age, attachment relationships are less characterized by the dependence of children on mothers for food and safety, and are more characteristic of a goal-directed partnership. Children begin to understand that their mothers have their own set-goals and intentions and begin to consider those along with their own set-goals and intentions. These goal-corrected partnerships are highly influenced by cognitive changes as children learn to consider the perspective of others. Qualitative and quantitative changes in their representative skills coincide with an increase in language skills to change the dynamics of the mother-infant attachment relationship (Bowlby 1969; Ainsworth, 1989).

Types of Attachment Patterns

In the early stages of attachment development, several factors have been identified as contributors to infants' attachment style. These factors include close physical contact between mothers and their infants, and consistent living environments in which infants can learn the consequences of their actions and recognize maternal patterns of behavior (Bowlby, 1969). Lastly, sensitive maternal responses to infant behaviors are considered a major contributor to infants' sense of security. Infants who receive positive,

sensitive and contingent responses from their mothers will likely develop a secure attachment style (approximately 67% of infants develop a secure attachment). Infants exposed to inconsistent, neglectful or intrusive parenting are at risk for developing an insecure attachment pattern (approximately 33% of infants).

Measures of Attachment

The most widely used method of assessing attachment in infancy is the Strange Situation Paradigm (SSP). The paradigm takes approximately 21 minutes to complete and involves 8 episodes in which the infant is either alone, in the presence of the mother, and/or in the presence of a stranger (Ainsworth & Bell, 1970; Ainsworth, Blehar, Waters & Wall, 1978). For securely attached infants, each episode triggers different patterns of behavior. In the presence of their mothers, secure infants will engage in exploratory behaviors in the laboratory room. Upon separation from their mothers, infants will engage in crying and following behaviors. In her absence, infants demonstrate decreased exploratory behaviors and upon the mothers' return, infants display proximity seeking and contact maintenance behaviors. In general, secure infants use their mothers as a secure base for exploration and safe haven when stressed (Moss, Bureau, Cyr & Dubois-Comtois, 2006). Infants with a preoccupied attachment style use their mothers as a safe haven but not as a secure base, that is, that they seek their mothers when distressed but show less exploration than securely attached infants in her presence. Infants with avoidant attachment styles develop the opposite pattern. They do not demonstrate high levels of distress upon separation and tend to avoid and ignore their mothers upon reunion (Main, 1996). Infants placed in the disorganized category typically do not have an established pattern of interacting with their mothers.

While there is an extensive amount of attachment research using the SSP there are also limitations to the procedure. First, the SSP is only valid when used with infants between 12 and 18 months of age. Second, it takes a long amount of time to administer and score and places stress on the infant. Also, because most infants are classified as securely attached, large samples are needed in order to make comparisons between secure and insecure infants. Finally, scoring of the paradigm is not sensitive to developmental changes in infants' responses to maternal separation and reunion (Waters & Deane, 1985). Alternative measures of attachment security have been used for infants outside of the 12 to 18-month old range.

The Preschool Attachment Classification System (PACS; Cassidy & Marvin, 1992) uses a similar structure to the SSP to assess attachment in 3 to 5 year olds and includes several separation and reunion episodes. Children's behaviors during those episodes can be used to classify children as secure, insecure-ambivalent, insecure-avoidant and insecure-disorganized. Unlike the SSP, the PACS can be used for older children but still has some of the same limitations since it is based on the same episodes.

The Attachment Q-Set (AQS; Waters, 1987) is another measure of attachment security which does not require as much time in administering and scoring, does not place stress on the child, can be used to assess attachment security in children between 12 months of age to 48 months of age, and has demonstrated moderate levels of convergent validity with the SSP (Van Izjendoorn, Vereijken, Bakersman-Kranenburg & Riksen-Walvern, 2004). Version 3.0 of the Q-set consists of 90 cards which cover a large range of children's secure base and exploratory behaviors. Observers sort the cards into 7 categories ranging from most characteristic of the child to least characteristic of the child.

Scores are correlated with criterion scores from a prototypically secure child to yield a continuous security variable. The Q-set does not distinguish between secure and insecure categories of attachment. Like with the SSP, in which attachment classifications remain highly stable from 12 to 18 months of age (Bretherton, 1985), attachment security measured with the AQS at 12 months of age is highly correlated with ratings at 36 months of age (Waters & Deane, 1985).

When used by observers, 3 to 4 hours of observation of the child at home must take place before the Q-set is sorted, and observer reliability is highly dependent on their confidence level in their understanding of the child (Teti & McGourty, 1996). To eliminate the time and effort required in using observer's Q-set ratings, mothers have also been used as sorters since they are already familiar with their child's behavior. While mothers' own psychological state and her feelings toward her child may affect her scoring (Moss, Bureau, Cyr & Dubois- Comtois, 2006), studies using mothers as sorters have revealed that correlations between observer and maternal ratings are moderate to high (Waters & Deane, 1985). Generally, the use of mothers has sorters has been found to be acceptable if they are trained to sort the Q-set appropriately, that is, if mothers are given clear instructions and ample time to look over the items before sorting (Teti & McGourty, 1996).

Consequences of Attachment

Attachment patterns established in infancy may influence the quality of the mother-child relationship in later years. For example, Moss and her colleagues have demonstrated that infants with disorganized attachment styles later develop two ways of interacting with their mothers: controlling-coercive and controlling-caregiving (Moss,

Cyr & Dubois-Comtois, 2004). Findings on the long-lasting effects of attachment on the mother-child relationship have been inconsistent, with some evidence showing that the relationship between secure attachment in infancy and positive social interactions becomes less stable as children approach the age of 3 (Bowlby, 1969). Broad consequences of insecure attachment patterns include the formation of negative views of social interactions and the development of negative patterns of social behavior. It has been demonstrated that infants with a disorganized attachment style demonstrate more aggressive behaviors in childhood than infants with any other attachment style (Main, 1996). In addition, it has been shown that children select friends with similar or complementary attachment styles which may reinforce their internal working models (Thompson, 2006; Bretherton, 1985).

Attachment and Jealousy

Studies examining the relationship between attachment and jealousy have been conducted using infant and adult samples but have yielded mixed results. In adulthood, some studies have found that individuals with secure attachments are less jealous of hypothetical threats to their romantic relationships than individuals with insecure attachments (Buunk, 1997), while others have found that a history of disrupted attachment history is not associated with romantic jealousy (Clanton & Koskins, 1991). Mixed results have also been found in infancy. In their study of attachment and jealousy behaviors in 11-month old infants, Hart and Behrens (2013), found that securely attached infants (categorized as such through the SSP) demonstrated greater mother-infant proximity during jealousy evocation than insecure-resistant infants, although insecure-avoidant infants demonstrated the largest increase in proximity seeking behaviors. Teti

and Ablard (1989) demonstrated that securely attached 18-month old infants showed less negativity toward their mothers when their mothers ignored them and demonstrated differential treatment toward their older sibling. Other studies have found that attachment security is not a significant predictor of jealousy for 16-month olds but is associated with greater hostility and verbal attempts of attention seeking for 50-month olds (Volling, McElwain & Miller, 2002). The present infant literature lacks sufficient knowledge about the impact of attachment styles on jealousy behaviors across infancy and whether measures of attachment collected toward the end of the first year of life (other than the SSP) are associated with jealousy behaviors. The current study will examine the relationship between attachment security, measured using the Attachment Q-set, and behavioral and physiological measures of jealousy infants when they are 12 and 24 months of age.

The Physiology of Jealousy

The electroencephalogram (EEG) was first used on humans in the 1920's by Hans Berger as a method of measuring brain-wave activity. At the time, the use of EEG involved the insertion of needles into the scalp and shaving of hair (Fox, Calkins & Bell, 1994). Currently, the use of EEG is non-invasive and involves placing electrodes either directly onto the scalp or via a cap placed on the head and filled with conductive gel. EEG measures the frequency and amplitude of brain waves associated with different levels of alertness, arousal, and cortical activity. Theta waves are associated with learning and memory, while beta and alpha waves are associated with states of arousal (Fox, Schmidt, Henderson & Marshall, 2007). Alpha waves are the type of EEG wave most studied in infancy because they are the most prominent at that stage of development. The

following paragraphs will discuss EEG asymmetry, a common method of analyzing infant EEG activity, and its relation to infant jealousy.

EEG Asymmetry

EEG asymmetry refers to the comparison of activity in the right hemisphere compared to the left hemisphere. Left asymmetry reflects greater activation in the left hemisphere and is associated with positive emotions, while right asymmetry reflects greater activation in the right hemisphere and has been linked with negative affect and avoidance biases (Marshall & Fox, 2007a). Some have argued that affective styles are moderated by asymmetry in frontal cortical activity (Marshall & Fox, 2007b). The injection of sodium amytal, a sedative drug, into the left carotid artery has been demonstrated to induce crying and pessimism. Injecting the same drug into the right carotid artery induces euphoria and smiling (Lee, Loring, Meader & Brooks, 1990). Studies on patients with brain damage have also demonstrated that damage to the right side of the brain results in increases in positive affect and damage to the left results in increases in negative affect (Sackeim, Greenberg, Weiman, Gur, Hungerbuhler, & Geschwind, 1982). Resting left frontal asymmetry is considered optimal as infants develop. Resting right frontal asymmetry, however, has been associated with behavioral avoidance in mother-infant interactions (Jones et al., 1997), poor social competence (Fox et al., 1995; Schmidt & Fox, 1994) and internalizing problems (Fox, Calkins, Schmidt, Rubin, & Coplan, 1996).

EEG Activity and Infant Jealousy

In adults, romantic jealousy has been associated with greater left frontal activation (Harmon-Jones, Peterson and Harris, 2009). Relationships between left frontal EEG

asymmetry and jealousy responses have also been found in infancy. In studies with 8-month-old infants, infants have been shown to demonstrate greater left mid-frontal EEG asymmetry along with increased gaze, reach and negative affect when their mothers ignored them and attended to a doll (Blau, 2010). Greater left lateral frontal asymmetry has also been found along with greater levels of arousal and gaze during the doll condition than the book condition for 8-month olds (Mize, Pineda, Marsh, Blau & Jones, 2014). In their study of 12-month-old infants, Mize and Jones (2012) found a moderate sized correlation between a composite of approach behaviors during the doll condition (i.e. mother-directed gaze, touch and proximity) and left-frontal asymmetry. Studies examining the relationship between behavioral jealousy responses and EEG asymmetry with infants older than 12 months of age have not been conducted. The current study will investigate whether baseline EEG asymmetry is related to behavioral expressions of jealousy in 12 and 24 month olds.

Cortisol

In the presence of a stressor, cortisol is the end product of the hypoythalamic-pituitary-adrenal (HPA) axis. A stressor will trigger the hypothalamus to release corticotropin-releasing hormone, triggering the pituitary to produce adrenocorticotropic hormone (ACH) and the adrenocortical axis to release cortisol (Hellhammer, Wust & Kudielka, 2009). Cortisol increases arousal by increasing blood flow, oxygen, heart rate and shifting resources away from processes that are less important in flight or fight situations such as the digestive system (Elverson & Wilson, 2005). In a negative feedback loop, cortisol triggers the pituitary gland to stop the release of ACH. Cortisol travels in the blood bound to a protein referred to as cortisol binding globulin. When

bound, the effects of cortisol on the body are inactive. Five to ten percent of cortisol in the blood is unbound and free to exert its effects, while the rest is picked up by tissues or cleared by the kidneys. Unbound cortisol can be found in saliva and salivary cortisol has been found to be a reliable measure of the amount of free cortisol present in the blood as it correlates highly with plasma cortisol (Gunnar & White, 2001).

Cortisol in Infancy

In addition to being released after a stressor, cortisol is also released by the body throughout the day. Adults have a cortisol circadian rhythm with peak cortisol levels in the morning and the lowest levels of cortisol at around midnight (Keil, 2012). By 2 months of age, infants demonstrate adult-like fluctuations in cortisol (Gunnar & Donzella, 2002). In early infancy, solid feedings and naps shortly before measurement are associated with increases in salivary cortisol levels (De Weerth & Van Geert, 2002). As feeding and sleeping patterns become more stable later in infancy, basal cortisol levels demonstrate a gradual decrease from 6 weeks to 12 months of age (Tollenaar et al., 2010).

As with basal cortisol levels, reactive cortisol levels also demonstrate a decrease with infant age. A longitudinal study by Jansen and his colleagues (2010) demonstrated that infant reactive cortisol levels decrease substantially from 3 months to 24 months of age regardless of the type of stressor presented (i.e., physical pain, maternal separation and exposure to novel stimuli). In the same study, physical pain was found to produce the most reactive cortisol increases, followed by maternal separation, and exposure to novel stimuli. Other studies have found that by 18 months of age, infants no longer demonstrate an increase in cortisol from baseline in response to maternal separation (Gunnar, Talge &

Herrera, 2009). An exception to this finding is that infants with disorganized attachment styles continue to demonstrate increases in cortisol in responses to maternal separation. Intrusive and withdrawn maternal behaviors have also been associated with increased cortisol reactivity in infancy (Crockett, Holmes, Granger & Lyons-Ruth, 2013). In the jealousy paradigm, mothers are physically present but are not responsive which may produce a stress response similar to that produced by physical maternal separation. Presently, no studies have been conducted examining infant stress responses to jealousy evocation. The current study will measure salivary cortisol before and after jealousy evocation to determine whether perceived threats to a mother-infant dyad relationship by a social rival will produce stress responses in infants at 12 and 24 months of age.

The Present Study

While jealousy is understood as a system of physiological, behavioral, social and emotional responses, few studies have examined these aspects of jealousy simultaneously in infants. Further, jealousy paradigms have not been examined as a potential stressor in infancy and thus typical cortisol reactivity and regulation patterns in response to jealousy paradigms have not been documented. In addition, the contribution of attachment security to infant expressions of jealousy has been vastly understudied.

The current study will examine infants' physiological and behavioral responses to Hart's infant jealousy paradigm at 12-months at 24-months of age. Behavioral data (specifically measures of protest and approach), salivary cortisol samples, and EEG activity will be collected across age. An assessment of attachment using the Attachment Q-set will be completed by the infants' mothers at both time points. The relationship between attachment security, EEG asymmetry patterns, cortisol reactivity and regulation

and affective jealousy expressions will be examined. It is expected that physiological and behavioral jealousy responses will vary depending on attachment security level and that jealousy responses will change with age.

Hypothesis 1: Infants at 12-months and 24-months of age will express behavioral and physiological jealousy responses during the social rival condition.

Hypothesis 1a: Approach

Consistent with previous findings (Mize & Jones, 2012; Hart, Field, Del Valle & Letourneau, 1998), it is hypothesized that infants will demonstrate more approach behaviors when their mothers ignore them and attend to the doll than when their mothers attend to the book. An approach composite variable will be created from the proportion of time that infants are observed to engage in mother-directed gaze and mother-directed proximity (including touch and reach variables). Higher proportions of approach behavior during the doll condition vs. the book condition are expected for the 12 month and 24 month observations.

Hypothesis 1b: Negative Affect

It is expected that at 12 and 24 months of age, infants will demonstrate higher proportions of negative affect during the doll condition than in the book condition. Hart (2013) describes infants' displays of negative affect during the doll condition in response to mothers' positive affect and vocalizations toward the doll as inversed affect sharing. Evidence of inversed affect sharing has been demonstrated in other studies of infant jealousy in 6 to 12-month olds (Hart & Carrington, 2002; Hart, Carrington, Tronick & Carroll, 2004; Hart, Field, Del Valle & Letourneau, 1998). Displays of negative affect in

response to jealousy evocation have also been found for 23-month old infants (Szabo, Dubas, & van Aken, 2014) and 4- year old children (Miller, Volling & McElwain, 2000).

Hypothesis 1c: Left-frontal EEG Asymmetry

Based on previous studies examining the relationship between EEG asymmetry and behavioral jealousy expressions (Mize & Jones, 2012; Mize, Pineda, Marsh, Blau & Jones, 2014), it is expected that approach behaviors during the doll condition will be associated with resting left-frontal EEG asymmetry at 12-months and 24-months of age.

Hypothesis 1d: Cortisol Reactivity

Salivary cortisol levels measured after the doll condition are expected to be higher than baseline cortisol levels. Although studies examining the association between jealousy situations and cortisol have not been conducted in infancy, the doll condition is expected to be a stressful condition for infants when they are 12 and 24-months-old since it is a form of maternal separation and since maternal separation has been shown to increase cortisol levels in infants (Gunnar, Talge & Herrera, 2009).

Hypothesis 2: Changes in the intensity of behavioral and physiological jealousy expressions will occur over time.

Hypothesis 2a: Negative Affect

Decreases in negative affect during jealousy situations have been found with age, possibly due to increased self-regulation abilities (Miller, Volling & McElwain, 2000; Volling, McElwain & Miller, 2002; Teti & Ablard, 1989). Therefore, it is expected that at 24 months of age infants will display lower proportions of negative affect during the doll condition than at 12 months of age.

Hypothesis 2b: Cortisol Reactivity

Given that reactive cortisol levels have been shown to decrease after the first year of life (Jansen, Beijers, Riksen-Walraven, & de Weerth, 2010), it is expected that at 24 months of age infants will demonstrate lower reactive cortisol levels than at 12 months.

Hypothesis 2c: Approach Responses

Cross-sectional studies conducted on the topic of infant jealousy have indicated that changes in approach behaviors occur over time and that the most intense manifestations of jealousy occur at 13 months of age (Masciuch & Kienapple, 1993). However, the use of longitudinal study designs in this field has been limited to samples of infants younger than 10 months of age (Hart, 2010). Given the changes in cognitive abilities, motor skills, and regulatory abilities that occur between within the second year of life, it is expected that at 24-months, infants will differ in their overall approach responses from those behaviors displayed at 12-months.

Hypothesis 3: Attachment security is associated with infant physiology and behavioral jealousy responses.

Hypothesis 3a: Attachment and Cortisol Reactivity

Insecure attachment patterns have been associated with increased stress reactivity involving social situations (Gunnar, Talge & Herrera, 2009; Gunnar & White, 2001). While the Attachment Q-set does not differentiate between insecure and secure categories, low attachment security scores have been shown to converge with insecure attachment classifications based on the Preschool Attachment Classification System (Moss, Bureau, Cyr, & Dubois-Comtois, 2006). It is expected that attachment security scores will be negatively correlated with cortisol reactivity. At 12 months and 24 months,

infants with low security scores are expected to demonstrate greater cortisol reactivity after the doll condition of the jealousy paradigm than infants with high security scores.

Hypothesis 3b: Attachment and Cortisol Regulation

Infant self-regulation abilities have been linked to maternal sensitivity and responsiveness (Bell & Ainsworth, 1972). Attachment security in infants has been found to correlate highly with maternal sensitivity (Crittenden, 2005). Based on their past experiences, secure infants grow to expect their mothers to protect them and soothe them under times of stress and these expectations become incorporated into their regulatory abilities (Crittenden, 2006). Although the current study, does not measure maternal sensitivity, it is expected that infants with higher attachment security scores will demonstrate lower cortisol levels measured 40 minutes after the doll condition (regulatory cortisol) than infants with low attachment security scores. In other words, infants with higher attachment scores are expected to demonstrate greater stress regulation.

Hypothesis 3c: Attachment and Behavioral Jealousy Responses

Attachment security ratings will be positively correlated with the proportion of jealousy behaviors expressed during the social rival condition. Findings from a previous study, which included a subset of the 13-month old participants from the present study, demonstrated that attachment security scores obtained from the AQS are positively correlated with global approach behaviors (Platt, Jones, & Valdez Palomino, 2017).

II. METHOD

Participants

Twenty-five participants were recruited from a birth records list obtained from the Florida Department of Vital Statistics and approved by the FAU IRB and the Florida Department of Health Institutional Review Board. The list contained birth dates, names and home addresses of infants born in the state of Florida. Postcards and flyers inviting mother-infant dyads to participate were sent to families residing in Martin and Palm Beach Counties. Printed recruitment materials were sent to families with children between the ages of 11-15 months of age.

All participants from the 11-15-month-old sample were invited to participate at 24-36 months of age. Twenty participants (11 male infants) returned for the second part of the study. Five participants did not return because they either relocated to another state (1), or did not return follow-up phone calls/emails (4). Infant ages at the 12-month visit ranged from 11-15 months (M=13.29, SD=0.96). Infant ages at the 24-month visit ranged from 23-36 months (M= 26.65, SD= 4.77). Maternal age for the final sample ranged from 25-54 years of age (M=32.63, SD=6.97). The sample contained infants of Caucasian (N=17), Hispanic (N=1), and mixed (N=2) ethnicities.

Materials and Procedure

Both visits took place in the infant developmental physiology lab at FAU in Jupiter. A detailed outline of procedures for each visit is presented in Figure 1. Upon

completion of each visit, mothers were given a $10 gas card and infants were given an age appropriate toy.

Jealousy Paradigm

12-month and 24-month visits

Upon arrival to the lab, a sample of saliva was collected from the infants. After the first saliva sample collection, mothers were directed to sit on a chair placed in the center of the laboratory and infants were directed to a play mat which was placed directly in front of the mother. While the infant was sitting on a play mat and interacting with a toy, the researcher entered the room with a colorful cookbook or an 18-inch True to Life Newborn doll (conditions were counterbalanced). The mother was asked to ignore her baby while enthusiastically reading the book or playing with the baby doll. Based on the length of the jealousy paradigms in previous studies (Hart & Behrens, 2013; Mize & Jones, 2012; Mize, Pineda, Marsh, Blau & Jones, 2014), mothers were asked to ignore their infants for 90 seconds during each condition for both the 12-month and 24-month visit. The conditions were separated by one minute of play between the mom and the baby. After the conditions, the infant was entertained by the research assistant while the researcher administered questionnaires to the mother. All other physiological measures were collected following the completion of the jealousy paradigm.

Physiological Measures

EEG:12-month and 24-month visits

Infants were fastened into a high chair and a stretch Lycra EEG cap, with the international 10-20 system, was placed on their heads. Electrodes in the frontal (F3, F4, F7 and F8), central (C3 and C4), parietal (P3 and P4) and occipital (O1 and O2) and

regions were prepared with a conductive gel. The vertex, Cz, was also prepared as a site of reference. Impedances were brought to less than 5k ohms across all regions and signals were amplified with a bandpass of 1-100 hertz using SA Instrumentation Bioamps. The sampling rate was set to 512 samples per second. Data was streamed onto a desktop computer screen and collected onto a hard drive using the Snapstream data acquisition system (HEM Data Corporation, 1991).

Three minutes of baseline EEG activity were collected while a research assistant distracted the infant during the cap placement (i.e. by blowing bubbles). Pacifiers, food, and other objects that the infant could place into his/her mouth were removed to prevent artifact due to chewing/sucking movements. At both data collection periods, baseline EEG was collected at the end of each visit, since the placement of the EEG cap may have been a stressful event for the infant and may have interfered with HPA reactivity arising from the jealousy paradigm itself. EEG activity was not collected during the book and doll conditions since infants were free to roam the room.

Artifact was removed using the EEGEDIT program (James Long Company, Caroga Lake, New York) and edited data was analyzed using 6-9 Hz frequency bands for the 12 and 24 month olds. The 6-9 Hz frequency band has been recommended in analyzing EEG data for infants after 6 months of age (Marshall & Fox, 2007a; Marshall, Bar-Haim & Fox, 2002). A second alpha range (10-12 Hz) was examined for 24-month-olds only since activity in the 6-9 Hz range has been shown to decline at around 2 years of age (Marshall & Fox, 2008).

Cortisol: 12 and 24-month visits

The cortisol circadian rhythm is adult-like for infants older than 2-months of age, in the sense that cortisol levels peak in the early morning hours. Therefore, to keep baseline cortisol levels as constant as possible across participants, the 12-month and 24-month visits were scheduled between 10:00am and 12:00pm.

As previously mentioned, baseline salivary cortisol samples were collected from the infants upon arrival to the lab. At both ages, baseline salivary cortisol samples were collected with a children's saliva swab (Salimetrics, Inc.). The swab was long enough for the researcher to hold one end of the swab while the other end of the swab rested in the child's mouth for 60 seconds. Additional saliva samples were collected 20-25 minutes and 40-45 minutes after the doll condition as measures of the infants' stress reactivity and regulation, respectively. Swabs were transferred to a -20C freezer immediately after saliva collection and were moved to a -80C freezer until centrifuged.

Questionnaires

Mothers were asked to complete several questionnaires regarding her mood (The Center for Epidemiologic Studies Depression Scale and Behavioral Inhibition/Behavioral Activation Scales), her family's demographic information and her infants' behavior (Colorado Child Temperament Inventory and Attachment Q-Sort). For both visits, the timing of the questionnaire administration varied depending on the order in which the doll and book conditions were presented (see Figure 1).

Maternal Mood and Demographic Information

The Center for Epidemiologic Studies Depression Scale is a self-report depression scale consisting of 20 questions. Scores over 16 are indicative of clinical depression

(CES-D; Radloff, 1977). Mothers' approach and withdrawal tendencies were measured using the 34-item Behavioral Inhibition/Behavioral Activation scales (Carver & White, 1994). The Demographic/Household Information questionnaire consists of questions regarding the infant's age and basic health information (i.e. weight and height at birth, APGAR scores) and mother's ethnicity, education, marital status, employment status and socioeconomic status.

Infant Behavior and Attachment

Mothers were asked to complete the Colorado Temperament Inventory during the 12-month and 24-month visits. The Colorado Child Temperament Inventory (CCTI; Rowe & Plomin, 1977) is a 30-item questionnaire intended to measure temperament in 1-6-year old children. A modified version of the CCTI, which has been used in previous studies (Mize, 2008; Mize & Jones, 2012) with high reliability scores, was used in the present study and includes the following scales: Attention, Activity Level, Emotionality, Sociability and Shyness.

Attachment was measured at 12-months and 24-months using the Attachment Q-set which consists of 90 cards. A copy of the Attachment Q-set items was sent to mothers before the initial 12-month visit so that they had to opportunity to familiarize themselves with the items and think about how each item related to their infants' behavior. During the visit, mothers were asked to sort the cards into 9 categories ranging from category 1 (extremely uncharacteristic of child) to 9 (extremely characteristic of child). Each category has a designated number of cards that can be placed into it, with the two extreme categories allowing for 4 cards each and the neutral pile allowing for the most cards (16 cards each). The Q-set yields 4 constructs: security, dependency, sociability and

social desirability (Waters & Deane, 1985). For the current study, only the security construct was coded. Scores for each item were correlated with a security criterion which represents scores from a protypically secure child. Therefore, attachment security scores ranged from -1 to 1.

Coding Behavioral Responses

Behavioral coding was conducted by two trained undergraduate students who were blind to the study's hypotheses. Coding began when the research assistant left the room at the beginning of each condition and end after the condition (90 seconds of coding for each condition for 12 and 24-month olds).

Based on existing coding systems for assessing jealousy in toddlers and young children (Miller, Volling & McElwain, 2000; Volling, McElwain & Miller, 2002), types of vocalizations were tallied for 24-month olds, including: protest/demand vocalizations (i.e., asking mother to "stop"), attention-seeking vocalizations (i.e., calling out for mother, vocalizations to draw attention towards themselves), and vocalizations about the task-item. All other behaviors were coded on a second-by-second basis using the program Observer. Gaze, proximity of infant to mother, touch, level of arousal, vocalizations and affective state were coded for both visits (Table 1). Interrater reliability for 20% of the behavioral data was calculated and Kappa scores ranged from .85 to .93.

III. RESULTS

Preliminary Analyses

One-way ANOVAs were used to determine the influence of task item order on approach behaviors, EEG asymmetry scores, and cortisol measures at both ages. The ANOVAs were not significant, suggesting that task order did not impact behavioral or physiological data. Cortisol concentration levels for all samples were found to be within the appropriate range for infants over the age of 6-months (Salimetrics, 2016). ASQ security scores were also within range and showed an average similar to previous research (Waters & Deane, 1985).

Hypothesis 1a: Approach as a Behavioral Jealousy Response

It was expected that infants would demonstrate more approach behaviors when their mothers ignored them and attended to the doll than when their mothers attended to the book. Higher proportions of approach behavior during the doll condition vs. the book condition were expected for the 12-month and 24-month observations.

Paired sample t-tests were conducted to compare proportions of mother-directed gaze, touch, and proximity between the book and doll conditions at both ages. At 12-months of age, proportions of gaze ($t(19) = -5.30$, $p < .001$), proximity ($t(19) = -3.76$, $p = .001$), and touch ($t(19) = -2.37$, $p = .029$) were significantly higher in the social rival condition than in the non-social rival condition. Similar results were found at 24-months of age. As expected, proportions of mother-directed gaze ($t(19) = -3.02$, $p = .007$) and proximity ($t(19) = -3.07$, $p = .006$) were higher during the doll condition than the book

condition. There were no differences found in touch behaviors between the social rival and non-social rival conditions at 24-months. Means and standard deviations for approach behaviors at both ages are presented in Tables 2 and 3.

Hypothesis 1b: Negative Affect as a Behavioral Jealousy Response

It was expected that at 12 and 24-months of age, infants would demonstrate higher proportions of negative affect during the doll condition than in the book condition. Paired sample t-tests were conducted to compare the proportion of negative vocalizations and negative facial affect during the book and doll conditions at both ages. The t-tests were not significant at 12-months. At 24-months, infants demonstrated more negative affect during the book condition (M=14.62, SD=22.82) than during the doll condition (M=7.60, SD=11.47), t (19) =2.31, p=.032. Tallied observations for vocalization types at 24-months of age did not indicate significant differences in the number of protest vocalizations and attention-seeking vocalizations uttered during the book and doll conditions. Infants produced more task-oriented vocalizations (i.e. “baby sleep”, “baby play”) during the doll condition (M= 3.83, SD= 5.04) than during the book condition (M=1.11, SD=2.08), t (17) =-2.26, p=.037.

Hypothesis 1c: Left-frontal EEG asymmetry as a Physiological Jealousy Response

A correlational analysis was used to examine the association between EEG asymmetry and the proportion of time that infants spent displaying approach behavior. There were positive correlations between mid-frontal EEG asymmetry and mother-directed gaze (r (17) =.55, p=.021) and touch (r (17) =.56, p=.027) during the book condition at 12 months. As shown in Figure 2, a positive correlation between lateral frontal EEG asymmetry and gaze during the book condition was also found (r (17) = .51,

p=.037). There were no significant correlations between EEG asymmetry in any region and approach behaviors during the doll condition at 12 months. Mid-frontal EEG asymmetry in the 6-9 Hz frequency band was correlated with gaze (r (17) = .52, p=.032) and touch (r (17) = .51, p= .036) during the doll condition at 24-months. These correlations are presented in Figures 3 and 4, respectively. Parietal (r (15) = .78, p=.001) and occipital (r (15) = .58, p=.023) EEG asymmetry in the 10-12 Hz frequency band was correlated with touch during the doll condition. Summaries of the correlations between EEG asymmetry and approach behaviors are presented in Tables 4 and 5.

Hypothesis 1d: Cortisol Reactivity as a Physiological Jealousy Response

Complete cortisol data (baseline, reactivity, and regulation measures) were available for 13 out of 20 participants at the 12-month visit and 16 out of 20 participants at the 24-month visit. Samples were not collected for 4 participants at 12-months. Other samples did not contain enough saliva necessary for analyses. Mean replacement and multiple imputation techniques (Young & Johnson, 2015) were used to replace missing data but did not change the results reported below.

Salivary cortisol levels measured 20 minutes after the doll condition were expected to be higher than baseline cortisol levels. Paired sample t-tests were used to determine whether reactive cortisol levels were higher than baseline cortisol levels at 12 and 24-months of age. Baseline levels were compared to two different reactivity variables: the first variable represented the exact cortisol levels collected 20-minutes post-stressor and the second variable was a change variable which was computed by subtracting reactivity scores from baseline scores. No significant differences between baseline and reactivity measures were found at 12-months of age or 24-months of age.

Cortisol baseline measures at 12-months and 24-months were correlated (r (15) = .72, p=.002). Reactivity (r (13) =.83, p<.001) and regulation (r (11) = .84, p=.001) measures were also correlated with corresponding cortisol measures across time. Total baseline, reactivity, and regulation cortisol concentration levels were computed across ages and compared using a paired sample t-test. No significant differences were found.

Hypothesis 2a: Age-related Changes in Negative Affect

It was expected that infants at 24-months of age would display lower proportions of negative affect during the doll condition than at 12-months. Paired sample t-tests were run to examine changes in negative vocalizations and affect during the doll condition over time. Infants produced significantly more negative vocalizations during the book condition at 24-months (M=18.48, SD=24.57) than at 12-months (M=7.29, SD=16.79).

Hypothesis 2b: Age-related Changes in Cortisol Reactivity

A one-way ANOVA was run to examine whether differences in cortisol reactivity existed between both time points. No differences were found. Infants were ranked in order of their cortisol concentration levels for each measure at both ages. A non-parametric correlation analyses was run to examine the stability of rank order for each measure over time. There were no significant correlations found.

Hypothesis 2c: Age-related Changes in Approach

A 2 X 3 repeated measures ANOVA with age (12-months and 24-months) and type of approach behavior (gaze, proximity, and touch) as within-subject factors was run to test for changes in approach behavior across age. There was a significant main affect for type of approach behavior, F (2, 18) = 48.76, p <.001. There was also a significant interaction between age and approach type, F (2, 18) = 5.66, p=.012. Follow up t-tests

indicated that significant differences across age were present for touch behaviors only, t (19) = 2.88, p=.01. Means and standard deviations are presented in Tables 2 and 3. Infants were also ranked by proportion of total approach behaviors displayed at 12-months and 24-months. A Spearman's rank order correlation was run using the two approach variables and was not significant *(*r_s (18) = 05, p=.83)

Hypothesis 3a: Attachment and Cortisol Reactivity

Attachment security scores were expected to be negatively correlated with cortisol reactivity. At 12-months and 24-months, infants with low security scores were expected to demonstrate greater cortisol reactivity after the doll condition of the jealousy paradigm than infants with high security scores. Correlational analyses were used to assess the relationship between stress reactivity and Attachment Q-set scores. No significant correlations were found between reactivity measures and AQS scores at 12-months or at 24-months.

AQS scores were converted to a categorical variable and infants were either placed in a below average security group or above average security group based on the criterion average of .3 (Van Izjendoorn, Vereijken, Bakersman-Kranenburg, & Riksen-Walvern, 2004). No significant differences in reactivity measures were found across AQS groups at either age. Because AQS scores collected at 12-months were strongly correlated with attachment scores at 24-months, r (16) = .90, p<.001, a variable representing total AQS scores across ages was created. Total reactivity scores across time were significantly correlated with total AQS scores across time, r (30) = -.38, p=.040 (Figure 5).

Hypothesis 3b: Attachment and Cortisol Regulation

Infants with higher attachment security scores were expected to demonstrate lower cortisol levels measured 40 minutes after the doll condition than infants with low attachment security scores. Regulatory cortisol levels were subtracted from reactive cortisol levels to produce a variable representing the change in cortisol levels from 20 to 40 minutes after the stressor. Correlational analyses were used to assess the relationship between regulatory cortisol and Attachment Q-set scores. The correlations were not significant at 12-months or at 24-months. Correlations using total scores (across age) were not significant. A one-way ANOVA comparing regulation measures by categorical AQS groups was not significant.

Hypothesis 3c: Attachment and Behavioral Jealousy Responses

Correlational analyses were used to determine the relationship between AQS security scores and levels of approach during the book and doll conditions. AQS scores were positively correlated with proximity during the book ($r(16) = .55$, $p=.029$) and doll conditions ($r(16) = .66$, $p=.006$) at 12-months. There were no significant correlations between AQS security scores and behavioral jealousy responses at 24-months.

A one-way ANOVA was used to compare jealousy behaviors by AQS categorical groups at 12-months. Infants with security scores above the criterion average had a higher proportion of proximity to mother during the doll condition ($M=75.52$, $SD=25.73$) than infants with security scores below the average ($M=20.00$, $SD=34.64$), $F(1, 14) = 10.17$, $p=.007$.

Exploratory Analyses

Moderate to high levels of arousal were compared across conditions and ages. At 12-months, infants displayed significantly higher levels of arousal during the doll condition (M= 64. 42, SD= 36.77) than during the book condition (M=35.32, SD=36.64), t (19) =-2.80, p=.011. A similar pattern was found at 24-months, t (19) = -2.07, p=.043. Infants demonstrated more arousal during the doll (M=28.61, SD=39.41) versus the book condition (M=18.36, SD=26.80. Levels of arousal during the doll condition significantly decreased from age 1 to age 2, t (19) =-4.19, p<.001.

A linear regression was run to examine whether AQS scores, cortisol reactivity, and EEG activity at 12-months predicted behavioral jealousy behaviors at 24-months. The regression was significant, F (5, 6) =12.36, p=.004, R^2=.911. Lateral frontal EEG asymmetry (b=.63, t (6) = 3.61, p=.011, temporal EEG asymmetry (b=-.75, t (6) =-4.09, p=.006, parietal EEG asymmetry (b=.46, t (6) =3.32, p=.016), AQS scores (b=.58, t (6) = 3.97, p=.007), and cortisol reactivity (b=.40, t (6) = 2.96, p=.025) emerged as significant predictors of total approach behaviors during the doll condition at 24-months. A regression analyses using the same predictors from the 12-month lab visit (excluding cortisol reactivity) were used to predict approach behaviors in the book condition at 24 months. The overall model and individual predictors were not significant.

IV. DISCUSSION

The current study aimed to identify associations between behavioral and physiological responses to jealousy evocation in infants, and how those associations change over time. The results of the study provide evidence that 12-month-old infants demonstrate jealousy responses, specifically approach behaviors, in response to maternal inattention and differential treatment towards a social rival. Infants continue to respond with approach behaviors when exposed to the same paradigm at 24-months of age, but the quality and quantity of these behaviors change. Underlying attachment security and physiological contributions to jealousy behavior also change with time. These findings partially support the hypotheses proposed regarding condition (social rival vs. non-social rival) and age differences and provide further support for the idea that the expression of jealousy seems to change with the development of regulatory abilities (Hart, 2016a). The following sections will attempt to explain the age-related differences in behavioral responses, EEG asymmetry, cortisol reactivity, and the jealousy-attachment relationship found in the present study.

Behavioral Responses

Approach Behaviors

Across time, infants demonstrated more approach behaviors during the social rival condition than during the book condition. This finding is consistent with previous studies which have used similar jealousy paradigms during this period of infancy (Hart &

Behrens, 2013; Mize & Jones, 2012). The use of a longitudinal design in examining these differences over time was useful because it allowed for a simultaneous examination of discontinuity in the development of jealousy and the role of individual differences in jealousy responses.

Twelve-month-old infants demonstrated differences in the proportion of mother-directed gaze, touch, and proximity between conditions; similarly, 24-month-olds displayed significant differences in approach behaviors except for mother-directed touch. The change in approach behaviors, particularly touch behaviors, could have resulted from differences in the procedure between the 12-month and 24-month laboratory visits. During the 12-month visit, mothers were seated at a chair while they held the doll. Infants could approach the mother from three different angles and attempt to touch the mother or the task-item. During the 24-month visit, mothers were instructed to stand over a crib placed next a wall and interact with the doll as it laid in the crib. Infants could only approach their mothers from one side. Observer ratings indicated that largest proportion of infant touch during the 24-month condition was directed toward the crib. That is, infants held on to the crib railings as they stood closely next their mothers while she interacted with the doll. The restriction in close access to the mother may explain why proximity was still significantly different across conditions at 24-months but not touch behavior. A decrease in touch behaviors over time could also represent a decrease in protest behaviors as infants at 24-months are expected to have an increased ability to regulate distress (Hart & Behrens, 2013).

Negativity

Infants were expected to demonstrate more negative facial affect and produce more negative vocalizations during the doll condition than during the book condition. Changes in the proportion of negative behaviors were expected to occur with age and with negativity decreasing over time. No significant differences were found in negativity ratings between conditions at either age and task-order did not seem to impact the results. Surprisingly, an increase in negative vocalizations was found with age during the book condition only. While these findings are not as predicted, low levels of sadness and overall negative affect across conditions have also been found in a similar study conducted using a sample of 24-month olds (Szabo, 2014). An analysis of the types of vocalizations produced at 24-months revealed that infants produced more task-oriented vocalizations during the doll condition than during the book condition. These vocalizations consisted of statements or questions regarding the doll. The lack of negativity along with the increased approach behaviors and task-oriented vocalizations taken together could indicate that infants at 24-months were demonstrating interest towards the social rival.

Arousal

Moderate to high levels of arousal (defined as body tension and cessation of play) were compared across conditions and ages as part of an exploratory analysis. At 12-months, infants displayed significantly higher levels of arousal during the doll condition than during the book condition. Higher arousal has been found previously in studies examining jealousy in one-year-olds (Mize & Jones, 2012). A similar of pattern of arousal was found again at 24-months. Infants demonstrated more arousal during the doll

versus the book condition. Levels of arousal during the doll condition decreased significantly from age 1 to age 2. Two year olds may be better able to regulate their emotions and may not need to rely on protest vocalizations and mother-directed touch to regain maternal attention and decrease arousal (Feldman, Masalha, & Alony, 2006). Infant jealousy studies that use arousal as a behavioral variable are scarce and more research is needed to investigate the relationship between observed levels of arousal and physiological indicators of arousal.

EEG Asymmetry

Left-frontal EEG asymmetry was expected to be correlated with approach behaviors at 12-months and 24-months given the relationship between frontal asymmetry and jealousy established in previous studies (Mize & Jones, 2012; Mize, Pineda, Blau, Marsh, & Jones, 2014) This hypothesis was not fully supported. At 12-months, left mid-frontal EEG asymmetry was positively correlated with mother-directed touch and gaze during the book condition. While the relationship between mid-frontal asymmetry and approach is in the expected direction, the condition during which the relationship occurs is unexpected. At 24-months, left mid-frontal, left parietal, and left occipital EEG asymmetry were associated with mother-directed gaze and touch during the doll condition. This age-related change may reflect developmental changes that are occurring within these brain regions. Parietal asymmetry in infancy has been found to reflect perceptual processing abilities (Fox & Davidson, 1987) and occipital asymmetry has been tied to visual attention (Fox, Schmidt, Henderson, & Marshall, 2007; Stroganova, Orekhova, & Posikera, 1999). Other studies have found relationships between right occipital asymmetry and jealousy in 9-month old infants (Mize, Pineda, Blau, Marsh, &

Jones, 2014) and between right parietal asymmetry and jealousy in adults (Harmon-Jones et. al, 2009). As most jealousy studies focus primarily on frontal regions, asymmetry results in other regions have not been fully explained.

One downside to the procedure used in the current study was that EEG activity was not collected during the conditions as was the case in other studies (Blau, 2010; Mize, Pineda, Blau, Marsh, & Jones, 2014). Therefore, direct associations between EEG activity and behavioral responses during the conditions could not be made. Still, the results found between asymmetry and global approach behaviors offer some insight about underlying physiological approach motivations.

Cortisol Measures

This was one of the first studies to examine the relationship between cortisol reactivity and infant jealousy responses. It was expected that the jealousy paradigm would be a stressor for infants at both ages and that they would demonstrate an increase in cortisol levels after the doll condition. There were no differences between baseline scores and reactivity scores at either age. Age-related changes in reactivity were also expected, specifically that reactivity scores would decrease with age as infants developed more sophisticated regulatory abilities. However, no age-related changes in reactivity were found. The cortisol reactivity measures in the current study were obtained from the saliva samples that were obtained 20 minutes after infants were exposed to the doll condition. Goldberg and her colleagues (2003) found that about half of the infants between the ages of 12 and 18 months of age in their sample produced a peak response at 20-minutes post-stressor. The other half of the sample did not produce a peak response until 40-minutes post-stressor. Even if it were the case that some infants reached a peak

response closer to 40-minutes post-stressor as opposed to 20-minutes post-stressor, the cortisol regulation measure that was obtained 40-minutes post-stressor did not differ significantly from the baseline levels either.

Home baseline cortisol levels were not obtained for the current study and thus increased and sustained cortisol reactivity in response to the laboratory setting cannot be accounted for at this time. Time-matched home baseline samples obtained in other studies have been found to differ significantly from laboratory samples (Goldberg et. al, 2003). Another methodological issue is that infants' waking time was not accounted for and waking time has been shown to interfere with baseline and reactivity cortisol levels (Goldberg et al., 2003). The infants' feeding schedule on the day of saliva collection was also not controlled for in the current study. Typically, participants are asked not to eat 30 minutes before saliva collection (Keil, 2012). Some sample swabs contained residue from food provided by the mother prior to or during the laboratory visits. pH levels were tested for those samples and they were found to be adequate for analysis.

Besides the methodological issues reported, it could be the case that the jealousy paradigm was not stressful enough for the infants to produce an increased cortisol response. Studies by Gunnar have found that infants in their second year of life can tolerate maternal separation for a few minutes without producing increase in cortisol (Gunnar, Talge, & Herrera, 2009; Gunnar & White, 2001). In relation to the behavioral responses of infants during the doll condition, it is possible that infants demonstrated behavioral indicators of arousal but that the jealousy paradigm was not enough of a stressor to produce physiological changes in stress reactivity.

Attachment Security

Attachment and Cortisol Reactivity

Attachment security scores were expected to be associated with cortisol reactivity. Specifically, it was expected that infants who had low ASQ scores would show a greater increase in reactivity levels from baseline than infants with higher ASQ scores. The correlations between ASQ and reactivity were not significant at either age. Given the small sample of infants who provided a viable sample, it is possible that there were just not enough participants to find an association. When samples were combined across time and compared to overall ASQ scores for the entire sample, reactivity was found to be negatively correlated with ASQ scores. Although the correlation was small (r=-.38), it was in the predicted direction and may indicate that infants with lower attachment security scores react differently to the paradigm than infants with higher scores. A deeper understanding of the relationship between attachment security and stress reactivity in jealousy is still needed and may achieved with a larger sample size.

ASQ and Behavioral Responses

It was hypothesized that attachment security scores would be positively correlated with approach behaviors during the social-rival condition. The results partially supported the hypothesis. Significant correlations were found between AQS scores and proximity in the doll condition and also between AQS scores and proximity in the book condition at 12 months. There were no significant associations between AQS security scores and approach behaviors in any condition at 24 months. When 12-month AQS continuous scores were converted into categorical scores, it was found that infants with AQS scores above the average of .3 displayed more proximity behaviors during the doll condition that

infants with AQS scores below the average. Low levels of jealousy (approach behaviors) have previously been found in samples of insecure infants as rated by the SSP (Hart & Behrens, 2013). Studies with older children have found that higher attachment scores were associated with a decrease in approach behaviors, particularly mother-directed gaze in 3-6 year olds whose mothers were ignoring them and reading a book to a "rival" child of a similar age (Bauminger-Zvieli & Kungelmass, 2012).

Exploratory Analyses

A linear regression was conducted to determine predictors of total approach behaviors during the doll condition at 24 months. Left EEG asymmetry in the lateral frontal and parietal regions, right temporal EEG asymmetry, cortisol reactivity, and ASQ scores at 12 months emerged as significant predictors of approach behaviors at age 2. The association between left EEG asymmetry in the frontal region and approach behaviors is consistent with previous findings. As stated earlier, more research is needed in order to understand the role of the temporal region in jealousy development. The finding that children who exhibit larger cortisol reactivity levels and have higher security ratings at age 1 show more approach behaviors at age 2 is consistent with the hypotheses presented in this study. It was expected that approach behaviors and AQS scores would be positively related and that the doll condition would produce an increase in cortisol levels.

The development of jealousy seems to evolve across the first two years of life and demonstrate underlying physiological processes that are predictable at an earlier age. The manifestation of jealousy seems to be more attachment oriented at 12 months of age given that there is an association between approach and attachment at age 1 but not at age 2. Jealousy behaviors may also be more physiologically related and socially oriented at

24 months as indicated by the link between EEG asymmetry and approach during the social-rival condition. From an evolutionary perspective, jealousy could be expected to be seen across conditions in young infants as any decrease in maternal attention could impact the infants' survival (Hart, 2016b). By 24 months of age, infants may have a more stable physiological system as well as increased cognitive abilities, thus social rivals that are similar in age would be more threatening (Lewis, 2013).

Limitations

In addition to the specific methodological issues presented earlier, there were several other broader limitations that impacted the study. The small sample size in the current study limited the types of analyses that could have been used with the data and the strength of the results. According to a review of the infant cortisol reactivity literature, studies that use a social stressor with infants show an increase in the strength of the stressor on the overall sample as sample size increases (Jansen, Beijers, Riksen-Walraven, & de Weerth, 2010). This was clearly illustrated in the current study when significant associations between cortisol reactivity and attachment security scores were not found when examined by age groups but where only evident with the total sample was examined. While using the total number of cortisol samples across time in the analyses resulted in significant results, it is important to note that these samples cannot be considered independent measures, as they were in fact repeated measures collected from the same participants. In regard to behavioral data, a time series analysis would have been useful in examining changes in jealousy behaviors in a small sample over time if additional data collection periods were added (Rohan, 2013).

Another broad limitation was that gender differences were not examined. Gender has been found to impact behavioral jealousy responses in previous studies, specifically fear and mother-directed gaze (Hart, Field, Del Valle, & Letourneu, 1998). Gender has also been shown to influence cortisol reactivity with boys showing a larger cortisol response after inoculation (Davis & Granger, 2009). Maternal reports of maternal mood and infant temperament were collected for this study but were not analyzed. Maternal CES-D scores have been associated with low levels of negativity (Hart & Behrens, 2013). Twelve-month-old infants of depressed mothers have also shown less touch, proximity, and gaze than infants of non-depressed mothers (Hart, Field, Letouneu, & Del Valle, 1998). In regard to physiological processes, maternal depression within infants' first year of life has been associated with infant regulatory processes including cortisol reactivity (Hessl et al. 1998). Maternal CES-D scores have also been associated with infant right EEG asymmetry (Davidson & Fox, 1982). Future studies should examine how maternal depression, infant jealousy responses, and patterns of attachment interact.

The California Temperament Inventory was also administered but was not analyzed. Measures of infant temperament, particularly the "Activity" scale on the California Temperament Inventory and the "Distress to Limitations" on Infant Behavior Questionnaire-Revised, have been found to be correlated to jealousy (r=.37, r=.34, respectively) (Mize & Jones, 2012).

Lastly, the operational definition of jealousy used in this study may have restricted a full understanding of the range of responses that could be interpreted as jealousy in infants. Jealousy in this case was defined as approach responses and negativity. Other profiles of jealousy (i.e., inhibited, dysregulated, organized, and

disinhibited) were not examined (Hart, 2015). There could be additional or different associations between those jealousy behaviors, attachment, and physiology that were not found because jealousy was conceptualized in a narrow manner.

Concluding Remarks

The study of jealousy in infancy is important because it helps us understand the emotional capabilities of infants and how they relate to others. Behavioral and physiological measures of jealousy may provide insight about the infants' understanding of the relationship between themselves and their caregiver. This study demonstrated that jealousy, as defined as approach behaviors during periods of maternal inattention and differential treatment towards a social rival, occur at 12 months of age and continue to be expressed, albeit differently, into age 2. These approach behaviors are related to physiology and attachment behaviors. Future studies should examine the long-lasting implications of early jealousy behaviors on the quality of parent-child relationships in later childhood and on peer relationships.

Table 1

Second-by-second Coding Categories for 12-month and 24-month visits

Code	Behavior Description
Gaze Direction of Infant	
5	Infant gaze is directed toward mother-item and is interacting with the task item
4	Infant gaze is directed toward mother-item, but is only looking and not interacting with the task item
3	Infant gaze is directed at activity mat or toys
2	Infant gaze is directed at other things in the room, rather than on mother or toys
1	Infant is covering eyes with hands, play mat
Proximity of infant to mother	
5	Within infant's arm length of mother
4	Approaching mother, but not yet within her reach
3	Remaining on activity quilt
2	Moving away from mother
1	On opposite side of room from mother
Touch mother or object	
4	Infant has any type of physical contact with mother
3	Infant has any type of physical contact with task object
2	Infant is touching other items around the room
1	None of the above-infant is not touching anything in the room
Approach- Withdrawal	

3 Approach behaviors: gaze at mother- item, approaching mother-item, close proximity to mother-item, touching mother-item, aggression toward mother-item

2 Neither

1 Withdrawal behaviors: avoid gaze at mother- item, distancing from mother item, hiding eyes or self

Level of Arousal

5 High arousal: play is interrupted, prolonged body tension

4 Moderate-high arousal: play is likely interrupted, intermittent body tension

3 Moderate arousal: play is discontinued

2 Low arousal: infant attends to mother-item play is interrupted

1 No arousal: infant ignores mother-item

Vocalizations

7 Very high intensity vocalizations: intense protests, screaming, crying, screeching, temper tantrums, etc.

6 High intensity vocalizations: hyperventilating crying

5 Moderate intensity vocalizations: intermittent fussing, whimpering, whining

4 Low level intensity vocalizations: fretting

3 Neutral vocalizations

2 Somewhat positive vocalizations: cooing, etc.

1 Very positive vocalizations: laughing, happiness, etc.

Affective State

3 Positive: happiness, smiling, laughter, cooing, etc.

2 Neutral

1 Negative: anger, sadness, fear- furrowed eyebrows, lips pressed together, frown or scowl, temper tantrums

Table 2

Paired sample t-tests of behavioral jealousy responses at 12-months

Variable Name	M(SD)	t-test Statistic	df	Significance
Approach Gaze Book	27.27 (18.07)	-5.303	19	p<.001
Approach Gaze Doll	57.82 (22.59)			
Approach Proximity Book	36.78 (33.29)	-3.760	19	p=.001
Approach Proximity Doll	65.05 (30.78)			
Approach Touch Book	15.12 (21.26)	-2.367	19	p=.029
Approach Touch Doll	32.11 (31.85)			
Negative Vocalizations Book	7.29 (16.79)	.421	19	NS
Negative Vocalizations Doll	5.84 (7.41)			
Negative Facial Affect Book	10.19 (14.59)	-.265	19	NS
Negative Facial Affect Doll	11.27 (20.99)			

Table 3

Mean proportions of behavioral jealousy responses at 24-months

Variable Name	M(SD)	t-test Statistic	df	Significance
Approach Gaze Book	36.45(29.03)	-3.027	19	p=.007
Approach Gaze Doll	63.45 (26.94)			
Approach Proximity Book	40.52 (30.57)	-3.077	19	p=.006
Approach Proximity Doll	65.23 (28.17)			
Approach Touch Book	20.95 (24.34	1.506	19	NS
Approach Touch Doll	10.18 (17.72)			
Negative Vocalizations Book	18.49 (24.57)	1.522	19	NS
Negative Vocalizations Doll	11.36 (16.73)			
Negative Facial Affect Book	14.62 (22.82)	2.310	19	p=.032
Negative Facial Affect Doll	7.60 (11.47)			

Table 4

EEG and behavioral correlations at 12-months

	Gaze Book	Gaze Doll	Proximity Book	Proximity Doll	Touch Book	Touch Doll
Mid-frontal 6-9 Hz	.552*	.273	-.091	.155	.559*	.000
Lateral frontal 6-9 Hz	.509*	.293	-.187	.065	.310	-.205
Parietal 6-9 Hz	.649	.198	-.268	.239	-.039	-.062
Occipital 6-9 Hz	.979	.288	-.268	-.031	-.118	.003

Table 5

EEG and behavioral correlations at 24-months

	Gaze Book	Gaze Doll	Proximity Book	Proximity Doll	Touch Book	Touch Doll
Mid-frontal 6-9 Hz	.007	.522*	-.182	.159	-.371	.512*
Lateral frontal 6-9 Hz	.247	-.234	.321	-.147	.167	.358
Parietal 6-9 Hz	-.003	-.250	.181	-.079	-.121	.735*
Occipital 6-9 Hz	-.153	.258	-.435	-.061	-.310	-.248
Mid-frontal 10-12 Hz	-.088	.093	-.160	-.226	-.224	.374
Lateral frontal 10-12 Hz	.479	-.422	.345	-.036	.234	.267
Parietal 10-12 Hz	.046	-.143	.225	.073	-.072	.781*
Occipital 10-12 Hz	.144	-.194	.071	-.164	-.164	.581*

12-month visit/24-month visit:

Book Condition First

Collection of Baseline Salivary Cortisol Sample→ Book condition (90 seconds)→ 1 minute play → Doll Condition (90 seconds) → Questionnaires→ Cortisol collection at 20 minutes post-stressor (measure of stress reactivity)→Attachment Q-Sort→Cortisol at 40 minutes post-stressor (measure of stress regulation)→Baseline EEG activity collection

Doll Condition First

Collection of Baseline Salivary Cortisol Sample→Doll Condition (90 seconds) → 1 minute of play→ Questionnaires→ Cortisol at 20 minutes post-stressor → Attachment Q-sort →Cortisol at 40 minutes post-stressor → Book→EEG

Figure 1. Outline of the procedures for each visit.

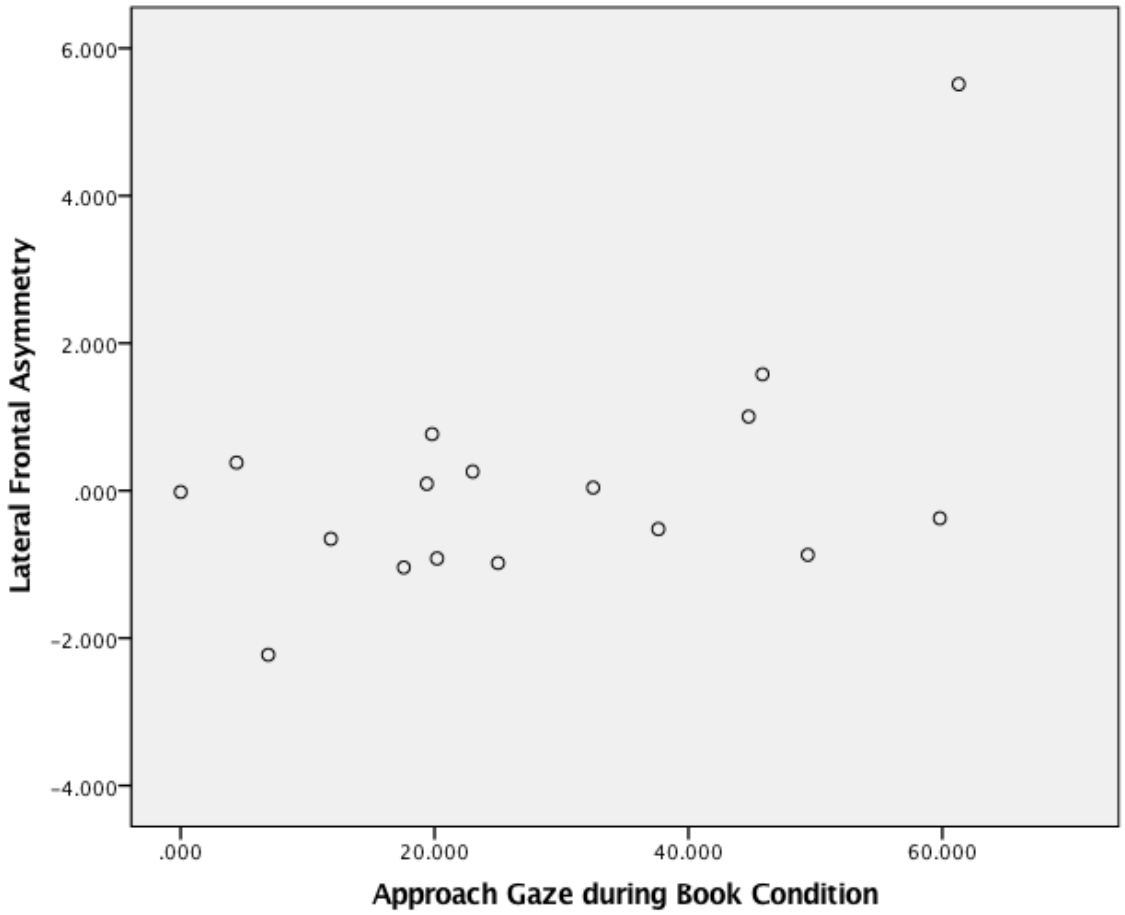

Figure 2. The positive correlation between lateral frontal asymmetry and mother-directed gaze during the book condition at 12-months.

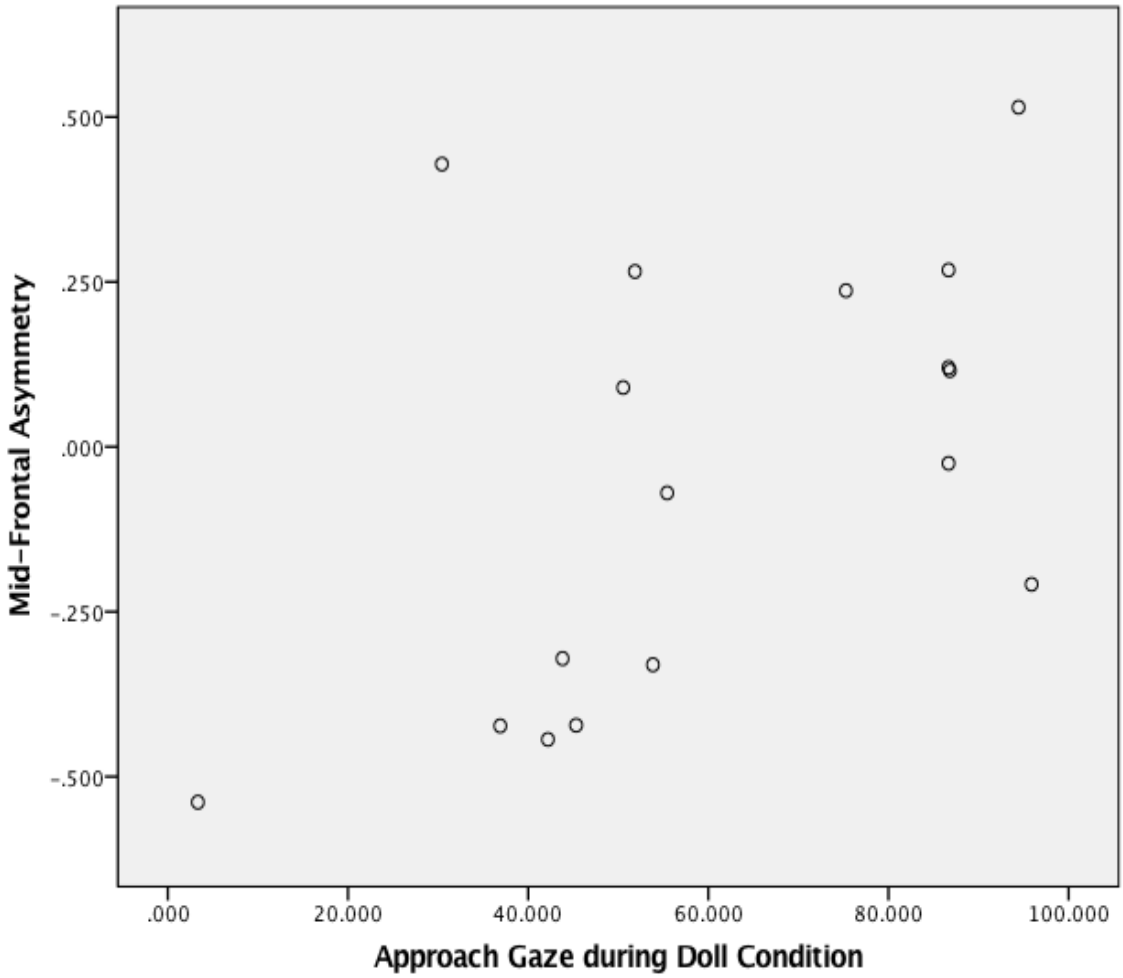

Figure 3. The positive correlation between left mid-frontal asymmetry and mother-directed gaze during the doll condition at 24-months.

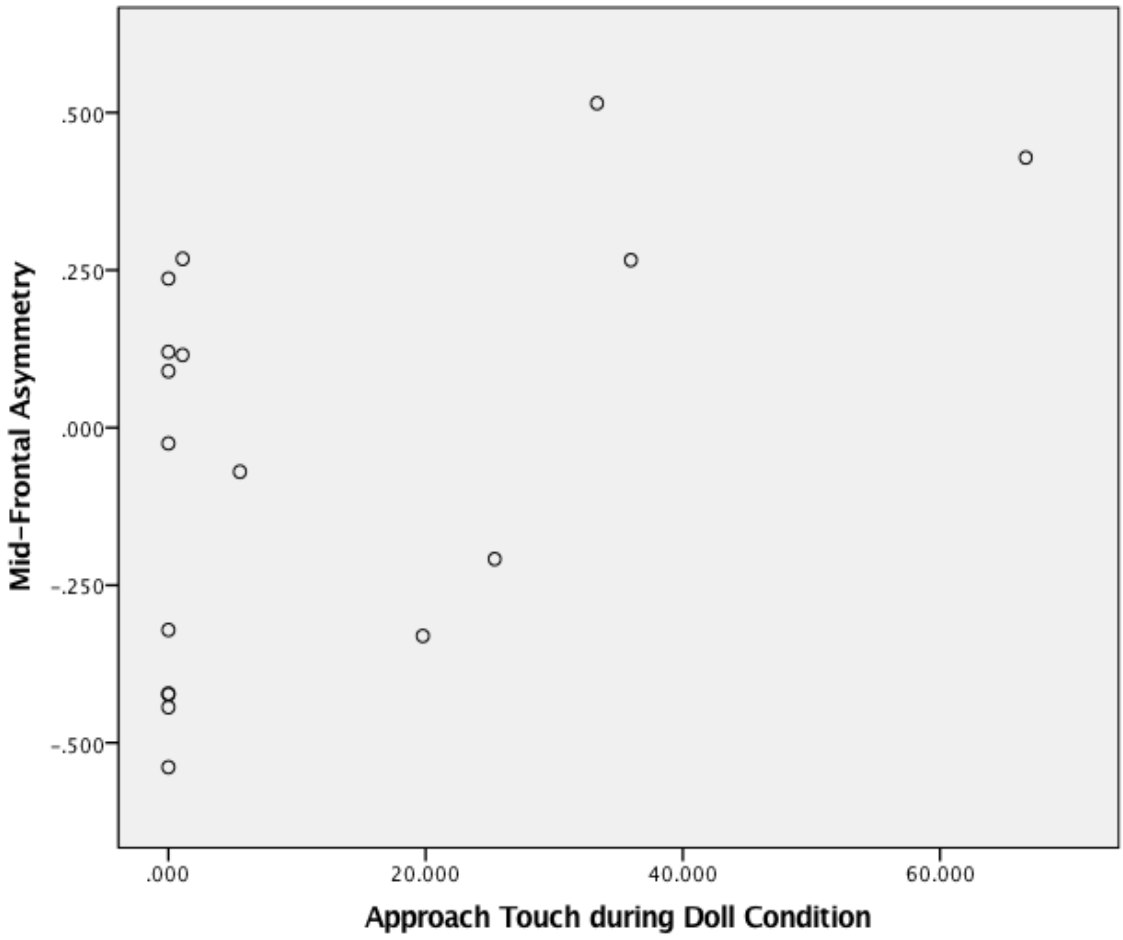

Figure 4. The positive correlation between left mid-frontal asymmetry and mother-directed touch during the doll condition at 24-months.

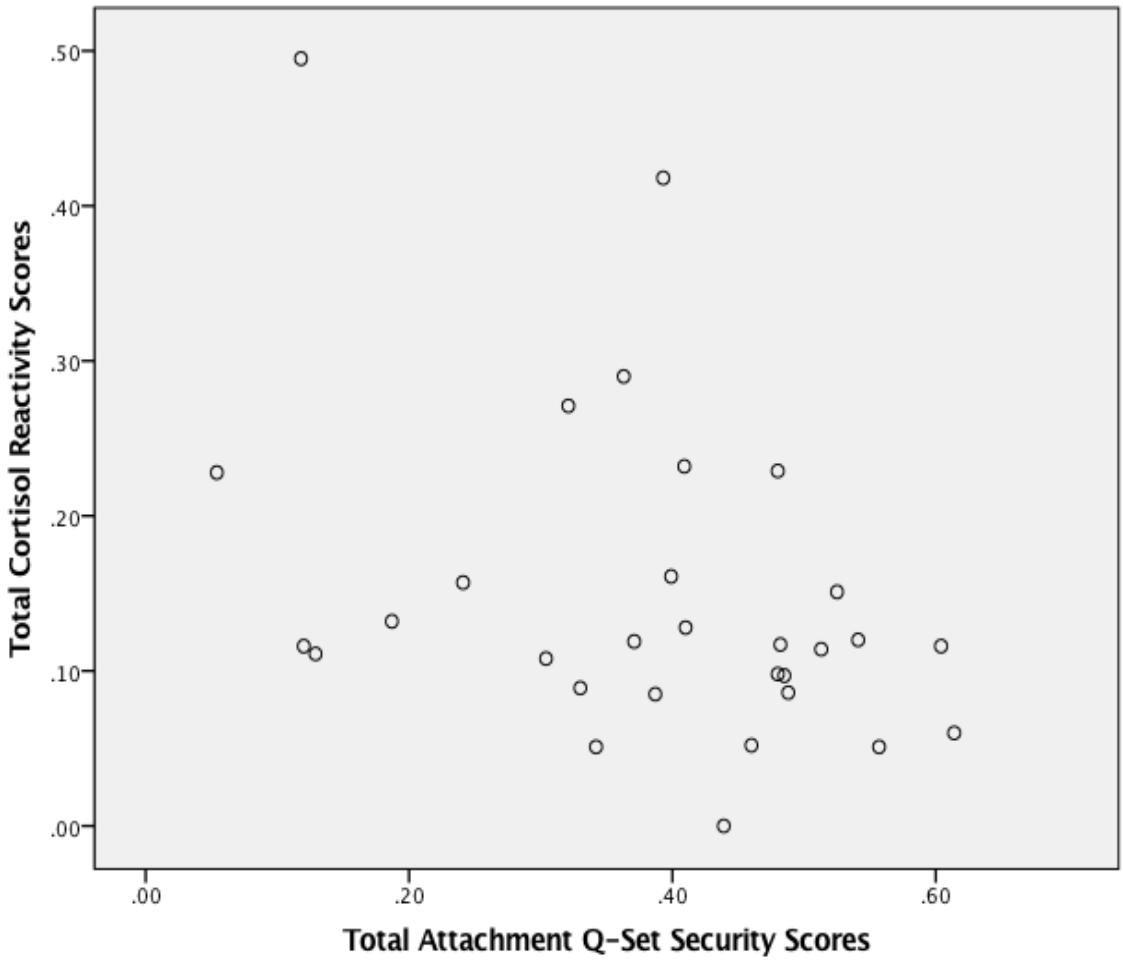

Figure 5. The negative correlation between total cortisol reactivity scores (combined across age) and total attachment q-set security scores.

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APPENDICES

Appendix A: Center for Epidemiological Studies-Depression Scale

Participant ID: _____ Date: _____

BIS/BAS

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement.
Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses. Choose from the following four response options:

1 = very true for me
2 = somewhat true for me
3 = somewhat false for me
4 = very false for me

1. A person's family is the most important thing in life. ___
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness. ___
3. I go out of my way to get things I want. ___
4. When I'm doing well at something I love to keep at it. ___
5. I'm always willing to try something new if I think it will be fun. ___
6. How I dress is important to me. ___
7. When I get something I want, I feel excited and energized. ___
8. Criticism or scolding hurts me quite a bit. ___
9. When I want something I usually go all-out to get it. ___
10. I will often do things for no other reason than that they might be fun. ___
11. It's hard for me to find the time to do things such as get a haircut. ___
12. If I see a chance to get something I want I move on it right away. ___
13. I feel pretty worried or upset when I think or know somebody is angry at me. ___
14. When I see an opportunity for something I like I get excited right away. ___
15. I often act on the spur of the moment. ___
16. If I think something unpleasant is going to happen I usually get pretty "worked up." ___
17. I often wonder why people act the way they do. ___
18. When good things happen to me, it affects me strongly. ___
19. I feel worried when I think I have done poorly at something important. ___
20. I crave excitement and new sensations. ___
21. When I go after something I use a "no holds barred" approach. ___
22. I have very few fears compared to my friends. ___

Appendix B: Behavioral Inhibition Scale/Behavioral Activation Scale

CES-D

The following questions concern how you've been feeling lately. For each question, please indicate how often you've felt this way during the past week. The choices are:

1 – Rarely or none of the time (less than one day)
2 – Some or little of the time (1-2 days)
3 – Occasionally or a moderate amount of the time (3-4 days)
4 – Most of the time (5-7 days)

		Less than 1 Day	1-2 Days	3-4 Days	5-7 Days
1.	I was bothered by things that don't usually bother me.	1	2	3	4
2.	I did not feel like eating, my appetite was poor.	1	2	3	4
3.	I felt I could not shake the blues even with the help from my family and friends.	1	2	3	4
4.	I felt I was just as good as other people.	1	2	3	4
5.	I had trouble keeping my mind in what I was doing.	1	2	3	4
6.	I felt depressed.	1	2	3	4
7.	I felt that everything I did was an effort.	1	2	3	4
8.	I felt hopeful about the future.	1	2	3	4
9.	I thought my life has been a failure.	1	2	3	4
10.	I felt fearful.	1	2	3	4
11.	My sleep was restless.	1	2	3	4
12.	I was happy.	1	2	3	4
13.	I talked less than usual.	1	2	3	4
14.	I felt lonely.	1	2	3	4
15.	People were unfriendly.	1	2	3	4
16.	I enjoyed life.	1	2	3	4
17.	I had crying spells.	1	2	3	4
18.	I felt sad.	1	2	3	4
19.	I felt like people disliked me.	1	2	3	4
20.	I could not get "going".	1	2	3	4

Participant ID: _____ Date: _____

23. It would excite me to win a contest. ___
24. I worry about making mistakes. ___
25. I am rather lively ___
26. I enjoy meeting new people. ___
27. I like going out a lot. ___
28. I would call myself happy go lucky. ___
29. I am mostly quiet when I am with other people. ___
30. I like mixing with other people. ___
31. I often make decisions on the spur of the moment. ___
32. I like plenty of bustle and excitement around me. ___
33. I nearly always have a "ready answer" when people talk to me. ___
34. I can easily adapt to new and unusual situations. ___

Appendix C: Colorado Temperament Inventory

Participant ID: _____ Date: _____ Circle: Mother or Father

Colorado Temperament Inventory

Please answer the items on this page about the behavior of this child by circling one of the numbers following each item. We know that no item will apply to your child in every situation, but try to consider his/her general behavior. Please answer honestly-there are no right or wrong answers.

	How much is the child like that?				
	Not at All (Strongly Disagree)				A Lot (Strongly Agree)
1. Child persists at a task until successful.	1	2	3	4	5
2. Child gives up easily when difficulties are encountered.	1	2	3	4	5
3. Child tends to be shy.	1	2	3	4	5
4. Child cries easily.	1	2	3	4	5
5. When upset by an unexpected situation, child easily calms down.	1	2	3	4	5
6. Child goes from toy to toy quickly.	1	2	3	4	5
7. Child likes to be with people.	1	2	3	4	5
8. Child is always on the go.	1	2	3	4	5
9. Whenever child starts crying, he can be easily distracted.	1	2	3	4	5
10. Child prefers playing with others rather than alone.	1	2	3	4	5
11. Child tends to be somewhat emotional.	1	2	3	4	5
12. When child moves about, (s)he usually moves about slowly.	1	2	3	4	5
13. If talked to, child stops crying.	1	2	3	4	5
14. Child makes friends easily.	1	2	3	4	5
15. Child is off and running as soon as (s)he wakes up in the morning.	1	2	3	4	5
16. Child finds people more stimulating than anything else.	1	2	3	4	5
17. Child often fusses and cries.	1	2	3	4	5
18. With a difficult toy, child gives up quite easily.	1	2	3	4	5

Participant ID: _____ Date: _____ Circle: Mother or Father

	How much is the child like that?				
	Not at All (Strongly Disagree)				A Lot (Strongly Agree)
19. Child is very sociable.	1	2	3	4	5
20. Child is very energetic.	1	2	3	4	5
21. Child takes a long time to warm up to strangers.	1	2	3	4	5
22. Child plays with a single toy for long periods of time.	1	2	3	4	5
23. Child gets upset easily.	1	2	3	4	5
24. Child is somewhat of a loner.	1	2	3	4	5
25. Child prefers quiet, inactive games to more active ones.	1	2	3	4	5
26. When alone, child feels isolated.	1	2	3	4	5
27. Child tolerates frustration well.	1	2	3	4	5
28. Child reacts intensely when upset.	1	2	3	4	5
29. Child stopped fussing whenever someone talked to him/her or picked him/her up.	1	2	3	4	5
30. Child is friendly with strangers.	1	2	3	4	5

Appendix D: Attachment Q-Set

Attachment Q-Set (AQS- Version 3)

For assessing secure base use in naturalistic settings.
Ages 1-5 years. Current as of 10/2006.
Additional information: www.johnbowlby.com

1. Child readily shares with mother or lets her hold things if she asks to.

Low: Refuses.

2. When child returns to mother after playing, he is sometimes fussy for no clear reason.

Low: Child is happy or affectionate when he returns to mother between or after play times.

3. When he is upset or injured, child will accept comforting from adults other than mother.

Low: Mother is the only one he allows to comfort him.

4. Child is careful and gentle with toys and pets.

5. Child is more interested in people than in things.

Low: More interested in things than people.

6. When child is near mother and sees something he wants to play with, he fusses or tries to drag mother over to it.

Low: Goes to what he wants without fussing or dragging mother along.

7. Child laughs and smiles easily with a lot of different people.

Low: Mother can get him to smile or laugh more easily than others.

8. When child cries, he cries hard.

Low: Weeps, sobs, doesn't cry hard, or hard crying never lasts very long.

9. Child is lighthearted and playful most of the time.

Low: Child tends to be serious, sad, or annoyed a good deal of the time.

10. Child often cries or resists when mother takes him to bed for naps or at night.

Low: Does not cry or resist going to bed.

11. Child often hugs or cuddles against mother, without her asking or inviting him to do so.

Low: Child doesn't hug or cuddle much, unless mother hugs him first or asks him to give her a hug.

12. Child quickly gets used to people or things that initially made him shy or frightened him.

Middle if never shy or afraid.

Low: Child is slow to get used to people or things.

13. When the child is upset by mother's leaving, he continues to cry or even gets angry after she is gone.

Middle if not upset by mom leaving.

Low: Cry stops right after mom leaves.

14. When child finds something new to play with, he carries it to mother or shows it to her from across the room.

Low: Plays with the new object quietly or goes where he won't be interrupted.

15. Child is willing to talk to new people, show them toys, or show them what he can do, if mother asks him to.

Low: Mother's suggestion does not increase willingness to engage new people.

16. Child prefers toys that are modeled after living things (e. g., dolls, stuffed animals).

Low: Prefers balls, blocks, pots and pans, etc.

17. Child quickly loses interest in new adults if they do anything that annoys him.

18. Child follows mother's suggestions readily, even when they are clearly suggestions rather than orders.

Low: Ignores or refuses unless ordered.

19. When mother tells child to bring or give her something, he obeys.

(Do not count refusals that are playful or part of a game unless they are clearly disobedient)

Low: Mother has to take the object or raise her voice to get it away from him.

20. Child ignores most bumps, falls, or startles.

Low: Cries after minor bumps, falls, or startles.

21. Child keeps track of mother's location when he plays around the house. E.g., Calls to her now and then notices her go from room to room.; Notices if she changes activities

Middle if child isn't allowed or doesn't have room , to play away from mom.

Low: Doesn't keep track.

22. Child acts like an affectionate parent toward dolls, pets, or infants.

Middle if child doesn't play with or have access to dolls, pets, or infants.

Low: Plays with them in other ways.

23. When mother sits with other family members, or is affectionate with them, child tries to get mom's affection for himself.

Low: Lets her be affectionate with others. May join in but not in a jealous way.

24. When mother speaks firmly or raises her voice at him, child becomes upset, sorry, or ashamed about displeasing her.

(Do not score high if child is simply upset by the raised voice or afraid of getting punished)

Low: Child does not become upset in response to such behavior.

25. Child is easy for mother to lose track of when he is playing out of her sight.

Middle if never plays out of sight.

Low: Talks and calls when out of sight. Easy to find; easy to keep track of what child is doing.

26. Child cries when mother leaves him at home with babysitter, father, or grandparent.

Low: Doesn't cry with any of these.

27. Child laughs when mother teases him.

Middle if mother never teases child during play or conversations.

Low: Annoyed when mother teases him.

28. Child enjoys relaxing in mother's lap.

Middle: If child never sits still.

Low: Prefers to relax on the floor or on furniture.

29. At times, child attends so deeply to something that he doesn't seem to hear when people speak to him.

Low: Even when deeply Involved in play, child notices when people speak to him.

30. Child easily becomes angry with toys.

Low: Child does not easily become angry with toys.

31. Child wants to be the center of mother's attention. If mom is busy or talking to someone, he interrupts.

Low: Doesn't notice or doesn't mind not being the center of mother's attention.

32. When mother says "No" or punishes him, child stops misbehaving (at least at that time). Doesn't have to be told twice.

Low: Child persists in misbehavior.

33. Child sometimes signals mother (or gives the impression) that he wants to be put down, and then fusses or wants to be picked right back up.

Low: Always ready to go play by the time he signals mother to put him down.

34. When child is upset about mother leaving him, he sits right where he is and cries. Doesn't go after her.

Middle: If never upset by her leaving

Low: Actively goes after her if he is upset or crying.

35. Child is independent with mother. Prefers to play on his own; leaves mother easily when he wants to play.

Middle allowed or not enough room to play

Low: Prefers playing with or near mother

36. Child clearly shows a pattern of using mother as a base from which to explore.

Moves out to play; Returns or plays near her; moves out to play again, etc.

Low: Always away unless retrieved, or always stays near.

37. Child is very active. Always moving around. Prefers active games to quiet ones.

Low: Child's activity level is low. Prefers quite activities.

38. Child is demanding and impatient with mother. Fusses and persists unless she does what he wants right away.

Low: Child waits a reasonable time if mother doesn't respond immediately.

39. Child is often serious and businesslike when playing away from mother or alone with his toys.

Low: Often silly or laughing when playing away from mother or alone with his toys.

40. Child examines new objects or toys in great detail. Tries to use them in different ways or to take them apart.

Low: First look at new objects or toys is usually brief. (May return to them later however.)

41. When mother says to follow her, child does so.
(Do not count refusals or delays that are playful or part of a game unless they clearly become disobedient.)

Low: Child ignores or refuses.

42. Child recognizes when mother is upset. Becomes quiet or upset himself. Tries to comfort her. Asks what is wrong, etc.

Low: Doesn't recognize; continues play; behaves toward her as if she were OK.

43. Child stays closer to mother or returns to her more often than the simple task of keeping track of her requires.

Low: Doesn't keep close track of mother's location or behavior.

44. Child asks for and enjoys having mother hold, hug, and cuddle him.

Low: Not especially eager for this. Tolerates it but doesn't seek it; or wiggles to be put down.

45. Child enjoys dancing or singing along with music.

Low: Neither likes nor dislikes music.

46. Child walks and runs around without bumping, dropping, or stumbling.

Low: Bumps, drops, or stumbles happen throughout the day (even if no injuries result).

47. Child will accept and enjoy loud sounds or being bounced around in play, if mother smiles and shows that it is supposed to be fun.

Low: Child gets upset, even if mother indicates the sound or activity is safe or fun.

48. Child readily lets new adults hold or share things he has, if they ask to.

Low: Child does not readily share with new adults when asked.

49. Runs to mother with a shy smile when new people visit the home.

Middle: If child doesn't run to mother at all when visitors arrive.

Low: Even if he eventually warms up to visitors, child initially runs to mother with a fret or a cry.

50. Child's initial reaction when people visit the home is to ignore or avoid them, even if he eventually warms up to them.

Low: Initial reaction s to approach and interact.

51. Child enjoys climbing all over visitors when he plays with them.

Middle if he won't play with visitors.

Low: Doesn't seek close contact with visitors when he plays with them.

52. Child has trouble handling small objects or putting small things together.

Low: Very skillful with small objects, pencils, etc.

53. Child puts his arms around mother or puts his hand on her shoulder when she picks him up.

Low: Accepts being picked up but doesn't especially help or hold on.

54. Child acts like he expects mother to interfere with his activities when she is simply trying to help him with something.

Low: Accepts mother's help readily, unless she is in fact interfering.

55. Child copies a number of behaviors or way of doing things from watching mother's behavior.

Low: Doesn't noticeably copy mother's behavior.

56. Child becomes shy or loses interest when an activity looks like it might be difficult.

Low: Thinks he can do difficult tasks.

57. Child is fearless.

Low: Child is cautious or fearful.

58. Child largely ignores adults who visit the home Finds his own activities more interesting.

Low: Finds visitors quite interesting, even if he is a bit shy at first.

59. When child finishes with an activity or toy, he generally finds something else to do without returning to mother between activities.

Low: When finished with an activity or toy, he returns to mother for play, affection or help finding more to do.

60. If mother reassures him by saying "It's OK' or "It won't hurt you", child will approach or play with things that initially made him cautious or afraid.

Middle if never cautious or afraid.

Low: Child does not accept mother's assurances.

61. Plays roughly with mother. Bumps, scratches, or bites during active play. (Does not necessarily mean to hurt mom)

Middle if play is never very active

Low: Plays active games without injuring mother.

62. When child is in a happy mood, he is likely to stay that way all day.

Low : Happy moods are very changeable.

63. Even before trying things himself, child tries to get someone to help him.

Low: Confident. Tries things himself before seeking help.

64. Child enjoys climbing all over mother when they play.

Low: Doesn't especially want a lot of close contact when they play.

65. Child is easily upset when mother makes him change from one activity to another.

(Even if the new activity is something child often enjoys.)

Low: Readily changes activities when mother suggest new ones.

66. Child easily grows fond of adults who visit his home and are friendly to him.

Low: Doesn't grow fond of new people very easily.

67. When the family has visitors, child wants them to pay a lot of attention to him.

Low: Does not particularly seek attention from visitors.

68. On the average, child is a more active type person than mother.

Low: On the average, child is less active type person than mother.

69. Rarely asks mother for help. Middle if child is too young to ask.

Low: Often asks mother for help.

70. Child quickly greets his mother with a big smile when she enters the room. (Shows her a toy, gestures, or says "Hi, Mommy").

Low: Doesn't greet mother unless she greets him first.

71. If held in mother's arms, child stops crying and quickly recovers after being frightened or upset.

Low: Not easily comforted.

72. If visitors laugh at or approve of something the child does, he repeats it again and again.

Low: Visitors' reactions don't influence child this way.

73. Child has a cuddly toy or security blanket that he carries around, takes it to bed, or holds when upset.

(Do not include bottle or pacifier if child is under two years old.)

Low: Can take such things or leave them, or has none at all.

74. When mother doesn't do what child wants right away, child behaves as if mom were not going to do it at all.

(Fusses, gets angry, walks off to other activities, etc.)

Low: Waits a reasonable time, as if he expects mother will shortly do what he asked.

75. At home, child gets upset or cries when mother walks out of the room.
(May or may not follow her.)

Low: Notices her leaving; may follow but doesn't get, upset.

76. When given a choice, child would rather play with toys than with adults.

Low: Would rather play with adults than toys.

77. When mother asks child to do something, he readily understands what she wants (May or may not obey.)

Middle if too young to understand

Low: Sometimes puzzled or slow to understand what mother wants.

78. Child enjoys being hugged or held by people other than his parents and/or grandparents.

Low: No particular interest in such contact.

79. Child easily becomes angry at mother.

Low: Doesn't become angry et mother unless she is very intrusive or he is very tired.

80. Child uses mother's facial expressions as good source of information when something looks risky or threatening.

Low: Makes up his own mind without checking mother's expressions first.

81. Child cries as a way of getting mother to what he wants.

Low: Mainly cries because of genuine discomfort (tired, sad, afraid, etc.).

82. Child spends most of his play time with just a few favorite toys or activities.

Low: Explores and plays (briefly) with a number of different toys.

83. When child is bored, he goes to mother looking for something to do.

Low: Wanders around or just does nothing for a while, until something comes up.

84. Child makes at least some effort to be clean and tidy around the house.

Low: Spills and smears things on himself and on floors all the time.

85. Child is strongly attracted to new activities and new toys.

Low: New things do not attract him away from familiar toys or activities.

86. Child tries to get mother to imitate him, or quickly notices and enjoys it when mom imitates him on her own.

Low: Doesn't show any particular interest in this such engagement.

87. If mother laughs at or approves of something the child has done, he repeats again and again.

Low: Child is not particularly influenced this way.

88. When something upsets the child, he stays where he is and cries.

Low: Goes to mother when he cries. Doesn't wait for mom to come to him.

89. Child's facial expressions are strong and clear when he is playing with something.

Low: Facial expressions are not particularly clear or varied.

90. If mother moves very far, child follows along and continues his play in the area she has moved to. (Doesn't have to be called or carried along; doesn't stop play or get upset.)

Middle if child isn't allowed or doesn't have room to move very far away.

Low: Child moves play to maintain proximity/access to mother.

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