THE RELATIONSHIP BETWEEN EMOTIONAL CONTAGION AND COGNITIVE DEVELOPMENT IN EARLY INFANCY

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Abstract:

Empathy incorporates cognitive and emotional responses (Hastings, Zahn-Waxler, & McShane, 2006), both of which have been widely studied at many developmental stages, revealing that attention (Braaten & Rosén, 2000), inhibition (Hansen, 2011), effortful control (Valiente, et al., 2004), and perspective-taking skills (Farrant, Devine, Maybery, & Fletcher, 2012) all influence emotional responding, i.e. empathy. In relation to empathy in infancy, however, these cognitive operations have not been thoroughly examined. Cognitive measures of attention, habituation, and memory were used as predictors of emotional contagion (as measured by latency to distress, duration, and intensity of distress, heart rate baseline and change, and baseline cortisol), a precursor of empathy, in infants at 3, 6, and 9 months of age (n = 37).

Emotional measures of distress were assessed in response to recorded cries of another infant. Cognition was assessed through an infant-controlled habituation procedure using a static, adult face, and by two novelty preference trials. Heart rate and looking time toward the stimulus were recorded to examine attention, information processing speed, and memory. Salivary cortisol was assessed at the beginning of the procedure.

More time spent in the disengaged attentional phase related to longer latency to distress, lower baseline heart rate, and lower baseline cortisol levels. A long latency to distress also related to less time in the sustained attention phase, failure to demonstrate an novelty preference, longer look duration, and fewer trials to habituation. Intensity was also negatively related to look duration. These findings suggest that a relationship between cognition and emotion may be observable in early infancy. More specifically, these findings indicate a potential relationship between faster processing speed (shorter look durations), attentional control (less time in the disengagement phase), and an increase in emotional sensitivity (shorter latency to distress) and emotion regulation (lower intensity).

Some emotional and cognitive variables demonstrated consistency over time and demonstrate developmental patterns that are consistent with the current literature. Gender differences and maternal influences were also found. Maternal influences are discussed as an important contributor to infant emotional responding and socioemotional development.

Keywords: Empathy development, emotional contagion, cognitive development, attention, cortisol, maternal influences

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CHAPTER I

INTRODUCTION

Empathy represents a key aspect of social functioning mainly due to its implications for prosocial and helping behaviors (e.g., Eisenberg & Miller, 1987). It is believed to motivate people to act toward the benefit of others and is considered a primary process used not only to facilitate altruism (e.g., Batson, 1991) but to dissuade aggressive behaviors (e.g., Phelps, 1994). Surprisingly, however, little is known about the origins of empathy development in early life. Behavioral outcomes such as helping behaviors are often used to measure empathy in individuals; however, these acts require a lack of egocentrism, an awareness of others (theory of mind), and the physical capabilities to help another, none of which has sufficiently developed in early infancy. Therefore, young infants are generally thought to be developmentally incapable of helping behaviors due to these physical and cognitive limitations. The majority of research devoted to empathy has focused on individuals from preschool age to adulthood, leaving the topic largely unexplored in infancy, one of the most crucial and influential stages of development (e.g., Landry, Smith, Swank, & Guttentag, 2008). Though studies exist that suggest the presence of behavioral markers for rudimentary forms of empathy in infancy, the question still remains whether infants are even capable of empathic behaviors. If so, how can these initial roots of empathy be identified and examined? The present study aims to identify early markers of empathy in infancy by measuring the interrelations among cognitive and emotional variables that are related to empathy later in life.

CHAPTER II

REVIEW OF LITERATURE

Development of Empathy

Empathy is believed to develop over time, each stage building upon the previous one (e.g., Roth-Hanania, Davidov, & Zahn-Waxler, 2011) in order for empathy to fully mature. According to Geangu, Benga, Stahl, and Striano (2010), the fundamental building blocks of empathy are considered to be emotional contagion (EC) and imitation (discussed in detail below). Eventually, cognitive abilities such as perspective taking, theory of mind and emotion regulation (see Emotion Regulation section below) begin to develop to build the structure of empathy that, depending somewhat on the environmental input received during development, becomes mature empathy in adulthood. The development of such a structure then leads to the increased potential for altruistic, prosocial, and helping behaviors. This bottom-up approach is present throughout infant development, making it possible for more mature forms of social, emotional, and cognitive skills to develop. For example, in a longitudinal study, Ungerer and colleagues (1990) assessed personal distress and self-regulatory skills in infants 4 months of age and how such skills predicted empathy-related behaviors at 12 months of age. At 4 months of age, self-regulation was assessed using the Still-Face Procedure (Gianino & Tronick, 1985) in which the infant's mother would interact with the infant for two minutes, leave the room, and upon returning, resist any interaction with the infant for another two minutes. The infant's coping behaviors in response to this mild social stressor were recorded, including signaling to the mother for attention, attending to an object such as a pacifier for self-comfort, or averting attention away from the mother. Then, at 12 months of age, empathic-like behaviors were assessed. Here, the infants viewed a 1-minute video of a peer smiling and then becoming upset and crying. The duration of the infants' distress responses to the recording was assessed. It was found that the individual differences in self-regulatory behaviors and personal distress in response to social stressors at 4 months were able to predict empathic responses at one year. More specifically, infants at 4 months demonstrating poor self-regulatory behaviors (as indicated by a higher frequency of self-comforting behaviors in response to the Still-Face Procedure) were more likely to exhibit a high personal distress response to the video at 12 months. These findings emphasize the possibility of continuity across ages in early empathy development and that a child's repertoire of regulatory behaviors in response to a distressing event is ever increasing and maturing over time (see Physiological Markers section below). The Ungerer et al. (1990) study emphasizes continuity over time with regard to individual differences in distress responses that could theoretically be consistent with later empathic responses in older children and adults. Thus they raise the possibility that empathic development is consistent over time, and that an assessment of early forms of empathy could predict individual differences in mature empathic responding at later ages.

This idea of continuity will be explored further in the following literature review through an overview of the work that has been conducted in infancy on empathy and empathy-related behaviors. First, the integration of the many definitions of empathy including both affective and cognitive components will be discussed. This will be followed by an overview of the studies of empathic responding and other empathy-related behaviors that can be seen in infancy, childhood, and adulthood. Additionally, physiological markers of the stress response system involved in emotional responding, such as cortisol and heart rate, will be discussed and their relationship to both cognitions and emotions. Finally, a discussion on the integration of cognition and emotion with regard to empathy development will be presented. This integration can enrich our overall understanding of empathy – including that of empathy's earliest formation – serve as a knowledge base to enhance child development literature, and identify tools to stimulate and nurture empathy from its beginnings.

Definition of Empathy

Empathy is a complex psychological construct that is best understood using a multidisciplinary approach involving social, emotional, cognitive, neurological, and physiological components (Feshbach, 1978). Such an extensive multidimensional perspective offers a more in-depth understanding that can lead to potential interventions into empathy and prosocial behaviors across the lifespan.

There are numerous definitions of empathy, each having undergone several transformations over the years. Many of these definitions focus on empathy in either affective terms such as an emotional response to another person (e.g., Hoffman & Levine, 1976; Moore, 1990), or cognitive terms such as understanding another's emotions (e.g., Deutsch & Madle, 1975; Kurdek, 1978). The affective view often includes affect matching, EC, and an automatic emotional reaction (see Emotional Contagion below). In contrast, other definitions of empathy highlight the cognitions involved, referring to empathy as involving perspective taking (Deutsch & Madle, 1975; Kurdek, 1978), observational imitation (Geangu et al., 2010), the ability to identify and understand the emotional state of another and the ability to discriminate between the other and the self (Feshbach, 1978). Most of these cognitive views, however, assume that the individual experiencing empathy has matured to a stage of cognitive development that allows for such advanced processes to take place. Additionally, as seen across many subfields of psychology, the recognition of the need to examine the social, emotional, cognitive, neurological, and physiological aspects together has emerged. In an attempt to gain a better understanding of empathy, the present study utilizes this multidimensional approach (e.g., Cozolino, 2006; Strayer, 1987), combining both the cognitive and affective components.

Such a multidimensional approach emphasizes that understanding the integration of cognition and emotion is crucial to understanding the many aspects of empathy and the development of it. Over two centuries ago, Adam Smith (as cited in Hastings, Zahn-Waxler, & McShane, 2006) defined empathy as “the ability to understand another’s perspective and to have a visceral or emotional reaction” (p. 483). This definition recognizes both the cognitive understanding as well as the emotional response involved in empathy. Many others have since agreed with this definition and adapted it. Decety and Jackson (2004), for example, outlined empathy as involving “not only the affective experience of the other person’s actual or inferred emotional state but also some minimal recognition and understanding of another’s emotional state” (p. 71), suggesting a more cognitive component is necessary. Similarly, according to Hastings et al. (2006), empathy involves recognizing (cognitive awareness) and sharing (emotional experiences) another’s emotional state. This integration is further outlined in the model proposed by Feshbach (1978) involving (1) affective sharing (feeling what the other is feeling), (2) a cognitive ability to take the perspective of another (knowing what the other is feeling), and an additional third category (3) self-other awareness (discriminating between the emotional states of the self and another). These elements – cognitive and emotional – are so intricately bound in current theory that it seems appropriate to conduct early developmental studies to link them in empathy research. Examining empathy’s origins and the underlying processes involved in its development is only a small part of understanding empathic responding. This knowledge can also enrich our overall understanding of empathy, increase the understanding of empathy’s earliest formation, serve as a knowledge base to enhance child development literature, and identify tools to stimulate and nurture empathy from its beginnings. The following literature review will provide an overview of the work that has been conducted in infancy on empathy, empathy-related behaviors, and the early development of empathy.

Empathy Development in Infancy

The majority of empathy research has left the developmental stages of early infancy largely unexplored. However, this lack of information is understandable given the physical and cognitive boundaries of such a young population. Infants and toddlers are both sensitive and responsive to the emotions of others, but the ways in which their empathy-related responses are manifested are largely limited by their cognitive and physical abilities (Ungerer et al., 1990).

Physical helping behaviors do not begin to emerge until the second year of life, in which the child exhibits empathic concern in the form of patting, touching or hugging someone in distress (Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992). In addition to the ability to initiate motor activities, mature empathy also requires certain key cognitive prerequisites, including self-other awareness, self-regulation of emotions, and diminished egocentrism (Decety & Jackson, 2004), all of which are underdeveloped (or perhaps even *un*developed) in infancy. The basis for self-other awareness lies in theory of mind, or the ability to recognize that another's mental state is distinctive from one's own. This is a developmental milestone that typically begins to emerge between the ages of 18 months and three years (Ungerer et al., 1990). Emotion regulation is thought to begin development in infancy (between 3 and 9 months) and continues to refine even into adulthood (Kopp, 1989; Lawton, Kleban, Rajagopal, & Dean, 1992; see discussion below for more information on emotion regulation) and egocentrism does not begin to decline until the age of 3 (Piaget, 1951), allowing the individual to think beyond purely self-focused desires and toward what another might want/need. Because each of these constructs is necessary to the development of mature empathy, but they do not develop until after the age of 1 year, their absence creates a significant obstacle for examining empathy prior to this time.

Although there are limitations to an infant's empathic abilities, recent research has indicated that the potential for empathy can be seen at birth, allowing an infant to connect with others emotionally and leading to empathic behaviors that are evident throughout the first few years of life (Zahn-Waxler et al., 1992). In other words, the basic building blocks of mature empathy are thought to be present long before the related intentional behaviors can be seen, pending development through interaction with others (Decety & Jackson, 2004). These basic building blocks are thought to include EC and imitation, both of which can be seen very clearly in early infancy (e.g., Sagi & Hoffman, 1976) and will be elaborated on below.

Emotional contagion. Emotional contagion (EC) is the ability to imitate or share emotions with another (Thompson, 1987) and in infancy is seen as an undeveloped form of empathy (Cummings, Hollenbeck, Iannotti, Radke-Yarrow, & Zahn-Waxler, 1986). Zahn-Waxler et al. (1992) hypothesized a biological predisposition for empathy that is seen in the first few days of life and is demonstrated through imitation of emotions (e.g., Field, Woodson, Greenberg, & Cohen, 1982; Meltzoff & Moore, 1977) and reflexive crying in response to another infant's cries, i.e. EC (e.g., Sagi & Hoffman, 1976; Simner, 1971).

In infancy, EC is considered automatic; a reflex that occurs before regulatory cognitions begin to develop (Simner, 1971). When an infant encounters another's distress, that infant is thought to experience EC, not yet mature empathy. This is an egocentric reaction that reiterates the fact that the infant's empathic responses are limited both cognitively and physically (lacking the ability to offer aid through mobility or language). The infant brain is very sensitive to input from the environment and to other's emotional cues (Ungerer et al., 1990), which suggests that EC is in fact an important process in developing empathy. It is not until an individual moves into the second year of life that the ability to distinguish the self from the other begins to emerge (e.g., Roth-Hanania et al., 2011). Through this cognitive developmental process, the child's emotional involvement in another's distress moves from shared, self-distress to sympathetic concern for the other, in which helping and prosocial behaviors begin to emerge. This reiterates the importance of examining empathy in its most rudimentary form, providing opportunities for interventions in its development. Infancy and early childhood are extremely malleable developmental periods; the first few years of life can provide individuals with the foundation of skills that will be used into adulthood (e.g., Ainsworth, 1989). Thus if empathy is present and can be detected in infancy, and is connected to more mature forms of empathy later in life, it can be argued that early infancy is a highly influential developmental stage in which changes can be made. This idea of changes and interventions in empathy development in infancy and childhood is discussed further in the Maternal Factors section below.

Empathy and EC can be measured most effectively through distress simulation paradigms (Eisenberg & Miller, 1987). In childhood, the use of laboratory experiments, stories, pictures, and videos are the most common. In laboratory experiments, the experimenter, mother, or another child feigns a mild injury, such as pinching a finger or bumping into a chair. At ages as young as one year, children show levels of emotional concern, attempt to understand the distress of others, and engage (or attempt to engage) in prosocial acts (the latter beginning as young as 8 months; Roth-Hanania, et al., 2011). Each of these behaviors was shown to increase with age (Roth-Hanania et al., 2011; Zahn-Waxler et al., 1992). In older children, adolescents and adults, empathy is typically examined using both distress simulation paradigms and parent or self-report measures (e.g., Rieffe, Ketelaar, & Wiefferink, 2010). With infants, however, many of the studies involving EC have used the contagious cry paradigm (e.g., Simner, 1971), or facial and postural mimicry (Meltzoff & Moore, 1977, 1983, 1992, 1994).

The contagious cry method consists of playing recorded cries of other infants and/or other noises and observing the infant's distress responses to the sound. This paradigm has been tested on multiple age groups including infants that are only a few hours old to beyond one year old. For example, Martin and Clark (1982) showed that infants as young as 18 hours will cry in response to another newborn's cry. This was further examined using a recording of white noise, a computer generated cry, and a recording of the infant's own cries (Martin & Clark, 1982; Sagi & Hoffman, 1976; Simner, 1971). With each of these stimuli, infants were not as responsive as they were to another infant's distress cries. In addition, the same paradigm was used, but with the cries of an infant of a significantly different age than the participant and yet another with the cries of a similarly aged primate (Martin & Clark, 1982; Sagi & Hoffman, 1976; Simner, 1971). Again, the infant's distress responses were stronger in the similar-aged human cry condition, thus demonstrating a more prominent EC response to those cries most similar to the infant's own. Sagi and Hoffman (1976) concluded that "the fact that one day-old infants cry selectively in response to the vocal properties of another infant's cry provides the most direct evidence to date for an inborn empathic distress reaction" (p. 175).

Very few studies regarding the contagious cry have expanded beyond the neonatal period (birth to one month). One exception is a study conducted by Geangu et al. (2010) in which the contagious cry phenomenon was demonstrated in infants at 1, 3, 6 and 9 months of age. It was found that infants at all four ages exhibited a vocal and facial distress response to the recorded cries and did not vary in duration or intensity across genders or age groups. Another exception is a study conducted by Roth-Hanania et al. (2011) involving 8- to 16-month-olds. The infants' empathic responding was observed cognitively through hypothesis testing (the infant's attempts to explore or comprehend the other's distress), emotionally through distress responses (or EC), and physically through prosocial acts. Prosocial acts increased most across ages, followed by empathic concern and hypothesis testing. Additionally, individual differences in both cognitive and emotional empathy predicted prosocial behaviors within the second year of life. This suggests that primitive forms of empathy exist in early infancy and are related to prosocial behaviors as they relate in adulthood.

There is evidence that, though egocentric in nature, EC persists into adulthood even after more mature forms of empathy develop (Dimberg, Thunberg, & Elmehed, 2000; van Baaren, Holland, Steenaert, & van Knippenberg, 2003; Wild, Erb, & Bartels, 2001). Outside of infancy, high levels of EC are not beneficial to general social functioning. Adults exhibiting personal distress reactions generally will only help another if there is no way to avoid the situation or if helping is the easiest way to relieve that individual's own distress (Ungerer et al., 1990). This response is typically due to emotional over-arousal (Eisenberg, Fabes, et al., 1998) and the incapacity to regulate those emotions—a developmentally appropriate response for an infant but not for adults. In adults, EC has been found to negatively relate to prosocial helping behaviors (Eisenberg & Fabes, 1990) and higher-level moral reasoning (Carlo, Eisenberg, & Knight, 1992; Eisenberg, Carlo, Murphy, & Van Court, 1995). Infants on the other hand, do not have the capacity to relieve another's distress or the cognitive understanding to do so.

Though high amounts are not beneficial in adulthood, EC in early life can be used as an accessible early marker for empathy, due in part to the under-development of necessary cognitive abilities for fully mature empathy (Geangu et al., 2010). EC in infancy has been theoretically linked to later empathy and labeled as a rudimentary version of empathy (Hoffman, 2000). EC appears to be laying the developmental foundation for later empathy, suggesting that there may be a consistency in the developmental trajectory of empathy (Cummings et al., 1986). However, longitudinal work in this area is still needed to determine the actual predictive abilities of EC on mature forms of empathy.

Imitation. Imitation in infants plays a significant role in empathy development. It differs from EC in that imitation can be both physical (imitating body movements) and emotional (imitating or mimicking emotional expressions). EC is affect sharing, in which the person is not only imitating the emotion, but also experiencing it themselves, whereas imitation is mimicking the emotion of another. Imitation however is integral for early social interactions by providing the tools necessary to begin to understand and discover the world from another's perspective. Such an experience with another person provides an interpersonal understanding that leads to perspective taking skills, theory of mind, and empathy later in development (Meltzoff, 2002). An infant's understanding that others are "like-me" provides an ever-expanding connection to interpersonal understanding and social cognition (Meltzoff, 2011). Meltzoff (2011) promotes the idea that an "infants' understanding of others' acts is enriched by performing similar acts themselves" (p. 53). In order for an infant to understand another's mental state and behavior, as would be necessary in producing an empathic response or in any social interaction, the infant assigns meaning to another's behaviors based on their own self-experiences. This gives infants a way to interpret their world and instill meaning into the acts of others without the use of language because the other is seen as "like-me" to the infant. Imitation acts as one of the first steps toward these goals and is thought to be one of the building blocks of empathy as it creates a foundation for perspective taking (e.g., Sagi & Hoffman, 1976).

Generally, facial and postural mimicry have been used in studies regarding emotional responses in infants. Through imitation, infants can make an initial rudimentary connection between the self and another. Meltzoff and Moore (1977) originally observed 12- to 21-day-old infants imitating the facial expressions of adults. Meltzoff and Moore (1983, 1989) were able to replicate this same study with infants less than 72 hours old. In each study, infants easily imitated the facial expressions and movements of the adults. This is true whether or not the infant is familiar with the adult (Meltzoff & Moore, 1992). It has also been shown that 6-week-old infants are able to not only mimic the facial expressions of adults, but also to imitate the same expression 24 hours later (Meltzoff & Moore, 1994), demonstrating the infant's ability to mimic the physical movements and also learn to make these expressions independently, thus beginning the process of emotion recognition and expression. Along these same lines, infants only a few hours old (average age, 36 hours) can distinguish between different emotions, including happy, sad, and surprised (Field et al., 1982).

Through the above reviewed studies, it can be argued that the potential for empathy is in fact present at birth (Zahn-Waxler et al., 1992). Emotional contagion behaviors can be seen very early in life and continue to manifest themselves throughout infancy (Geangu et al., 2010). Likewise, imitation can be clearly seen as an early marker for empathic behaviors. Through imitation, an infant can begin to observe and draw conclusions about their own and other's emotional states, thus leading to a fully developed theory of mind (Meltzoff, 2011). Once an individual has matured beyond infancy, these contagion and imitation behaviors could potentially transform into more beneficial, prosocial behaviors, contingent on the amount of reinforcement and nurture received at this critical developmental stage.

Maternal factors. Though not directly incorporated into the hypotheses of the current study, the effects of nurture on the development of empathy and emotionality in general are highly influential and will be briefly discussed here. Father-child interactions, though very influential in a child's development, will not be addressed here as the literature is very sparse on the topic and data were not collected in the current study on this topic.

Infants are both sensitive and responsive to their environments, absorbing available input, whether positive or negative (Ungerer et al., 1990), and these early interactions can shape the psychological development of the child and lay a stable or unstable foundation for the child's psychological health into adulthood (National Scientific Council on the Developing Child, 2012). The evidence demonstrating how parenting behaviors and parent-child interactions strongly influence later development is becoming more recognized and robust (e.g., Landry et al., 2008), particularly as it pertains to neurological development and the need for what is termed "serve and return" (ZERO TO THREE: National Center for Infants, Toddlers, and Families, 2005). Serve and return is a developmental theory in which the interaction between the child and parent is highly influential, especially in early years. The infant "serves", or reaches out to their parent in a social or emotional way, expecting a certain interactive response ("return"). For example, an infant may interact through babbling or facial expressions, and typically, adults will respond by imitation of the vocalizations or expressions. This back-and-forth is an essential part of the infant's socioemotional development, and when it is disrupted, the infant's development often suffers. An environment in which the adult does not interact with the child in a healthy way can create major stress for the child. This stress can impact the developing brain and increase the likelihood of developmental and behavioral problems later in life (see Stress Response System section below for more detail).

Earlier it was mentioned that EC responses to continue develop into empathic behaviors later in life, however, in order for this to occur, a positive, nurturing, supportive environment is needed. Most of the current research on the impact of maternal interactions on empathy development include subjects no younger than preschool, thus, as is the case with much of the empathy development research, limited work is available in the infancy period. Some of the research provided indicates that early in infancy, low levels of maternal interactions (as would be the case for depressed mothers), increases arousal in infants (Field, 2002; Field, Diego, Hernandex-Reif, & Fernandez, 2007) whereas positive maternal interactions tend to decrease infant personal distress and increase prosocial behaviors later in infancy (Spinrad & Stifter, 2006; Valiente et al., 2004). For instance, Field et al. (2007), using the contagious cry paradigm, found differences in the emotional arousal in infants of depressed versus non-depressed mothers. Additionally, Spinrad and Stifter (2006) show that maternal responsiveness negatively predicted the infant's personal distress response in 10- and 18-month-old infants.

In relation to emotion regulation (discussed below), Ursache, Blair, Stifer, and Voegtline (2013) provide evidence that the quality of caregiving affects infants' level of regulation. To elaborate, a high level of negative affect in infancy is indicative of children who themselves have the most positive outcomes later in development when in supportive environments. On the other hand, these children with high negative affect in infancy have the worst outcomes in unsupportive environments. In other words, in highly emotional situations, strong support systems (positive parent-child relationships) are likely to provide an environment that is beneficial to developing self-regulatory behaviors, whereas low supportive environments do not (Ursache et al., 2013).

In conclusion, a child's environment strongly influences emotional development, particularly with regards to emotional reactivity and regulatory behaviors. These differences in development of emotionality have implications for how a child responds to distressing events (behaviorally, psychologically, and physiologically) and for later cognitive development of regulatory capabilities. Each of these aspects will be covered in the subsequent sections of this literature review.

Empathy and Prosocial Behaviors

Empathy is a crucial factor in the expression of prosocial behaviors and is correlated with many prosocial, helping reactions in both child and adult populations. For example, separate meta-analyses conducted by Feshbach (1978) and Eisenberg and Miller (1987) both concluded that a positive relationship exists between empathy and prosocial behaviors for both children and adults. In children, Iannotti (1975, 1985) observed that measures of empathy (emotion matching) in preschool, kindergarten and third grade children were related to prosocial acts toward peers (i.e., sharing). Similarly, self-report measures of empathy have been found to correlate with prosocial acts of sharing in children (Dolan, 1983). Strayer (Strayer, 1983; Strayer & Roberts, 1984) demonstrated that children's empathy was positively related to parent reports of prosocial acts. In adults, self-reported empathy has been shown to relate to prosocial acts such as volunteering to help another in need (e.g., Archer, Diaz-Loving, Gollwitzer, Davis, & Foushee, 1981) and self-reports of prosocial attitudes and past prosocial behaviors (e.g., Burleson, 1983).

In an early study conducted by Iannotti (1975), cognitive and emotional empathy, aggression, role-taking skills and altruism were assessed in 6- to 9-year-old boys. The children were shown pictures of other children in social situations and read a corresponding story. In this population, empathic responses increased with age and were positively related to role-taking and altruistic behaviors. A few years later, Iannotti (1985) conducted a second study that assessed prosocial behaviors in preschool children using three different approaches: observation in a natural setting; measures of perspective taking, empathy, and prosocial acts; and teacher ratings of prosocial behaviors. With each of these three measurement approaches, empathic responses were found to predict prosocial acts such as sharing, cooperation, and helping behaviors. Specifically, perspective taking was related to helping behaviors and was able to predict teacher ratings of prosocial behaviors.

Additionally, Buckley, Siegel, and Ness (1979) assessed empathy, perspective taking, and prosocial behavior in children 4-5 years old. Empathy was measured through a narrative measure in which the child was asked to indicate the child's own feelings and the feelings of the character of the story, as well as situational and emotional role taking. Sharing (giving part/all of a snack to the child's best friend) and helping (assisting with cleanup of a box of pencils that fell to the ground) were also assessed. Additional measures were used to examine perspective taking (selecting a gift for an opposite-sexed sibling or friend, for example). Finally, teacher-ratings of empathy and prosocial behaviors were collected. The authors found a positive relationship between empathy, prosocial behaviors, sharing, and perspective taking that was strongest when directed toward their peers.

Finally, Feshbach (1978) examined empathy in relation to altruism in 3- to 8-year-old children. Perspective taking, empathy, and altruistic behaviors were measured. Perspective taking skills were examined through a task in which the child was asked to rotate a model (consisting of toy trees, buildings, and animals) so that a toy cartoon character would have the same view of the model as the child. Empathy and altruistic behaviors were measured through emotion recognition, helping behaviors (cleaning up a puzzle that fell apart) and sharing (a cookie at snack time). Positive correlations between empathy and altruism, and between altruism and perspective taking were found.

While correlational work is important to understand empathy, the research has been further extended through intervention studies. Though uncommon, attempts have been made to cultivate empathic behaviors in childhood. Iannotti (1975), for example, implemented training procedures in an attempt to increase empathic responses in 6 year olds. The children were asked to respond to empathy arousing conditions either egocentrically or in an others-centered manner. He found that the children trained to role-play or role-switch, both others-centered conditions, exhibited significantly more short-term empathic and prosocial behaviors than did children in the control group. Similarly, Feshbach (1978) reports that empathic behaviors positively related to teacher ratings of prosocial behavior in elementary school children who participated in empathy training sessions. More recently, interventions have been made in school systems to increase the empathic responding and prosocial behavior in children. For example, in a study conducted by the Roots of Empathy organization (e.g., Santos, Chartier, Whalen, Chateau, & Boyd, 2008), prosocial behaviors (sharing, including, and cooperating) and aggression (physical, relational, and social or bullying) were measured in elementary school aged children. Randomized control trials were used with one group receiving empathy and prosocial behavior interventions, and another receiving no change. Those children in the intervention groups showed increased helping behaviors, perspective taking, sharing, and peer acceptance, as well as decreased aggressive behaviors toward their peers. Through these studies, it appears that empathy-enhancing training has at least some effect on young children's prosocial behaviors, albeit potentially short-term or limited to context. Perhaps if training—for parents and children—were to begin at younger ages than 6 years, infancy or preschool for example, changes in empathy and prosocial behaviors might be more enduring.

While there is debate among researchers on the motivation behind prosocial behaviors—egocentric or altruistic—it is widely agreed that empathy plays an essential part in prosocial and positive behaviors, rendering empathy an important construct to examine. It is conceivable that if more is known about empathy, especially regarding the early predictors and influences, effective interventions can be made to nourish and develop in children empathic behaviors and prosocial responses that last a lifetime.

Empathy-Related Behaviors

In adulthood, empathy is associated with two related responses: sympathy and personal distress, both of which will be discussed here. Sympathy is an emotional reaction that is based on the uneasiness of another's emotional state. It involves feelings of concern and sorrow for the other person. While a component of empathy, it differs slightly in that sympathy does not include the sharing of another's emotional state (Eisenberg, Wentzel, & Harris, 1998). It is believed to stem from empathy, however, and may promote relatively advanced cognitive processes such as perspective taking (Valiente et al., 2004). In adults, sympathy has been positively related to prosocial behaviors (Eisenberg & Fabes, 1990) and higher-level moral reasoning (Carlo et al., 1992; Eisenberg, Carlo, et al., 1995).

Personal distress, the other component of empathy identified in adulthood (Eisenberg, Wentzel, et al., 1998), relates closely to EC in that both can lead to individuals attempting to alleviate their own distress without a required specific regard for the well-being of another

(Eisenberg & Fabes, 1990). In adulthood, the term EC is used frequently as the sharing or imitation of another's emotional state (Thompson, 1987), and could include positive, negative, or neutral emotions (excitement, distress, or yawning for example). The term personal distress tends to be used to describe a self-focused, aversive emotional reaction, such as anxiety or discomfort, to another's emotional state (Eisenberg & Fabes, 1990; Eisenberg, Wentzel, et al., 1998). Both of these constructs, EC and personal distress, can be managed by emotion regulation in adulthood (See Emotion Regulation below) and require cognitive processes such as decreased egocentrism and theory of mind or a self-other awareness. For instance, if an individual were able to effectively regulate emotional arousal resulting from another's emotional display (negative or positive), the individual would not become so overwhelmed by emotion that the individual would shift the focus of attention from the other to the self (egocentrism and theory of mind), as would be the case in both personal distress and EC (Eisenberg et al., 1994). In infancy however, emotion regulation, theory of mind or self-other awareness are only beginning to develop and egocentrism has not yet declined. This implies that EC, and not personal distress, can be seen at these young ages. Therefore, it is EC that is typically measured in the infant research (e.g., Simner, 1971). However, at these young ages, EC is often mistaken for and labeled as personal distress as the literature regarding infant EC is primarily focused on negative emotional reactions (e.g., Martin & Clark, 1982). For the purposes of this study, the two will be considered homologous in the infant population.

In addition to sympathy and distress, emotion regulation is an important factor in empathy and its development (many other types of regulatory processes become essential to the discussion on physiological stress responses as well as the integration of cognition and emotion. These relationships will be elaborated on in the Physiological Markers and Cognition and Emotion sections below). Emotion regulation is defined as "the process of initiating, maintaining, modulating, or changing the occurrence, intensity, or duration of internal feeling states and emotion-related physiological processes" (Eisenberg, Fabes, Guthrie, & Reiser, 2000, p. 137). Cummings (1987) examined children's reaction to anger and conflict in adults. He observed that children tended to fall into one of three categories of responding: under-controlled (labeled as ambivalent; high emotional arousal, aggressive behaviors, and other dysregulated behaviors), over-controlled (labeled as unresponsive), or neither (labeled as concerned; felt an emotional reaction to the situation but did not overreact). Of the three groups, it was children in the latter that tended to exhibit the most sympathetic behaviors.

Building on such results as reported in Cummings (1987), Eisenberg and Fabes (1992) proposed a theoretical model to describe the interaction between regulation and emotional reactivity. In short, the theory states that individuals can fall into one of two emotional reactivity categories and one of three regulation style categories. For emotional reactivity, an individual can express moderately high or moderately low emotional intensity in response to an emotionally evocative event. With regards to regulation style, an individual can express high inhibition, optimal regulation, or under-regulation. Ursache et al. (2013) add that emotional arousal and automatic, rudimentary regulation can lead to the development of higher-order self-regulatory behaviors such as attentional control (see Cognition and Emotion) and other executive functions (see also Kopp, 1989). Additionally they argue that the relationship between emotional arousal and later executive functioning is moderated by regulation of the emotional arousal. In other words, high levels of emotional arousal are beneficial and indicate improved executive function development when accompanied by high levels of regulation, but they indicate poorer executive function development when accompanied by low levels of emotion regulation.

In conclusion, empathy incorporates many psychological processes including personal distress, sympathy (e.g., Eisenberg, Wentzel, et al., 1998), and self-regulation (e.g., Ungerer et al., 1990). Regulation has a strong influence on personal distress responses and EC (e.g., Eisenberg et al., 1994). In infancy, regulatory behaviors are automatic and still in early developmental stages, thus further development of them is dependent on many things, including quality of environment and caregiving (Ursache et al., 2013). Finally, since empathy has strong connections to prosocial behaviors in childhood and adulthood (e.g., Eisenberg & Miller, 1987), it is important to examine the early development of empathy as well as the underlying factors that contribute to it in order to find a potential critical period for intervention.

Physiological Markers

In addition to external behavioral responses to another's distress, individuals also demonstrate internal responses such as changes in heart rate (HR) or other measures of the body's stress response systems (Ungerer et al., 1990). This internal response can be especially useful in infant research where the population is limited in both cognitive abilities as well as external, behavioral responses. Whereas an adult can respond verbally or with physical helping behaviors, a young infant has only limited capabilities of responding. Regardless of whether an infant feels empathy toward another, the infant is not only largely unaware of the causes of another's distress, but also unable to help alleviate that distress either verbally or physically. Despite these limitations of mobility, language, and cognitive resources, the infant is still capable of imitating the emotional distress of another externally and of exhibiting an internal, physiological response to the situation (Ungerer et al., 1990).

The biological underpinnings are just as important as the behavioral markers in the multidimensional process of empathy. Many of the self-focused emotional responses utilize the same neural processes as an other-oriented response. For example, the identification of pain, distress, or emotions experienced by another is processed by the same areas of the brain that identify pain, distress, and emotions in the self (Eisenberger & Lieberman, 2004; Eisenberger, Lieberman, & Kipling, 2003). The insula, a neural structure that is closely tied to emotional and empathic responding, has also been found to become activated during imagination of (i.e., perspective taking) and imitation of another's emotions (Singer & Lamm, 2009). This suggests that emotional empathy, or imitating and understanding the emotions of others, utilizes the same areas of the brain as understanding emotions of the self (Bernhardt & Singer, 2012; Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Shirtcliff et al., 2009) and provides further evidence for the genesis of empathy-related behaviors existing in imitation and EC in infancy. Thus, even neurologically, perspective taking is influenced by the occurrence of one's own similar feelings and the belief that the other is "like-me."

This neurological form of perspective taking can also be seen through the mirror neuron system (MNS), a system fundamentally linked with emotion-related activity (Shirtcliff et al., 2009). Mirror neurons can be activated by self-performed actions, the observation of another's performance of actions (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996), and the implied action of another (Iacoboni et al., 2005; Pineda et al., 2008). The MNS is thought to have a significant role in one's ability to represent another's action as well as another's intentions and emotions (Oberman, Ramachandran, & Pineda, 2008). This system has contributed to the development of social skills such as imitation, theory of mind and empathy (Gallese, 2001) and is sensitive to the degree to which the other person is perceived as familiar, or "like-me" (Oberman et al., 2008).

Though the MNS has not yet been observed in infants, for practical and cost reasons, one way that mirror neurons can be examined in older children and adults is through the suppression of mu rhythms (brain wave frequencies of 8-13 hertz that are thought to reflect mirror neuron activity; Oberman et al., 2008) in the brain. Stronger abilities to suppress the mu rhythm are indicative of higher levels of imitation and empathy and can be conditioned in children in order to increase their abilities to imitate others (Pineda et al., 2008). Improvements in imitation and information processing skills in children with Autism (Pineda et al., 2008) and Attention Deficit Hyperactivity Disorder (ADHD; Strehl et al., 2006) have been seen through mu rhythm suppression training. Both of these disorders have been significantly linked to deficits in social and communicative abilities such as theory of mind, imitation, and empathy, suggesting a strong connection between the mirror neuron system and empathy.

Furthermore, in addition to the insula and the MNS, the neurological foundations of interpersonal connections, including mother-child bonding and friendships (Shirtcliff et al., 2009), involve the limbic system, a neurological system involved in a variety of social behaviors, including empathy and social information processing (Nelson, Leibenluft, McClure, & Pine, 2005). Though empathy involves multiple areas within the brain, empathy-related processes are largely represented by the limbic system (Eisenberger et al., 2003) that sends and receives a wide variety of information, including the instructions to release cortisol (discussed in detail below; Gunnar & Quevedo, 2007). As one of the stress hormones that can be released as a result of limbic activation, cortisol is released in order to help the body regulate stress. More detail on cortisol's role in both emotional and cognitive processing will be provided below.

Stress Response Systems

The body's stress response systems are critical for developing empathy and other socioemotional responses. In the case of empathy, the body's biological response to an emotionally distressing event helps to initiate a behavioral response, or prosocial behaviors. Biological responses to stress involve two main systems: the sympathetic nervous system (SNS) and the hypothalamic-pituitary-adrenal (HPA) axis (Gordis, Granger, Susman, & Trinkett, 2006). The activity of the SNS, commonly referred to as the body's "fight or flight" response, includes an increase in HR, respiratory rare, and skin conductance, among other things (Gordis et al., 2006). One function of the HPA axis is releasing the stress-regulating hormone cortisol. These two systems are commonly used to assess both emotional arousal and attentiveness, especially in infancy due to the limitations presented when studying such a young population (e.g., Colombo, Richman, Shaddy, Greenhoot, & Maikranz, 2001; Davis & Granger, 2009). In infancy, physiological markers as a method of assessment are both practical and effective, particularly when compared to maternal report or other empathy measures, and are considered to be the most effective measure of emotional arousal (Eisenberg & Fabes, 1990). The present study will examine specific markers of both of these stress response systems.

Sympathetic Nervous System. Stress and potential threats are the main activators of the SNS (Liew et al., 2003), therefore, the SNS can be used to assess stress levels due to physical, emotional, or social distressing events. The SNS plays a major role in the body's stress reactions and management, in particular, the body's "fight-or-flight" reactions. In infancy, EC responses are highly influenced by stress, thus measurement of EC responses via the SNS is relevant. Indicators of activity in the SNS, such as HR, skin conductance, and in infants, sucking, are often used in EC studies due to the arousal response that often occurs (Liew et al., 2003; Zahn-Waxler, Cole, Welsh, & Fox, 1995). Heart rate measures in particular will be used for the present study.

Heart rate. Heart rate (HR) is a well-established measure of attentiveness and arousal in emotional situations such as an EC paradigm (Liew et al., 2003; Zahn-Waxler et al., 1995), and is used often in infant research (e.g., Colombo et al., 2001; Reynolds & Richards, 2008). Heart rate deceleration is associated with attending to and processing information about the environment (See Infant Cognitive Processing for more information; Reynolds & Richards, 2008). Outside of infancy, sympathy, helping, and other prosocial behaviors tend to accompany HR deceleration (Eisenberg & Fabes, 1990; Zahn-Waxler et al., 1995). For example, Zahn-Waxler et al. (1995) observed that HR deceleration in response to social stressors positively predicted increased levels of empathy and prosocial behaviors in 4 and 5 year olds. On the other hand, HR acceleration is typically associated with higher stress, anxiety, and coping (Reynolds & Richards, 2008; Zahn-Waxler et al., 1995) and is indicative of high levels of personal distress and low levels of helping behaviors (Eisenberg & Fabes, 1990; Field et al., 1982; Simner, 1971; Zahn-Waxler et al., 1995).

In other words, in children, HR deceleration is indicative of empathy development and prosocial behaviors and is therefore relevant to the study of EC.

Additionally, higher baseline HR (BS HR) has been associated with higher levels of empathic concern and prosocial behaviors. For example, in 4- and 5-year-old children, Zahn-Waxler et al. (1995) assessed empathic concern, prosocial behaviors, avoidance behaviors and HR among other things. Behavioral responses to both hypothetical and real situations involving another's distress were used to measure empathy and prosocial behaviors. It was found that higher BS HR as well as HR deceleration predicted both empathic concern and prosocial behaviors. Conversely, Zahn-Waxler et al. (1995) also observed that lower BS HR was associated with increased aggressive and avoidance behaviors. A meta-analysis showed a clear association between conduct disorder, antisocial behaviors, aggression and a lower BS HR (Ortiz & Raine, 2004). This is supported by Raine, Venables, and Mednick (1997), who found that low BS HR in 3-year-old children was a predictor of aggression at age 11. To summarize, HR deceleration and higher BS HR levels tend to be indicative of empathy, prosocial behaviors and attentiveness to the environment in childhood, whereas HR acceleration and low basal levels are associated with aggression and antisocial behaviors.

Hypothalamic-Pituitary-Adrenal (HPA) Axis. The HPA axis is a stress regulation system in the body that is activated when a stressful event is encountered, particularly social stressors (Gordis, Granger, Susman, & Trinkett, 2008). In such events, the HPA axis releases a regulating hormone, cortisol. While individuals have a baseline (BS) level of cortisol, an increase can be seen after a stressful event. The present study aimed to measure BS cortisol, but likely received some interference from the child's physiological reactions to the experimental situation (See Methodology section for more detail). Cortisol can be easily measured through saliva and, along with SNS measures (Liew et al., 2003). Activity in the SNS, as noted above, is closely tied to the HPA axis; therefore, synchrony can usually be seen between the two systems (Oosterlaan, Geurts, Knol, & Sergeant, 2005).

Cortisol and emotion. Stress hormones, such as the adrenal hormone cortisol, have a significant influence on activity within the limbic system. Cortisol has an important role in responding to social stressors and regulating areas of the brain that facilitate empathic or prosocial behaviors (Shirtcliff et al., 2009), as well as emotional learning and memory (Roozendaal, 2002). Cortisol has been shown to have wide-ranging influences on the social brain, particularly under conditions of social stress (Taylor et al., 2000). It acts as a consequence of brain activation in areas such as the hippocampus (which facilitates emotion-related functions, Shirtcliff et al., 2009), the anterior cingulate cortex (which aids in connecting our emotions with our understanding of the emotions of others; Shirtcliff et al., 2009), and the amygdala (which processes emotions-related expression, learning, memory and regulation; Kalin, Shelton, & Davidson, 2007). By utilizing the same brain areas to represent both physical and social distress, these neural mechanisms involved in empathy promote prosocial and empathic behaviors. Cortisol is activated through each of these mechanisms (Shirtcliff et al., 2009). Thus, although brain imaging is not common in infant research due to monetary costs and impracticality, the cortisol reactions based on these areas of activation is a much simpler measure of emotional reactivity, especially in infants. Cortisol measurement can therefore be used as a physiological measure of emotion and an additional measure of empathy-related responses in infancy. Additionally, since it is primarily found in saliva, it can be measured using a simple cotton swab in the mouth.

The literature regarding a direct connection between cortisol and empathy is limited. More theoretical support than empirical evidence is provided for cortisol's role in the expression of prosocial behavior and even less for cortisol's specific role in empathic behaviors, though some exists. Currently, the only study on the relationship of cortisol and empathy examined both male and female young adults (Nakayama, Takahashi, Wakabayashi, Oono, & Radford, 2007). It was shown that males with higher levels of empathy also showed higher levels of cortisol whereas, for females in this study, the relationship between cortisol and empathy showed a negative relationship. Though not specifically measuring empathy, Sethre-Hofstad, Stansbury, and Rice (2001) observed that mothers who were more strongly attached to their children showed higher cortisol responses when observing their child in a stressed state. Furthermore, initiation of social interactions, social competence, and popularity are related to higher cortisol reactivity in children (Tennes & Kreye, 1985).

Conversely, older children and adolescents with lower BS cortisol levels tend to display more antisocial and aggressive behaviors, similar to the patterns of high and low BS HR mentioned above. For example, low basal cortisol levels can be seen in children with symptoms of oppositional-defiant or conduct disorder (Oosterlaan, et al., 2005; Snoek, Van Goozen, Matthys, Buitelaar, & Van Engeland, 2004), aggressive, disruptive, and violent children (McBurnett, Lahey, Rathouz, & Loeber, 2000), those exhibiting antisocial and callous behaviors (Loney, Butler, Lima, Counts, & Eckel, 2006; Susman, 2006), individuals with psychopathic traits (van Honk, Schutter, Hermans, & Putman, 2003), and children with other externalizing behavior problems (Shirtcliff, Granger, Booth, & Johnson, 2005; Smider et al., 2002). Additionally, low basal cortisol levels found in adolescents were predictive of callousness in young adulthood (Burke, Loeber, & Lahey, 2007). Finally, poor social skills in female adolescents and adults (Adam, 2006; Booth, Granger, & Shirtcliff, 2008) were related to lower trait, or BS, levels of cortisol, demonstrating a connection between socio-emotional functioning and cortisol levels.

Though low basal and reactive levels of cortisol tend to be associated with aggressive and antisocial behaviors, high basal and reactive cortisol can also be detrimental. Elevated BS cortisol can contribute to many physical problems in adults (Wrosch, Miller, Lupien, &

Pruessner, 2008). In particular, high basal cortisol is associated with problems in the immune, metabolic, and central nervous systems (Heim, Ehlert, & Hellhammer, 2000). Therefore, optimal levels are in the moderate range for both basal levels of cortisol and responsive measures.

Although these findings are not directly related to empathy, they suggest that an optimal level of social and emotional arousal, including moderately high levels of basal cortisol, may facilitate empathic and prosocial behavior (Eisenberg, 2007; Eisenberg et al., 1994). Due to its ease of use and numerous physiological connections to the emotional system, cortisol levels may prove to be a good indicator of emotional distress (i.e., empathy) in infancy.

The development of the physiological stress system is thought to be influenced by both genetics and early environmental experiences. This gene x environment interaction can be seen in trait cortisol levels. Trait cortisol has been shown through twin studies and genetic models to be moderately heritable (Bartels, de Geus, Kirschbaum, Sluyter, & Boomsma, 2003; Van Hulle, Shirtcliff, Lemery-Chalfant, & Goldsmith, 2012). But genetics is not predestined; in fact, the environment has a strong influence on gene expressing in terms of which genes are expressed or not, and the timing of when the gene is expressed. This gene x environment theory of development applies to the stress response system (see Scarr & McCartney, 1983 for a review on gene x environment interactions). Briefly, Scarr and McCartney (1983) suggest that the gene x environment interaction is a complex system in which gene expression can be influenced by environmental interactions and genetics can also influence the environment that is experienced. This interaction between genes and environment can be seen in parent-child synchrony of trait cortisol. In other words, the basal, or trait, patterns of cortisol in the parents are likely to be similar to basal, or trait, patterns of cortisol in their children because of genetics (Papp, Pendry, & Adam, 2009; Williams, Cash, Daup, Geronimi, Sephton, & Woodruff-Borden, 2013). However, the parent-child environment is also highly influential in the child’s stress response system. For example, mothers with anxiety disorders demonstrated trait cortisol synchrony with their children

(Williams, Cash, Daup, Geronimi, Sephton, & Woodruff-Borden, 2013), and this synchrony was strengthened by the amount of time the dyads spent together (Papp, Pendry, & Adam, 2009). This strengthening would be especially evident in an early infant sample, as the majority of an infant's life in the first year is often spent with the mother. While anxiety disorders are heritable, the environment of a child with a highly anxious mother would also influence the child's development and the expression of physiological stress systems, such as cortisol.

Other factors could influence the early development of the stress response system including the child's attunement to the mother, attachment styles, and early experiences of stress. For example, several studies have demonstrated that infants with secure attachment styles are better able to regulate their physiological stress responses, whereas infants with insecure, anxious or disorganized attachments showed greater dysregulation of the stress response system (Gunnar & Cheatham 2003; Gunnar & Quevedo 2007). Additionally, chronic exposure to moderate or extreme stressors can result in a permanently increased physiological stress response (Weik & Deinzer, 2010). For example, individuals having experienced extreme and/or chronic stressors demonstrate a lower BS cortisol. A recent meta-analysis on the effects of stress on cortisol concluded that chronic stress could actually result in down regulation of the HPA axis, including BS cortisol levels (Miller et al., 2007). With acute stress, the HPA axis is activated and cortisol is increased as the body's biobehavioral response to an outside threat. When the threat is gone, the HPA axis sends negative feedback to regulate cortisol back down to normal levels. With chronic stress however, the threat and the stress do not diminish. This chronic stress then leads to a dysregulation of cortisol as the body's attempt to cope with prolonged stress (Hek et al., 2013). For example, chronic stress in adults, and trauma in particular (e.g., combat or domestic violence), is associated with reduced cortisol levels (e.g., Seedat, Stein, Kennedy, & Hauger, 2003; Yehuda et al., 1995; Yehuda, Teicher, Trestman, Levengood, & Siever, 1996). This dampening of cortisol may be due to withdrawing or disengaging from the chronic stress as a coping mechanism for the stress and is often seen when chronic stressors are out of the individual's control (e.g., Mason et al., 2001). Another similar explanation for this is that individuals "toughen" themselves after an encounter with a stressor in order to prepare themselves for later stress (Miller et al., 2007). This supports the importance of environment on the development of the stress response system in early life. For example, a mother that is overly stressed is likely to also be somewhat disengaged from her child. Infancy is a crucial period for development of HPA axis regulation system and exposure to chronic stress in infancy, such as a disengaged parent, could lead to the down regulation of the HPA axis and potentially a dysregulated and altered pattern into adulthood (Liu et al., 1997; Miller et al., 2007).

Self-regulation. The release of cortisol follows a different pattern depending on the type of stressor that it is responding to. For example, a daily or mild stressor initiates the release of cortisol, which then follows a negative feedback inhibition loop. This negative feedback communicates with the HPA axis, telling it when the situation is no longer a threat. The HPA axis is then deactivated and the system is brought back to normal levels (Weik & Deinzer, 2010). On the other hand, when the HPA axis is responding to a long-term or extreme stressor, the negative feedback loop becomes disinhibited and the HPA axis remains activated in order to continue responding to the stressor (Miller, Chen, & Zhou, 2007). As mentioned above, chronic stress can also highly influence the regulation of the HPA axis, causing permanent dysregulation (Weik & Deinzer, 2010).

This regulatory process plays an important role in the individual differences of emotional and physiological response to stress. The ability to self-regulate can determine one's level of reaction to stress and there is variability within individual responses. For example, Individual A may become overwhelmed by the feelings of another (personal distress), when Individual B may have little or no reaction at all (indicative of antisocial behaviors). Note that this reaction is different than what is found in Autism Spectrum Disorders in which the issue is perspective taking and an awareness of the other's emotional state, rather than an issue with the emotional responding.

Cortisol and cognition. Not only is cortisol a major factor in arousal due to emotional situations as mentioned above, but it is also associated with learning, memory (Oosterlaan et al., 2005), attention (Stadler et al., 2011) and executive functioning (Cutuli, 2012; Ursache et al., 2013). The stress response systems' purpose is to help the organism avoid harmful and threatening situations. It is involved in conditioned or learned emotional responses to threat and, cortisol in particular, helps to activate the amygdala, the brain area primarily devoted to the long-term storage of emotional memories (Oosterlaan et al., 2005). This connection between cortisol and memory may also play a role in the antisocial and aggressive behaviors associated with low cortisol, as mentioned above. Reduced activity in the stress response system may lead to poor memory of and inappropriate learned responses to negative stimuli, thus the antisocial and aggressive behaviors are developed and maintained instead (Oosterlaan et al., 2005).

Low levels of BS cortisol tend to be more prevalent in hyperactive children and those with ADHD. This may indicate a dysregulation of the HPA-axis, with low levels related to under-arousal of the stress response system. Under-arousal in general is thought to be a common denominator underlying many of the symptoms of ADHD (Stadler et al., 2011). Additionally, BS levels of cortisol have been negatively related to executive functioning in a high-risk population of school-aged children (Cutuli, 2012). Cutuli (2012) suggested that this implies an inverted-U relationship between cortisol and cognition. The levels of reactivity in relation to performance on both cognitive and emotional tasks (e.g., executive functioning, empathy, and prosocial behaviors) follow this inverted-U pattern (Ursache et al., 2013). In other words, when emotional arousal (including cortisol and HR level) is in a moderate range, self-regulation, control behaviors, and executive functioning are at their most optimal levels and are facilitated by arousal. On the other hand, when arousal is extremely high or extremely low, these abilities are reduced (Eisenberg et al., 1994; Ursache et al., 2013). Therefore, for the current study, three groups potential of emotional responders will be examined.

The relationships between emotional arousal, cognitive development, and the stress response system lead to a conclusion to use SNS and HPA axis markers to assess early empathy development and EC. The use of stress response markers is well documented as effective measures of emotional arousal and the body's reaction to social stress. Heart rate measures are more common in the infant literature, thus the use of salivary cortisol in addition to HR to assess EC, could provide a new insight into the measurement of empathy development in infancy.

Thus far in this literature review, emotional responding, empathy, and related behaviors have been the main topic of discussion. Cognitive variables such as executive functioning and memory have been briefly considered, however, the integration of cognitions and emotions goes much more in depth. The following section will elaborate on many of the connections between cognition and emotion, and in particular, the cognitive underpinnings of empathy and empathy development.

Cognition and Emotion

Cognitive and emotional development have been extensively investigated at many developmental stages, and there is a wealth of information connecting the two. As noted above, empathy is thought to involve different cognitive functions, including, but not limited to perspective taking and self/other distinction. These, combined with the appropriate emotions and adequate nurturing, help to generate socially acceptable, prosocial responses to situations and to create insights into the thoughts and feelings of others (Farrant, Devine, Maybery, & Fletcher, 2012). Although these processes have been established in older children, adolescents, and adults, the knowledge is sparse regarding the cognitions that underlie empathy in infancy. The present study aims to address this gap.

As discussed above, empathy utilizes the cognitive processes of both perspective taking skills and theory of mind; however, they do not stop there. In fact, in older children and adults there are numerous other cognitive skills involved. Recent studies have revealed that cognitive operations such as effortful control (Valiente et al., 2004), response inhibition (Hansen, 2011), attention (Braaten & Rosén, 2000), and information processing (Phelps, 1994) all influence emotional and empathic responding, highlighting the link between empathy and cognition in older children and adults.

Regulatory behaviors are a vital component of empathy. As briefly mentioned above, the ability to regulate, or control, one's emotional reactions, allows the individual to adequately attend to the situation at hand (Eisenberg et al., 1994). Additionally, regulatory behaviors become essential to the discussion on the physiology of stress as well as the integration of cognition and emotion.

Many studies have associated different types of control and regulatory behaviors with an individual's ability to empathize and sympathize with others (Eisenberg et al., 1994; Eisenberg et al., 1996; Guthrie et al., 1997). For example, (Rothbart, Ahadi, & Hershey, 1994) found a positive relationship between mothers' reports of effortful control (the ability to inhibit a dominant response and perform a subdominant response; Derryberry & Rothbart, 1997; Rothbart et al., 1994) and empathy in their 7-year-old children. Likewise, Eisenberg and Fabes (1992) found that emotion regulation (the ability to control internal emotional states and processes; Eisenberg, Fabes, et al., 1998) , a construct similar to effortful control, is related to empathic responses in children. In particular, based on parent and teacher reports, regulation shares a positive relationship with sympathy (Eisenberg et al., 1996; Eisenberg, Wentzel, et al., 1998) and is predictive of low levels of personal distress later in childhood (Ungerer et al., 1990). In other words, children who were able to efficiently regulate their emotions reported fewer feelings of personal distress, were more sensitive to others' emotions, and demonstrated more empathic, prosocial and sympathetic responses than those less able to emotionally regulate. Thus, for individuals with the ability to regulate and control their emotional stimulation, it is likely their actions will be less self-focused and instead, have the components necessary for empathic and prosocial responses.

Conversely, there is evidence that toddlers with higher behavioral inhibition (the ability to suppress impulses and resist inappropriate or negative behaviors; Kochanska, Murray, & Coy, 1997) also demonstrate higher levels of empathy (Hansen, 2011). For example, high levels of inhibition are positively related to sympathetic responding, demonstrating that those with high inhibitory control are more able to maintain an optimal distance from the emotionally stirring situation and inhibit a self-serving response (Eisenberg et al., 1994). This is an important regulatory behavior that is necessary to produce an empathic response (Hansen, 2011).

Attentional control (e.g., the ability to focus and shift attention; Derryberry & Rothbart, 1988) has also been identified as another empathy-related construct. Like the other cognitive constructs reviewed above, it has been linked with low levels of personal distress and high levels of sympathy (measured through HR deceleration or acceleration respectively in response to empathy-inducing films; Guthrie et al., 1997). Moreover, Braaten and Rosén (2000) examined differences in empathy and emotion regulation in 43 boys (mean age of 8 years) with and without ADHD. Those with ADHD typically experienced issues regarding the self-regulation of affect and inhibitory control. These include a reduced appreciation of another's feelings (i.e., decreased empathy), increased emotional responsivity, an inability to anticipate emotional reactions, a decreased ability to regulate emotions (Barkley, 1997), and diminished perspective taking skills, what Barkley (1994) states is likely due to deficits in the prefrontal cortex functioning. Measuring the behavioral and emotional responses to empathy-inducing anecdotes, Braaten and Rosén (2000) found that boys with ADHD were more emotionally reactive, less empathic, less able to match another's emotion, and less able to take the affective perspective of the character in the story when negative emotions were involved than those without the disorder. Additionally, when shown an empathy-inducing film, Eisenberg, Fabes, et al. (1995) observed that children's (aged four to six years) teacher-reported attentional regulation was positively related to facial expressions of concern. Finally, Schwenck et al. (2011) found that children (mean age of 12) with ADHD and conduct disorder had stronger deficits in perspective taking and empathy than those without either disorder. This research suggests that the mechanisms necessary for attentional control are also necessary for—or at least highly related to—empathic responding. This is supported in part by the connection between ADHD and inhibition—a beneficial process in generating an empathic response.

Finally, empathy is enhanced by cognitive functions such as memory and information processing, though the literature is somewhat sparse in this area. Eisenberg, Wentzel, et al. (1998) suggest that an empathic, sympathetic, or personal distress response can be evoked in children and adults by retrieving from memory the information that may be relevant to assessing another's emotional state. For example, one can experience empathy by remembering a personal experience of what it feels like to be socially rejected, and thus feel empathy toward another in a similar situation (similar to the "like me" concept outlined by Meltzoff (2011) and described in more detail above). Phelps (1994) suggested that low levels of empathy relate to deficits in social information processing (decision making abilities regarding interpersonal behaviors; Kupersmidt, Stelter, & Dodge, 2011). She observed that male adolescents low in both cognitive (perspective taking) and affective (empathic concern) empathy exhibited deficits in information processing. Moreover, self-reported empathy scores were related to social/emotional information and language processing. Similarly, Fitzgerald and Asher (1995) reported that prosocial children felt more unsure of their judgments of others' intents than aggressive children. This suggests a higher sensitivity toward and a higher awareness of another's situation (perspective taking). These findings demonstrate that individuals with higher empathy levels are able to integrate contextual and social information more rapidly, carefully, and accurately than others. Altogether, these studies indicate a connection between cognitions (i.e., regulation, attention, memory, and information processing) and emotions (i.e., empathy).

Many of the studies reviewed above involving a relationship between cognition and emotion are limited to a population that has matured developmentally beyond infancy. Although the capacity for self-regulation, control, and empathy develops rapidly throughout early childhood, during infancy these processes are limited, at best. Regardless of these measurement restrictions, precursors to empathy such as imitation and EC can be used. Additionally, attention, information processing and memory can be measured in infancy via visual habituation and novelty preference methods through the use of physiological and behavioral markers (HR and looking time; see Infant Cognitive Processing below for more information). Because these markers can be measured early in life, connections can be made between cognitions and emotions as early as infancy. The current literature is sparse, however, regarding the cognitive underpinnings of empathy in such a young population. As a result, the present study aims to address this issue.

Infant Cognitive Processing

Visual Information Processing

Similar measurement issues, such as the inability of the infant to verbally communicate, arise in infant cognitive research as appear in the infant socioemotional research discussed above. For example, in adulthood information processing speed can be measured through reaction times and memory recall (e.g., Luciano et al., 2001). In infancy, however, the lack of verbal and motor skills constricts measurement options and challenges researchers to find alternative ways to examine these processes. Visual information processing (VIP) has been used in the infant literature for decades and has been valuable in predicting later cognitive and intellectual functioning, such as encoding, storage, and retrieval in older children and adults (Courage, Reynolds, & Richards, 2006). VIP is typically assessed through infant habituation to a stimulus and novelty preference (see below for detail) and measured through infant looking (both look duration and number of looks to a stimulus). In infancy, shorter look durations and fewer looks are indicative of faster, more efficient information processing as well as a more mature forms of attention (Colombo, Shaddy, Richman, Maikranz, & Blaga, 2004; Courage et al., 2006). Shorter and fewer looks also correlate with higher performance on cognitive measures later in childhood (Courage et al., 2006) including language outcomes (Colombo, 1993). Longer looks are thought to indicate that infants need more time to "familiarize" with (i.e., encode) the stimulus to show recognition, as look duration has been negatively correlated with recognition performance (Colombo, Mitchell, & Horowitz, 1988; Colombo et al., 2001).

For the first 6 to 9 months of life, look durations tend to decrease over time as the child habituates faster to the new stimulus. This decline indicates an improvement in processing efficiency (Colombo et al., 2001; Colombo, Shaddy, et al., 2004; Courage et al., 2006). After this age, look durations tend to plateau and even increase slightly, implying an increase in endogenous, or voluntary, controlled attention at these older ages, potentially due to more developed frontal cortices. After 6-9 months, the infant begins to demonstrate stronger cognitive skills and increased resistance to distraction and the development of endogenous attention (Colombo, Shaddy, et al., 2004; Courage et al., 2006). Colombo and Mitchell (1990) suggest that this habituation paradigm and these look durations are the strongest indicators of developmental attentional abilities and individual differences in cognitive development.

Novelty preference. Novelty preference (NP) is a measure used in infancy for recognition memory and encoding; typically it immediately follows the VIP habituation procedure (Colombo, et al., 2001). NP consists of a novel stimulus appearing simultaneously with the habituated VIP stimulus and is also measured by duration and number of looks to the novel stimulus. Higher NP (longer looks to the novel stimulus, as opposed to the previously habituated stimulus) is indicated by a novelty quotient of greater than or equal to .55. Infants who looked at the stimulus for more than 55% of the 10 total seconds of the trial (a standard time frame for this measure; Colombo, et al., 2001) were considered to have recognized the familiar stimulus (from the VIP trial), whereas those looking at the novel stimulus less than 55% of the trial were not (Colombo, et al., 2001). Greater that 55% indicates that the initial information was encoded and stored in the infant's memory and is associated with better cognitive performance, including higher language production in toddlerhood (Colombo, Shaddy, et al., 2004). This dichotomous variable was used in the present study as opposed to a continuous one based on previous work done by Colombo and others (e.g. Colombo 2001, Fagan, et al 1986) in which this value was representative of the average performance of the infants.

Heart rate-derived attention. The relationship between information processing and attention can be measured through HR during looking paradigms such as those used for VIP (e.g, Reynolds & Richards, 2008). Looks toward the stimulus can be separated into three distinct phases of attention defined by the pattern of HR (acceleration/deceleration) that typically occurs during visual fixation, a period of time in which the infant is looking at the stimulus for more than two consecutive seconds and does not look away for more than one second at a time. These HR-defined phases of attention include orienting (OR), sustained attention (SA), and attention termination (AT; Richards, 2003); all are measured in beats-per-minute (BPM). OR is defined by a period of time in which the infant is looking at the stimulus but not yet encoding the information and is indicated by a higher-than-baseline HR. OR is thought to indicate an initial engagement with the stimulus and a latency to begin encoding the information (Colombo et al., 2010; Colombo, Shaddy, et al., 2004). SA is indicated by HR deceleration below baseline and implies optimal information processing. Infants demonstrate better recognition of information encoded during SA (Colombo, Shaddy, et al., 2004; Richards, 2003) and are more resistant to distraction (Lansink, Mintz, & Richards, 2000). Finally, AT is indicated by a final increase in BPM above baseline following SA. AT occurs while the infant is still visually fixated to the stimulus, however, is not thought to be encoding information. This is typically seen as disengagement (Colombo et al., 2001). Looking time does not directly reflect attention, therefore the percentage of time spent in these three phases was used to estimate the infants' attention to the stimulus (Courage et al., 2006).

Over the course of the first year of life, the percentage of time spent in each of these phases changes due to developments in attentional abilities. For example, Colombo, Shaddy, et al. (2004) describe the developmental tract of percentage of time spent in SA as decreasing from the middle to the end of the first year of life and that this decrease is likely due to improvements in the efficiency of information encoding. During this same time frame, the percentage of time spent in OR tends to increase and the percentage spent in AT decreases. The increase in OR is likely a result of the decrease in SA, however the decrease in AT is thought to reflect a growth in the infants' ability to inhibit looking or voluntarily disengage attention after encoding. In sum, the expected pattern of attentional phases over the first year of life are an increase in percentages of OR, and decreasing percentages of SA and AT (Colombo, Kannass, et al., 2004; Colombo, Shaddy, et al., 2004).

Present Study

To briefly summarize; empathy is an important factor in socioemotional development, due to its behavioral outcomes such as prosocial behaviors (Eisenberg & Miller, 1987). It can be most holistically defined in both cognitive and emotional terms and is thought to incorporate three major aspects: affect sharing, perspective taking, and self-other awareness, or theory of mind (Feshbach, 1978). The study of empathy, however, is lacking in early ages, such as infancy. This is due in part to the difficulties in studying such a young population with underdeveloped physical, cognitive, and emotional systems. Thus a different construct, perhaps a precursor to empathy, can be examined in infancy. Imitation is the most basic form of empathy (Meltzoff, 2011; Sagi & Hoffman, 1976) and can be observed in infants as young as only a few hours old (Martin & Clark, 1982). Emotional contagion is a form of affect imitation or sharing and is thought to be a building block in the process of forming mature empathy (Geangu et al., 2010). Although not beneficial in adulthood, EC in infancy is predictive of later empathic responding (Ungerer et al., 1990).

Empathy requires not only emotional reactions, but cognitive processes as well (Feshbach, 1978). These cognitions include constructs such as perspective taking, theory of mind, effortful control, information processing, memory, and attention (e.g., Braaten & Rosén, 2000; Eisenberg & Fabes, 1992; Eisenberg et al., 1994; Eisenberg et al., 1996; Guthrie et al., 1997; Rothbart et al., 1994). For example, later in childhood, individual differences in attentional control correlate with empathic responding, perspective taking and self-regulation of emotions (e.g., Braaten & Rosén, 2000).

Though these cognitive-emotional connections can be observed easily in childhood and beyond, they are more difficult to assess in infancy, if they indeed exist. Measures of the SNS and other physiological processes can act as markers for both emotional and cognitive abilities in infancy. Heart rate can be measured to assess attentional abilities, information processing, and emotional arousal (Colombo et al., 2001). Looking time can assess information processing speed and memory (Colombo, Shaddy, et al., 2004). Additionally, salivary cortisol measures the HPA axis functioning and emotional reactivity to a stressor (Davis & Granger, 2009; Ortiz & Raine, 2004). The present study aimed to assess EC in infancy through behavioral and physiological measures and to explore the potential connections between cognitions and emotions in infancy.

Because empathy has such a positive impact on social interactions, it is important to understand the processes that underlie it. If the variables involved in the development of empathy are understood, perhaps interventions can be made at very early stages in its development. Most researchers would agree that empathic responding involves cognitive, emotional and physiological components. In infancy, empathy is difficult to detect, therefore, the study of each of these aspects might help reveal the roots of empathy present in early life. There has been little emphasis on the integration of cognition and emotion in the processes that contribute to empathy in such a young population, thus this connection in infancy should be examined in order to potentially discover, even influence, predictive variables of later empathic responding. Furthermore, though it is generally agreed that physiological factors are closely integrated with emotion, empathy in infancy has rarely been examined in light of physiology.

The purpose of this study was to make this connection by identifying cognitive markers in infancy that can be linked to early empathy development. This study aimed to address the limited literature in this area by increasing our understanding of the processes that underlie empathic responding in infants. This was done through measuring behavioral (EC) responses to distress, physiological states (BS cortisol, BS HR, and HR reactivity due to stress), as well as the infants' visual habituation and NPs (indicative of information processing speed and attention) at three different time points within the first year of life.

It was hypothesized that emotional and cognitive variables would relate in each individual at each time point (i.e., 3, 6, and 9 months). More specifically, percentages of time spent in the HR-defined phases of attention, look duration to a stimulus, and NP (attention, memory, and information processing measures) would relate to duration and intensity of distress, latency to first distress response, BS cortisol levels, BS HR and HR change from pre- to during-distress simulation task at each age (3, 6, and 9 months).

The direction of the expected relationship is unclear in this young of a population. In older children and adults, it is clear that increased levels of attention and other cognitive measures are indicative of higher emotional arousal (as evidenced by increased personal distress, HR, and cortisol). As mentioned above, personal distress (or emotional contagion) in childhood and adulthood indicates poor regulatory behavior. Additionally, less arousal positively predicts helping behaviors. This indicates that the individual is aroused enough to attend to the situation but not over aroused (e.g., Braaten & Rosén, 2000). In infancy, however, this behavior is seen as a precursor to empathy since regulatory systems are not yet available for infants. Because this relationship has not yet been examined in a population so young, the direction of the relationship is unclear. If the assumption remains that EC in infancy leads to later empathic responding in childhood and adulthood as suggested above, then it is expected that moderate to high emotional arousal in infancy would correlate with positive cognitive outcomes such as information processing and attention (due to the lack of emotion regulation skills at this early age). More specifically, positive cognitive outcomes (increased time spent in the HR-defined phase of sustained attention, high levels of NP, decreased look duration and smaller number of looks) would correlate with high emotional arousal (higher HR increase, higher BS cortisol, increased intensity and duration of distress, and a shorter latency to distress).

However, it should also be noted that it is possible that three groups of emotional responders could emerge: over-responders, moderate-responders, and under-responders. It is believed that the mid-range responsive group exhibits the optimal level of benefits as evidenced by the problems associated with dysregulation (e.g., Eisenberg et al., 1994; Ungerer et al., 1990). Additionally, this pattern is seen in both the behavioral emotional literature as noted above regarding emotion regulation and control (Eisenberg et al., 1994) as well as the physiological literature regarding stress response regulation in terms of cortisol and HR (e.g., Shirtcliff et al., 2009; Zahn-Waxler et al., 1995).

It was additionally hypothesized that each of the variables mentioned above, both cognitive and emotional (i.e., distress latency, intensity, and duration, BS cortisol, BS HR, and difference in HR, as well as HR-defined attention, novelty preference, and looking time), would display continuity across time points and relate to each other over time. For example, it was expected that the intensity of distress would remain consistent or on a similar trajectory for each child from 3 to 6 months and also from 6 to 9 months and remain in the same group of responders over time (over/moderate/under).

Slightly conflicting evidence exists on the early developmental trajectory of emotional responding. Due to the ever-increasing cognitions that are developing within the first few years of life, the number of variables impacting the development of emotional responding continues to increase. For example, (Kagan, Snidman, & Arcus, 1998) demonstrate that from 4 months to 5 years of age, children show discontinuity and decline in negative emotional responding. This is likely due, in part, to the gradual increase in regulatory behaviors across development. Ursache et al. (2013) observed regulatory behaviors of negative emotions to emerge only after 15 months of age. In particular, levels of reactivity remained similar from 7 to 24 months of age; however, regulatory behaviors were not observed until 15 months and then doubled between 15 and 24 months. For the current study, it was expected that reactivity would remain consistent between 3 and 9 months of age, given the instability of regulatory behaviors at these ages.

Ultimately, this study aims to present a clearer picture of the integration of cognition and emotion in infancy, emphasizes the potential impact that information processing speed and attention have on empathy development, addresses the gap in current infant literature regarding underlying cognitive processes involved in empathy, and provides additional support for early interventions in empathy development.

CHAPTER III

METHODOLOGY

Participants

As a part of a larger study assessing maternal nutrition and cognitive and emotional development in infancy, 37 mother-infant dyads were assessed at Oklahoma State University's Developmental and Psychophysiology Laboratory at three separate time points: when the infants were 3, 6, and 9 months of age (+/- 2 weeks). All infants (14 males, 23 females) were full-term, had non-complicated deliveries, were primarily breastfed at the time of the 3-month appointment and weighed between 3 kg and 4 kg at the time of birth (*M* = 3.46).

Mothers ranged in age from 19 to 37 years (*M* = 28.3 years). Thirty-two mothers were Caucasian (86.5%). Thirty-four mothers were married (91.9%). The number of children per family ranged from 1 to 5 (*M* = 1.58). Mothers were generally highly educated, with 94.6% (*n* = 35) having at least some college education and 64.9% of those (*n* = 24) having a post graduate degree or above. Forty percent of mothers (*n* = 15) reported a yearly household income of over $60,000, 27% (*n* = 10) reported $40,000-60,000, 31.6% (*n* = 8) of mothers reported within the range of $15,000-40,000 and 8% (*n* = 3) reported income below $15,000 (1 mother did not provide income information). At the time of the 3-month appointment, 15 of the mothers (40.5%) were unemployed, 5 (13.5%) were working part-time, 16 (43.2%) were working full-time, and one other did not report employment data.

Flyers describing the study were posted on the university campus, as well as in childcare and healthcare facilities, libraries, infant clothing retailers, and other infant and maternal service organizations throughout the greater area. Additionally, a press release was issued, advertisements were posted in the local newspaper, and letters were sent to organizations with potential interest in the goals of the study. Mothers were compensated monetarily for all three appointments to help cover the costs of travel ($40 for the 3-month appointment, and $25 for the following two appointments). All participants and data were treated in accordance with the university's Institutional Review Board.

Maternal Materials and Measures

The present study was part of a larger one measuring cognitive development, nutrition, and multiple parenting variables. These maternal measures were assessed as confounding variables to the cognitive measures and as potential additional contributors to the infant's emotional responding. Except for the PANAS and maternal interference (see below) that were administered at all three appointments, each maternal measure was assessed at the 3-month appointment only.

Demographic questionnaire. A demographic questionnaire was administered at the initial 3-month appointment in order to gather general information about the mothers, infants and other immediate family members. Gathered information included gender, ages, infant birth weight, pregnancy history, maternal income levels, marital status, number of children per family, and maternal education level.

Maternal interference. Previous research has shown that maternal responsiveness affects empathy development. Therefore, maternal responsiveness and interference were assessed during the emotional responsiveness segment of this study at all three appointments. It was scored on a scale of 0 (no interference or contact with the infant) to 3 (generally disrupting or ending the session).

Adult and Adolescent Parenting Index version two (AAPI-2). The AAPI-2 (Bavolek & Keene, 2005) and its five construct scores (Expectations of Children, Empathy Towards Children's Needs, Use of Corporal Punishment as a Means of Discipline, Parent-Child Role Responsibilities, and Children's Power and Independence) were used to assess parenting risk levels of maternal attitudes. The scores on each of the five constructs are based on known behaviors of abusive parents and assess the risk of maltreatment of children. *High* scores (8 to 10) on the AAPI-2 indicate *low* parenting risk, moderate scores (4 to 7) indicate moderate to average risk, and low scores (1 to 3) indicate high parenting risk.

Symptom Checklist-90-Revised (SCL-90-R). The SCL-90-R (Derogatis, 1994) was used to evaluate a broad range of psychological issues and psychopathology symptoms and their severity. Three (Interpersonal Sensitivity, Depression, and Anxiety) of the nine total (Somatization, Obsessive-Compulsive, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism) constructs from the SCL-90 were used for the present study. Higher scores indicate more symptoms for each construct.

Parenting Styles and Dimensions Questionnaire (PSDQ). The PSDQ (Robinson, Mandleco, Olsen, & Hart, 1995) was used to assess parenting styles that may affect the child's behaviors. Through maternal self-report the PSDQ yields three different parenting styles (Permissive, Authoritarian, and Authoritative). Higher scores indicate a greater presence of each parenting style. The Permissive scale includes the following subscales: lack of follow-through, ignoring misbehavior, and self-confidence. The Authoritarian scale includes the following subscales: verbal hostility, corporal punishment, non-reasoning/punitive actions, and directiveness. Finally, the Authoritative scale includes the following subscales: warmth and involvement, reasoning/induction, democratic participation, and good natured/easy going (Winsler et al., 2005).

Parenting Stress Index Short Form (PSI-SF). The PSI-SF (Reitman, Currier, & Stickle, 2002) was also used in the present study. It is a shortened version of the original PSI and contains 36 items, yielding four scores; Parental Distress, Parent-Child Dysfunctional Interaction, Difficult Child, and a total stress score. Respondents are asked to answer by indicating their level of agreement with each item on a 5-point scale ranging from 'strongly agree' to strongly disagree'.

Positive and Negative Affect Scale (PANAS). The PANAS (Watson, Clark, & Tellegen, 1988) is a 10-item mood scale that yields two scores (a positive affect score and a negative affect score). These scales have been shown to be internally consistent and stable over a period of approximately 2 months. This was the only maternal measure that was administered at all three appointments (when the infant was 3, 6, and 9 months of age).

Infant Materials and Measures

Cognitive Measures. At all three ages, heart rate was derived from the electrocardiogram (EKG) and was recorded through two electrodes placed on the infant's chest and one placed on the infant's abdomen. All EKG signals were assessed using Biopac EKG100B amplifier software and the data were evaluated using AcqKnowledge software (Biopac, Santa Barbara, CA). For all procedures, the infant was securely placed in a stationary car seat and a 22-inch computer monitor and hidden video camera were positioned directly in front of the infant.

Visual Information Processing. An infant-controlled visual habituation task was utilized. After a short baseline period, a single static adult face (with neutral affect) appeared on the computer monitor. The stimulus remained on the screen until the infant looked away for more than 1 second. The stimulus then reappeared after 2 seconds. The infants were considered to have habituated to the stimulus when the duration of each of two consecutive looks at the stimulus equaled half the length of the mean of the two longest looks. The trial would conclude at this time. Infant looks were video recorded and coded live based on eye movements to and away from the stimulus. Number of looks toward the stimulus as well as duration of looks were recorded.

Novelty preference. Directly following visual habituation, the computer monitor displayed a novel, static adult face alongside the first as a way to assess memory. These two faces remained on the screen until the infant looked toward one or both of the stimuli for 10 seconds at 3 months or 5 seconds at 6 and 9 months. The infant's looking time toward each of the faces was recorded. NP is measured by the percentage of total looking time toward the novel stimulus. If this percentage is greater than or equal to 55% of the total looking duration, it is recorded that NP has been achieved. If the total looking time during this phase is less than 55% of the 10 seconds of stimulus presentation, NP has not been achieved (Kennedy et al., 2008).

Heart Rate-Derived Attention. Changes in infant HR were used to measure attention. The infant's HR was recorded during the habituation phase of the visual information processing segment. The EKG data were digitized, stored and coded for each individual HR-defined phase of attention within a look toward the stimulus deriving a percentage of time that the infant spent in each of the attentional phases. Orienting (OR) is ideally the first occurring of the attentional phases and is indicated by visual fixation and higher-than-baseline BPM before a drop below baseline. Baseline is measured for each infant individually as the average BPM over a two-minute period before the stimulus is presented. Sustained attention (SA) is indicated by a decrease in BPM below baseline for at least five beats and also accompanied by visual fixation. Finally attention termination (AT) is indicated by an increase in BPM above baseline, also during visual fixation but after a SA period. If the infant looked away from the stimulus for 1 second or less, it was considered a continuous look and coded as such.

Measures of Emotional Responsiveness. In order to elicit an EC response in infants, a recording of infant cries supplied by Dr. Nancy Eisenberg (Arizona State University) was used. The tape consisted of five minutes of a similar-aged infant's distress cry and was played through two speakers positioned directly in front of the infant. The infants were video recorded during this time and the videos were coded at a later time.

Behavioral Measures. During the recorded cries, each infant's BS state, latency to first distress response, intensity and duration of distress were assessed. The coding system was derived from the Laboratory Temperament Assessment Battery (LAB-TAB; Goldsmith & Rothbart, 1996) emotion coding procedures. Baseline state was rated on a scale ranging from 1 to 5 (1 = tired/drowsy, 3 = alert/active, 5 = crying). Intensity of distress was rated on a scale ranging from 0 to 5 (0 = no facial region shows codeable fear/distress movement, 3 = an appearance change occurs in all three facial regions or there is strong facial distress, 5 = infant is crying and flailing arms and/or legs or other strong protest). Distress coding was segmented into 20-second epochs.

In addition to the video recording, information was gathered regarding the infant's general emotional state throughout the appointment (e.g., if the infant was fussy, calm, sleepy, etc.), if the infant cried in response to the recorded cries, if the mother used any soothing techniques during the segment and if the infant seemed uncomfortable with being placed in the car seat.

Heart rate. As a physiological assessment of infant response to the recorded cries, infant HR was measured at all three time-points (3, 6, and 9 months of age). The EKG data were collected, signals were assessed, and the data were manually edited for artifact. The average change in HR of infants was measured from pre- to during-task.

Cortisol. At the 6- and 9-month visits only, saliva was acquired to assess basal cortisol levels using a long swab designed for children under 6 years old to chew or suck on. Note that the current study terms the cortisol used as "basal" or "baseline", however, it is likely not true baseline, or trait, cortisol. The samples in the current study were taken shortly after the arrival of the mother and child to the appointment. True basal, or trait, levels are typically sampled shortly after waking in the mornings and for multiple days in a row. There is likely to be some interference in the current samples of cortisol as the infants were likely reacting to the new environment and responding to their mother's reactions to the new situation (possibly an anxious reaction). Thus the "baseline" levels assessed in this study are not necessarily true baseline, but as close to baseline as was logistically possible.

A small drink of water was given to the infant approximately two minutes before collection to minimize interference from food, beverages or breast milk, as those can affect the measurement of cortisol. When collecting saliva samples, experimenters were careful to not handle the end of the swab that went in the infant's mouth, and the end that was touched by the experimenters was cut off and thrown away. This was done in order to minimize any potential for additional outside contaminants in the sample. All samples were collected using kits from Salimetrics (State College, PA).

Following saliva collection, the samples were promptly stored at -20°C until assayed for cortisol at Oklahoma State University using equipment from Salimetrics (State College, PA). Inter-assay variation (CV) was computed for the mean of duplicate assays. Values are reported in units per milliliter (u/mL).

Procedure

The mother-infant dyads visited the Developmental and Psychophysiology Laboratory at Oklahoma State University when the infant was 3, 6, and 9 months of age. The infant was placed in a stationary car seat directly facing a 22-inch computer monitor and hidden video camera. Two HR recording leads were placed onto the infant's chest and one on the infant's abdomen. For the length of the procedure, the mother remained in the room and the infant was video recorded.

Shortly upon arrival, salivary cortisol samples were taken. The attention, visual habituation, and NP trials occurred simultaneously in which HR and looking time were measured. Following these segments, the EC data were collected. A 2-minute baseline period began during which the baseline emotional state was assessed. During this time, either the mother or the experimenter quietly played or talked with the infant to engage, but not over-arouse, the infant. Once the trial began, the mother was asked to stand behind the infant, out of the infant's line of sight. Following the initial baseline period, the 5-minute audio clip was played. The procedure was aborted if the mother requested it to stop at any point or if the infant cried for 30 consecutive seconds or more. Both behavioral and HR data were collected during this segment. At a convenient time during the appointment, the mother completed the demographic questionnaire and other parenting assessments.

CHAPTER IV

FINDINGS

Descriptive Statistics

Descriptive statistics for all cognitive and emotional variables are reported in Tables 1 and 2. It should be noted that the EC procedure was aborted for some infants due to the mother's request (*n* = 2 at 9 months) or the experimenter's decision (*n* = 1 at 3 months; *n* = 3 at 6 months; *n* = 3 at 9 months) because of excessive fussiness or crying (measured by 30 or more consecutive seconds of crying). Other missing data for the EC paradigm came from the inability to code the video recorded data (*n* = 7 at 3 months, *n* = 3 at 6 months, and *n* = 9 at 9 months). Additionally, some infants were missing HR data due to either experimenter error (*n* = 7 at 3 months BS; *n* = 4 at 3 months during cries; *n* = 1 at 6 months BS) or excessive artifact from crying or movement (*n* = 2 at 3 months BS; *n* = 2 at 3 months during cries; *n* = 1 at 6 months BS; *n* = 5 at 6 months during cries). Both data points were needed to calculate the HR difference scores; therefore, if any infant was missing one of the two required data points, the HR difference was not calculated (*n* = 10 at 3 months; *n* = 7 at 6 months; *n* = 5 at 9 months). Missing data for cortisol were due to insufficient amounts of saliva for proper assays (*n* = 4 for 6 months; *n* = 11 for 9 months).

HR-derived attention was missing data for excessive fussiness (*n* = 1 at 3 months; *n* = 1 at 6 months). Visual habituation was missing two data points (*n* = 1 at 3 months for excessive crying, and *n* = 1 at 6 months because the infant would not look at the stimulus). Finally, NP was missing multiple data points for excessive fussiness (*n* = 2 at 3 months; *n* = 1 at 6 months), computer malfunction (*n* = 2 at 3 months; *n* = 1 at 6 months), and sleeping (*n* = 1 at 3 months). Three infants did not return to their 9-month appointment. Finally, outliers were removed from all variables if the data point fell outside 3 standard deviations from the mean (*n* = 1 for latency to distress at 3 months, *n* = 2 for latency to distress at 6 months, *n* = 2 for latency to distress at 9 months, *n* = 1 for Diff HR at 6 months, *n* = 1 for BS cortisol at 6 months, *n* = 3 for average look duration at 3 months, *n* = 2 for total look duration at 3 months, *n* = 1 for average look duration at 6 months, and *n* = 1 for total look duration at 9 months). Due to the amount of missing data and the relatively small sample size, cases were deleted pairwise for any analyses involving more than one variable and the *n* varies for each analysis conducted.

Hypothesis 1

The first purpose of the present study was to examine how cognitive measures of attention, information processing, and memory would be correlated with and/or able to predict EC as measured by behavioral distress, HR, and cortisol. This relationship was analyzed only within each age (e.g., 3-month cognitive variables against 3-month emotional variables, etc.).

To test this hypothesis, correlations were computed to assess the relationships between each of the cognitive and emotional variables within each age group. For hypothesis 1, the total number of correlations computed was 412, with values ranging from *r* = .003 to *r* = .941 (though many of the significant correlations were trivial. For example, the correlation between %OR and %SA at 6 months was *r* = .941 and is trivial because the variables are dependent and contribute to the same total percentage). No significant correlations between cognitive and emotional variables were found at 3 months. At 6 months, BS cortisol was negatively correlated with %AT (*r* = -.412, *p* = .021, *n* = 31). At 9 months, latency to first distress was correlated positively with the percentage of time spent in the HR-defined phase of attention termination (%AT; r = .462, p = .018, n = 26) and negatively with %SA (r = -.380, p = .055, n = 26).

Independent samples t tests were conducted at alpha levels of .05 to test for differences between the two NP groups (≥ .55, and < .55; see Novelty Preference section in literature review for more information) and each of the emotional variables. The effect sizes of many of the analyses were not large; with only a few exceptions, all were below η^2 = .40. At 3 months, a marginally significant difference was found for duration of distress, with the infants exhibiting a NP (n =8, M = 119.13 sec) having a shorter average duration of distress than those without a NP (n = 24, M = 178.0 sec), t (25) = 1.878, p = .072, η^2 = .124. No other significant differences were found for NP groups.

Observation Oriented Modeling (Grice, 2011) was also used to examine the relationships between the 3, 6, and 9 month cognitive measures and the 3, 6, and 9 month emotional measures. OOM is a novel data analysis technique in which the goal is to identify unique and meaningful patterns within the observations themselves, rather than to estimate abstract population parameters from sample statistics such as means, variances, and correlations. Aggregate statistics are thus avoided and emphasis is instead placed on understanding all of the individuals in the study. Moreover, because OOM is similar to non-parametric techniques, very few assumptions are involved in the analyses, a fact which eliminates the influence of outliers and permits the exploration of non-linear patterns between measures.

OOM analyses are based on units (like values on a scale) that must be populated by a sufficient number of observations in order for patterns to be confidently identified. In the present study, most of the cognitive and emotional variables were trichotomized in order to explore possible non-linear relationships while sufficiently populating each unit of observation. With trichotomization the ranges of values included in each unit of observation differed for each variable and each age group; and with 37 total participants, approximately 12 children were included in each unit. For example, latency to distress scores could range from 0 to 500 seconds. At 3 months the actual scores ranged from 0 to 78 seconds. Therefore, to have groups as equal groups as possible, the observed values were grouped into three units: 0 seconds for group 1 (12 observations), 1 to 22 seconds for group 2 (8 observations), and 23 to78 seconds for group 3 (8 observations). Two variables were dichotomized (change in look duration and NP) due to the nature of the variables. Change in look duration was divided into an 'increase' and a 'decrease' group, and NP was split at .55 (discussed above).

Hypothesis 1 states that the cognitive and emotional variables are related, and the multi-unit frequency histogram (or multigram) based on contrived data for 3-month latency to distress and %AT in Figure 1 shows the type of pattern expected. As can be seen, most of the children in the first (lowest) unit of latency to distress are also observed in the first (lowest) unit of %AT, while most of the children in the third (highest) unit of latency to distress are also observed in the third (highest) unit of %AT. Based on the overall linear-like pattern in these contrived observations, OOM classifies each child's observations accordingly and tallies the number correctly classified. The dark bars in the multigram in Figure 1 indicate the correctly classified observations, while the hatched bars indicate incorrectly classified observations. The number of correctly classified observations is reported as the Percent Correct Classification (PCC) index and is accompanied by a probability statistic referred to as a chance value, or *c*-value, derived from a randomization test (see Grice, 2011, p. 57-59). The PCC index for the contrived data in Figure 1 is 90% while the *c*-value is less than .001. High PCC values and low *c*-values thus indicate robust patterns within the observations.

Multigram, PCC indices, and c-values were examined for each pair of the emotional and cognitive variables for each of the three ages. Figure 2 shows the results for those analyses that yielded PCC indices greater than 50% and *c*-values less than .25. As can be seen in panel 2.1 of

Figure 2, at 3 months of age the lowest %AT group of infants could not be differentiated between groups of BS HR, however, the infants with mid- and low-range BS HR also showed higher percentages of AT (PCC = 51.9%, *c* = .25). NP was dichotomized *a priori* (≥ .55, and < .55) resulting in unequal numbers of infants in each group (at 3 months, those exhibiting a NP, *n* = 8; those not exhibiting a NP, *n* = 24). However, at 3 months, the majority of those exhibiting a NP also had a short latency to distress at 3 months (PCC = 72.0%, *c* = .23). The low NP group showed no differentiation (see panel 2.2 for the multigram).

At 6 months of age, infants with higher %AT also showed low- to mid-range BS cortisol levels, and those with high BS cortisol levels also tended to have a lower %AT (PCC = 51.6%, *c* = .19; see panel 2.3). Also at 6 months, look duration change from 3 to 6 months (increase or decrease) showed no differentiation except that the infants that increased in look duration (*n* = 7) all showed higher levels of intensity of distress at 6 months (PCC = 74.3%, *c* = .07; see panel 2.4).

Finally, at 9 months of age, the majority of infants with a high %AT also showed a longer latency to distress, and those with mid-range %AT also showed a short latency to distress (PCC = 53.9%, *c* =.20). The lowest %AT group showed no differences (see panel 2.5). Additionally, the infants with low- to mid-range numbers of looks at 9 months also had mid- to high-range intensity of distress at 9 months. Those with more looks could not be differentiated with regard to intensity (PCC = 51.5%, *c* = .18; see panel 2.6).

Changes in the cognitive and emotional variables over time (3, 6, and 9 months) were also compared in OOM. Panel 3.1 of Figure 3, for example, shows a child's contrived data for the %AT and Latency variables in which both decrease from 3 to 6 months and then again from 6 to 9 months. The blue line represents the relative magnitudes for %AT, and the red line represents the relative magnitudes for Latency. Panel 3.2 shows contrived data for another child in which %AT and Latency decrease from 3 to 6 months and then increase from 6 to 9 months. In both of these hypothetical examples, the patterns of relative change between the cognitive and emotional variables match perfectly. Panel 3.3 shows data for a hypothetical child in which the changes over time for %AT and Latency do not match. In the OOM analysis, the individual pattern for each child is examined, and pairwise matches (3 vs. 6, 3 vs. 9, and 6 vs. 9 months) are tallied for all children and reported as the PCC index. A randomization test is also used to generate a *c*-value.

Each of the cognitive variables (HR-defined phases of attention, NP, number of looks, and average looking time) was compared to each of the emotional variables (latency to distress, duration, and intensity of distress, BS cortisol levels, BS HR, and HR change from pre- to during-task). Of the 42 analyses, five yielded PCC values of at least 50% and *c*-values less than .25. As seen in panel 4.1 of Figure 4, changes in %AT over time matched changes in latency to distress (PCC = 50.8%, c = .10), and the majority of individual patterns demonstrated a decrease in both %AT and latency to distress, either from 3 to 6 months, 6 to 9 months, or 3 to 9 months. Changes in number of looks also matched latency to distress over time (PCC = 50.8%, c = .08), with the majority again demonstrating a decrease over time in both number of looks and latency to distress from 3 to 6 months, 6 to 9 months, or 3 to 9 months (see panel 4.2). Changes in average look duration matched changes in both intensity of distress (PCC = 56.8%, c = .02) and latency to distress (PCC = 52.5%, c = .17) with the majority demonstrating a decrease in average look duration, latency to distress, and intensity of distress over time from either 3 to 6 months, 6 to 9 months, or 3 to 9 months (see panels 4.3 and 4.4 respectively).

Hypothesis 2

The second hypothesis states that each of the emotional variables and each of the cognitive variables will display continuity across time points and correlate with each other over time. For example, it was expected that the intensity of distress will remain consistent or on a similar trajectory for each child from 3 to 6 months and also from 6 to 9 months.

To test this hypothesis, a correlation matrix was run to examine the predictive values within each variable across time. A total of 160 correlations for emotional variables and 94 correlations for cognitive variables were run for hypothesis 2. Values ranged from r = .005 to r = .998, though many of the correlations were trivial as discussed above. The positive correlation between intensity from 6 to 9 months was significant (r = .342, p = .041, n = 36). The difference in HR over the EC paradigm showed consistency from 6 to 9 months (r = .449, p = .021, n = 26). No other significant correlations were found in SPSS for the developmental trajectory of the emotional variables over time. An OOM analysis revealed consistency between BS HR from 3 to 6 months (PCC = 57.6%, c = .07; see panel 5.1 of Figure 5 for multigram) revealing that most of the infants with mid-range BS HR at 3 remained in the mid-range BS HR at 6, and from 6 to 9 months (PCC = 60.0%, c = .02) revealing that most of the infants with low- and mid-range BS HR at 6 months remained in those groups at 9 months (see panel 5.2 of Figure 5 for multigram). No other consistencies in the emotional variables were found using OOM.

Paired samples t tests were run in order to examine if any mean differences in time points could be seen for each emotional variable. Duration of distress showed a significant increase from 3 to 6 months; t (29) = -2.630, p = .014, η^2 = .193, and a significant decrease from 6 to 9 months, t (35) = 2.313, p = .027, η^2 = .133. Difference in HR showed a significant increase from 3 to 9 months and from 6 to 9 months; t (23) = -2.067, p = .050, η^2 = .157; t (25) = -41.61, p < .001, η^2 = .986, respectively. Finally, BS HR showed a significant decrease from 3 to 6 months, 6 to 9 months, and 3 to 9 months; t (25) = 4.76, p < .001. η^2 = .475; t (29) = 3.51, p = .001, η^2 = .298; and t (23) = 6.85, p < .001, η^2 = .671, respectively. No significant differences were found for cortisol from 6 to 9 months.

Developmental Changes of Cognitive Variables. Paired samples *t* tests were run to examine the developmental changes in HR-defined attentional phases, looking time, and NP from 3 to 9 months. A significant increase in %OR from 3 to 9 months, t (32) = -2.725, p = .01, η^2 = .188; a slight, non-significant decrease in %SA from 3 to 9 months, t (32) = 1.241, p = .224, η^2 = .046; and a significant decrease in %AT from both 3 to 6 months, t (34) = 3.092, p = .004, η^2 = .219; and from 3 to 9 months, t (32) = 2.937, p = .006, η^2 = .212.

A significant decrease in look duration was found from both 3 to 6 months, t (34) = 3.854, $p < .001$, η^2 = .317; and from 3 to 9 months, t (32) = 4.093, $p < .001$, η^2 = .344; and a non-significant difference, or plateau, from 6 to 9 months, t (32) = 1.43, p = .162, η^2 = .060. Finally, a significant increase in NP was found from 3 to 6 months, t (30) = -2.834, p = .008, η^2 = .211. However, NP plateaued from 6 to 9 months, t (32) = 1.437, p = .160, η^2 = .061.

Additional Findings

Gender Differences. Independent samples *t* tests were run at alpha levels of .05 to test for differences between genders on both emotional response measures (latency to distress, intensity, and duration of distress, HR, and cortisol) as well as on cognitive measures (HR, NP, and looking time). Regarding the emotional response variables, significant differences were found between male and female infants on distress intensity at 3 months of age, with females (n = 19, M = 30.32) exhibiting higher levels of total distress intensity than males (n = 11, M = 18.09), t (28) = 2.199, p = .036, η^2 = .147, and BS distress with females (n = 19, M = 2.95) exhibiting higher BS distress than males (n = 11, M = 2.09), t (22.45) = 3.248, p = .004, η^2 = .320. Additionally, BS HR at 6 months showed significant differences with females (n = 21, M = 144.13) exhibiting higher levels of BS HR than males (n = 13, M = 134.91), t (32) = 2.07, p = .047, η^2 = .118. No other significant differences were found for emotional response variables and gender.

For the cognitive variables, the percentage of time spent in the HR-defined phase of attention orienting (%OR) at 9 months showed significant differences with males (n = 13, M = .553) spending more time in OR than females (n = 21, M = .313), t (32) = -2.75, p = .01, η^2 = .191. Finally, the percentage of time spent in the HR-defined phase of sustained attention (%SA) at 9 months showed significant gender differences with females (n = 21, M = .584) spending more time in SA than males (n = 13, M = .364), t (32) = 2.88, p = .007, η^2 = .206. No other significant differences were found for cognitive variables and gender.

Exploratory Analyses. The present study was part of a larger study assessing cognitive development, nutrition, and multiple parenting variables. Exploratory analyses were run to determine if any parenting variables (parenting style, attitudes, psychological problems, or stress) contributed to the emotional responding variables. The first variable used was the Adult and Adolescent Parenting Index version two (AAPI-2;) and its five construct scores (Expectations of Children, Empathy Towards Children's Needs, Use of Corporal Punishment as a Means of Discipline, Parent-Child Role Responsibilities, and Children's Power and Independence) to assess parenting risk on each of the five constructs. A high score on the AAPI-2 indicates low parenting risk, whereas a low score indicates high parenting risk.

Second, the Symptom Checklist-90-Revised (SCL-90-R; Derogatis, 1994), evaluating a broad range of psychological issues and psychopathology symptoms, was used. Three of the nine constructs from the SCL-90 were used for these analyses (Interpersonal Sensitivity, Depression, and Anxiety). Higher scores indicate more symptoms for each construct. Next, the Parenting Styles and Dimensions Questionnaire (PSDQ; Robinson, Mandleco, Olsen, & Hart, 1995) was used that determines three different parenting styles (Permissive, Authoritarian, and Authoritative). Higher scores indicate a greater presence of each parenting style. The Parenting Stress Index Short Form (PSI-SF; Reitman, Currier, & Stickle, 2002) was also used yielding four scores (Parental Distress, Parent-Child Dysfunctional Interaction, Difficult Child, and a total stress score). The Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988) was used as well. The PANAS yields two scores (a positive affect score and a negative affect score) and was administered at all three appointments (when the infant was 3, 6, and 9 months of age). Finally, maternal demographics were assessed including maternal income and number of children per family. Only these two factors were assessed due to relatively little variability in other demographic variables including maternal education (relatively high average on maternal education with most mothers having at least a college degree) or marital status (the large majority were married).

Correlations were run to assess the relationship between infant emotional response variables and maternal variables. The significant correlations were then added to multiple regression equations to determine if the combination of multiple maternal measures could account for the variance found in the emotional responding variables. The variables were added to regression equations based on theory and similarity of variables. For example, a regression equation would be tested between significant correlations of empathy towards children's needs and interpersonal sensitivity, but not between empathy towards children's needs and maternal income. The following analyses will be organized by emotional response variables.

First, BS HR at 3 months was negatively correlated with Permissive parenting (PSDQ: $r = -.461$, $p = .018$), and at 9 months positively with both Empathy toward Children's Needs (AAPI-2; $r = .462$, $p = .008$) and Parent-Child Role Responsibilities (AAPI-2; $r = .395$, $p = .025$). Difference in HR was negatively correlated at 3 months with both the total PSI score ($r = -.563$, $p = .002$) and Parental Distress (PSI; $r = -.426$, $p = .027$). No linear regression equations were significant for BS HR or difference in HR.

Cortisol levels at 6 months correlated negatively with Parent-Child Dysfunctional Interaction (PSI; $r = -.381$, $p = .035$). Cortisol levels at 9 months correlated negatively with

Parental Distress (PSI; $r = -.470$, $p = .015$). Additionally, intensity of distress at 6 months was negatively correlated with Negative Affect at 6 months (PANAS; $r = -.353$, $p = .035$). At 9 months, intensity of distress was negatively correlated with Permissive parenting (PSDQ; $r = -.387$, $p = .022$). No linear regression equations were significant for cortisol or intensity of distress.

Duration of distress at 6 months was negatively correlated with Interpersonal Sensitivity (SCL-90; $r = -.416$, $p = .01$). At 9 months, duration of distress was negatively correlated with Permissive parenting (PSDQ; $r = -.544$, $p = .001$), Authoritarian parenting (PSDQ; $r = -.420$, $p = .012$), and Parental Distress (PSI; $r = -.381$, $p = .022$). A multiple linear regression analysis revealed that the linear combination of Parental Distress and Authoritarian parenting was significant, $F(2, 32) = 6.87$, $p < .003$, $R = .548$, and accounted for 30% of the variance in duration at 9 months ($R^2 = .30$).

Finally, latency to first distress response at 3 months was positively correlated with Expectations of Children (AAPI-2; $r = .407$, $p = .034$). At 9 months, latency to distress was positively correlated with Depression (SCL-90; $r = .410$, $p = .037$), Permissive parenting (PSDQ; $r = .485$, $p = .014$), Authoritarian parenting (PSDQ; $r = .425$, $p = .034$), Parent-Child Dysfunctional Interaction (PSI; $r = .629$, $p = .001$), and Parent-Child Role Responsibilities (AAPI-2; $r = .392$, $p = .047$). A multiple linear regression analysis revealed that the linear combination of Parent-Child Role Responsibilities and Parent-Child Dysfunctional Interaction was significant, $F(2, 23) = 12.91$, $p < .001$, $R = .727$, and accounted for 53% of the variance in latency to distress at 9 months ($R^2 = .529$). An additional multiple linear regression analysis revealed that the linear combination of Depression and Authoritarian parenting was significant, $F(2, 22) = 4.892$, $p < .017$, $R = .555$, and accounted for 31% of the variance in latency to distress at 9 months ($R^2 = .308$).

CHAPTER V

CONCLUSION

Hypothesis 1

Hypothesis 1 states that the cognitive measures of attention, information processing, and memory would be correlated and/or able to predict the emotional measures of distress. Very few relationships were found at 3 or 6 months of age, but those that were are interesting. At 3 months, infants with a high %AT also tended to have lower BS HR. In childhood, a lower BS HR is typically associated with higher aggression and antisocial behaviors (e.g., Zahn-Waxler, et al., 1995). Additionally, the research on the implications of time spent in AT is limited, and thus the outcomes are not as clear as those of SA. However, AT indicates a period of disengagement in which the infant remains visually fixated on the stimulus after the conclusion of meaningful information processing (which occurs during SA; Colombo, et al., 2010). Less time spent in AT predicts subsequent recognition (i.e., NP, as does more time spent in SA; Colombo, et al., 2010). In the present study, %AT also showed a pattern with BS cortisol at 6 months of age in which infants demonstrating a higher %AT also showed lower levels of cortisol. This result was demonstrated with both OOM analyses and correlational analyses (in which higher cortisol levels correlated with lower %AT). Recall that BS cortisol in the current sample is not necessarily the same measurement of BS cortisol as many of the studies mentioned, as it was not assessed upon waking, but instead, shortly after the infant arrived at the appointment. Thus the infant's reaction to the new environment and the infant's response to the mother's reaction in the new environment could interfere with the cortisol samples in the present study. However, the current cortisol samples will be considered similar to BS cortisol. Similar to BS HR, low levels of BS cortisol are typically related to higher levels of aggression and antisocial behaviors in older children and adults (e.g., Snoek, Van Goozen, Matthys, Buitelaar, & Van Engeland, 2004). Therefore, these relationships suggest that negative indicators of empathy (as measured by EC through low BS HR at 3 months and low BS cortisol at 6 months) are related to more negative cognitive variables (as measured by more time spent in the disengagement phase). It should be noted however that these relationships (between %AT and BS HR and between %AT and BS cortisol) are not very strong and further research is necessary to fully understand them.

Also at 3 months, infants exhibiting a NP showed a shorter latency to distress. NP indicates the encoding of information into short-term memory and a short latency to distress could indicate a higher sensitivity to emotional situations. The relationship then between NP and shorter latency to distress relates to the finding discussed above in which %AT and BS HR are negatively related and suggests that positive cognitive behaviors are related to positive (i.e., more sensitive) emotional behaviors. This could help support the hypothesis that cognitions and emotions are related and are detectable as early as 3 months. This finding is relatively weak, however, therefore replication is needed to assess this potential further.

The conclusion that EC and cognitions are related is further supported in the present study through the finding that, at 9 months, a shorter latency to distress was related to a higher %SA and a lower %AT. The finding that infants with a high %AT also showed a longer latency to distress was evident in both the correlational analyses and those run with OOM. Additionally through OOM, the individual patterns seen over time in %AT at 3, 6, and 9 months of age matched the individual patterns seen in latency to distress at 3, 6, and 9 months of age. The majority of patterns that matched showed both variables decreasing over time. These patterns likely indicate normative development and are not necessarily related to one another. Additional research is necessary to investigate these relationships further as they are not very strong in the present study.

A short latency to distress indicates that the infant responds to the emotionally distressing situation relatively quickly. This could possibly indicate a higher sensitivity to emotional situations. SA is indicative of optimal information processing and infants during this phase of attention are processing information, show greater recognition of the information later (e.g., Colombo, Richman, Shaddy, Greenhoot, & Maikranz, 2001; Frick & Richards, 2001; Richards, 1997a, 2003), and are more resistant to distractions (e.g., Lansink, Mintz, & Richards, 2002; Richards & Lansink, 1998). As mentioned above, AT is associated with disengagement and shorter amounts of %AT relate to faster information processing (Colombo et al., 2010). The relationship, then, between shorter latency to distress, more time spent in SA, and less time spent in AT supports the hypothesis that a higher sensitivity to distress is related to more positive cognitive abilities.

Additionally, the simultaneous decrease in %AT and latency to distress over time could indicate a progression in the development of both sensitivity to distress and control of attentional engagement. These findings are consistent with the relationship between BS HR and %AT (at 3 months of age) mentioned above in that a higher sensitivity to emotional situations is potentially related to positive cognitive outcomes also at 9 months of age. Therefore the finding linking lower %AT and higher %SA with shorter latency to distress suggests that at 9 months of age a connection can already be seen between emotion and cognition. At older ages (preschool, childhood, and adulthood), a relationship between attention and empathy is apparent (Braaten & Rosén, 2000). The finding in the present study suggests that perhaps this relationship is beginning to develop and become visible as early as 9 months of age. Such results lend support for early detection of the relationship between emotion and cognition, in particular the relationship that is seen at older ages between attention and empathy (Braaten & Rosén, 2000). Perhaps the correlations between attention and EC at 9 months of age can be seen as a precursor to the findings of Braaten and Rosén (2000) in which a relationship was found between attention and empathy measured through ADHD diagnoses and the behavioral/emotional responses to empathy-inducing anecdotes. The relationship is seen in the present study at earlier ages as shown through %AT and BS HR at 3 months and %AT and BS cortisol at 6 months. However, these are not as strong as that demonstrated at 9 months of age. This could indicate an ever increasing and developing connection between emotion and cognition that begins at least as early as 3 months of age and continues to develop into childhood.

Additional findings from the OOM analyses in the present study include a relationship between look duration and intensity of distress in which infants who increased in look duration from 3 to 6 months of age also showed a greater intensity of distress at 6 months. An increase in look duration in infancy has shown to have less than optimal cognitive outcomes (such as in language development, in preschool; Colombo, Shaddy, et al., 2004) and thus this finding could potentially support a hypothesis that an increase in look duration could predict higher levels of emotionality in infancy. However, this OOM analysis was run on a very small subsample of infants (those that increased in look duration from 3 to 6 months of age, n = 7) and replication with a larger sample is needed to fully understand the nature of this relationship. The majority of infants, however, demonstrated a significant decrease in look duration from 3 to 9 months (consistent with much of the literature; e.g., Colombo, Shaddy, et al., 2004). This decrease corresponds with a decrease in both latency to distress and distress intensity over time as well. In other words, of the participants who demonstrated a decrease in look duration, the majority also demonstrated a decrease in emotional response of latency to distress and intensity over time. A decrease in latency to distress over time could indicate a growing sensitivity to emotional situations, whereas a simultaneous decrease in intensity over time could indicate the beginnings of emotion regulation. Both sensitivity and regulation are necessary to become aware of another's emotions (sensitivity), but also to distance one's self from the situation enough to react in an others-centered manner (regulation). Perhaps these abilities are beginning to develop, can be measured, and can be predicted by cognitive variables such as look duration as early as at least 3 months of age.

The majority of infants who demonstrated a decrease over time in trials to habituation (number of looks toward the stimulus) also demonstrated a decrease in latency to distress from 3 to 9 months. Additionally, at 9 months only, the infants with fewer trials to habituation also showed greater intensity of distress. Fewer trials to habituation are thought to indicate faster or more efficient information processing, but not necessarily more accurate processing. This finding could indicate that those infants with faster processing may assess an emotional situation and respond to it more quickly (shorter latency). The response may or may not be accurate or appropriate however, due to the quick appraisal. This could lead to over- or under-responders to emotional situations due to quickly appraising the situation and assuming there is a threat when there may not be one, or vice versa, assuming there is no threat when there is. This response could be adaptive, for example, if an individual overreacts to the situation, the individual is then prepared for the possibility of a threat. On the other hand, if an individual underreacts to the situation, the individual is not attending to the situation and thus does not respond emotionally or behaviorally to the situation.

The implications of intensity of distress are somewhat contradictory. In the present study, it was found that an increase in intensity was related to both fewer trials to habituation (more efficient processing) and an increase in look duration over time (slower processing speed). This could be interpreted in multiple ways, however. The increase in intensity of distress may not have a linear relationship with cognitive outcomes. Perhaps, as is the case in the adult literature, the intensity of distress response in an emotional situation has an inverted-U pattern. For example, a small increase in intensity could assist an individual in an empathic, prosocial response by arousing the individual enough to attend to the situation, but not so much that the individual is overwhelmed and does not help. This could be the case in infancy as well regarding information processing behaviors (instead of prosocial behaviors that are not yet available in an infant's repertoire). This could be interpreted one of two ways; 1) if an infant is slightly aroused, the infant can process the events of the situation; if the infant is overaroused, the infant's focus shifts from the situation and onto relieving his own distress; or 2) if an infant has fast information processing abilities, the infant can assess the emotional situation before becoming overaroused. However, this pattern may become more apparent in a sample with more variability in emotional responding.

In summary, a relationship was demonstrated at all three ages between emotional contagion and cognitions, though the relationships were much stronger at 9 months of age. Higher %AT demonstrated relationships between longer latency to distress, lower BS HR, and lower BS cortisol levels. A long latency to distress was also related to a lower %SA and the failure to demonstrate a NP. These findings suggest the presence of a relationship between positive cognitive behaviors (more attentional control through lower %AT, more information processing through higher %SA, and memory through NP) and positive emotional behaviors (sensitivity to distress through a shorter latency to distress and implications for prosocial behaviors through high BS HR and cortisol), and vise versa, thus supporting the first hypothesis. Additionally, %AT and latency to distress decreased together over time, possibly indicating a connection between the development of sensitivity to distress and attentional control. These findings most strongly support a relationship between attentional abilities and emotional behaviors, a relationship that is demonstrated in older children (Braaten & Rosén, 2000). Also, both a decrease in look duration and fewer trials to habituation corresponded with shorter latency to distress and a decrease in intensity of distress (for look duration only) over time. This potentially indicates a relationship between faster processing speed (shorter look durations), an increase in emotional sensitivity (shorter latency to distress), and emotion regulation (lower intensity).

These findings all support the first hypothesis of the present study by suggesting that a connection (though weak at times, particularly at younger ages) between cognition and emotion can be demonstrated at very early ages. This connection is a basic requirement for empathy later in development (Eisenberg, 2007). Due to the weak nature of many of the correlations and other analyses, further research is needed to fully establish and understand the development of such a relationship.

Hypothesis 2

Hypothesis 2 states that distress, or EC, will remain consistent across time, at 3, 6, and 9 months of age. This was partially supported in the current study and demonstrated by the consistency of duration of distress, difference in HR, and BS HR.

Duration of distress increased from 3 to 6 months and then decreased again at 9 months. An increase in duration at 6 months could indicate an increasing sensitivity to distress, and the decrease that follows could potentially indicate the initial development of emotion regulation abilities. However, additional research is needed using a larger sample in order to fully understand this trend.

An additional pattern seen in the present study was the increase in difference in HR during the EC paradigm from 3 to 9 months, and both difference in HR and intensity of distress had significant positive correlations from 6 to 9 months. These results suggest that 1) over time, the infants were more physiologically aroused by the EC paradigm and 2) an infant with a strong physiological (high difference in HR) and behavioral (intensity of distress) reaction at 6 months was also likely to have a similar physiological reaction at 9 months. The decrease in duration, but increase in both HR response and intensity of distress could suggest that although the infants are still emotionally aroused by the situation, perhaps, by the age of 9 months, they begin to regulate behavioral responses to distress (the duration, but not the intensity or the physiological HR reaction).

Additionally, from 3 to 9 months of age, BS HR on average decreased and showed that most infants in the mid-range remained in the mid- to low-range across time. This could also help explain the increase in difference in HR over time. The difference in HR from BS to post-task is smaller if the BS HR is initially high. Therefore, as BS HR decreases, difference in HR will naturally increase. These continuities, though modest, could potentially be a preliminary marker of and lead to empathic responding and emotion regulation later in life.

Development of Cognitive Variables. The development of the cognitive variables measured (information processing, attention, and memory) from 3 to 9 months is consistent with the current literature. The present data show that %OR increases and %AT decreases while %SA stays relatively stable from 3 to 9 months. Very few correlations were found between ages within the cognitive variables. This indicates that the cognitive variables were not necessarily continuous overtime, however average relationships were found from age to age and were consistent with other research conducted on these age groups. Colombo et al. (2010) demonstrated a similar pattern from 4 to 8 months in which %AT decreased and %SA remained consistent (no changes were found in %OR over time, but other studies have demonstrated an increase in %OR over time; Colombo & Shaddy, 2004). Recall that SA is the phase in which most information processing occurs and HR is below baseline, whereas AT is thought to indicate a period of disengagement in which the infant is maintaining visual fixation with the stimulus but HR has increased above baseline (e.g., Richards & Casey, 1992). A decline in %AT over time is associated with better long-term cognitive outcomes (e.g., Colombo, Shaddy, et al., 2004). The stability of %SA and the decrease in %AT imply that over time, the infants are improving their information processing skills and attentional control.

Also consistent with previous literature, the current data show a decrease in look duration from 3 to 6 months, followed by a plateau to 9 months. The opposite was true for NP, demonstrating an increase from 3 to 6 months followed by a plateau to 9 months. Colombo (Colombo, Harlan, and Mitchell, 1999; Colombo et al., 2004) has also demonstrated both of these developmental trends. He has found that look duration decreases from approximately 2 to 6 months of age and then plateaus up to 1 year and that NP increases and plateaus over the first year of life. For the purpose of the present study, the importance of these similar cognitive developmental trajectories is simply that of replication and reliability of the measures used.

Additional Findings

Gender Differences. Gender differences were found in emotional responding variables of intensity of distress and BS HR. For each of these variables, females had higher levels overall, potentially indicating a higher level of emotionality. Intensity demonstrated a gender difference only at 3 months of age, whereas BS HR demonstrated this difference at both 3 and 6 months of age. This general gender difference is consistent with much of the literature (e.g., Hoffman & Levine; Sagi & Hoffman, 1976; 1976; Simner 1971). Additionally, Baron-Cohen’s Empathizing-Systemizing hypothesis (Baron-Cohen, Knickmeyer, & Belmonte, 2005) supports this finding. Empathizing is characterized by attempting to identify with and respond to another’s emotions, whereas systemizing is characterized by analyzing systems or numbers. Baron-Cohen demonstrates that females typically display higher scores on an empathizing scale and males typically display higher systemizing scores (Baron-Cohen, 2003; Baron-Cohen, Knickmeyer, & Belmonte, 2005; Wakabayashi, Baron-Cohen, & Wheelwright, 2006). The present finding suggests that this hypothesis can be seen at a very early age. Both BS HR and intensity of distress were higher in females, suggesting a potential indication in infancy of the tendency for females to display more empathizing characteristics than males.

Exploratory Analyses. Maternal variables, collected as a part of a larger study on cognitive development, nutrition, and parenting, showed many strong relationships to infant emotional responding. First, BS HR was negatively related to permissive parenting and positively to maternal empathy. As discussed in the present literature review, a low BS HR is indicative of aggression and antisocial behaviors, whereas a higher BS HR is typically indicative of empathic concern and prosocial behaviors in older children (Zahn-Waxler et al., 1995). Additionally, the subscales of the permissive parenting scale include items relating to lack of follow-through, ignoring misbehavior, and lack of self-confidence. Thus, in the present study, the negative relationship here indicates that infants with higher BS HRs (or are potentially more prone to prosocial behaviors later in life) also tend to have parents who demonstrate follow-through, self-confidence, and discipline for misbehavior (low permissive parenting scores).

Additionally, high maternal empathy scores also related to a higher BS HR in infants. This suggests that the infants already potentially prone to prosocial behaviors later in life also have parents who demonstrate empathy toward them. Perhaps, the infants with a high BS HR are predisposed from infancy to exhibit more prosocial behaviors later in life, but a combination of high BS HR and maternal displays of empathy encourage such behavior and it becomes an observationally learned response. However, longitudinal data from infancy into toddlerhood are needed in order to test this hypothesis.

Difference in HR during the EC paradigm, or physiological emotional responding, was negatively related to the parental distress subscale of the Parenting Stress Index (PSI) and to the total PSI score. A high difference in HR indicates acceleration in HR and a strong physiological reaction to the emotionally distressing situation. In older children and adults, HR acceleration typically is associated with higher personal distress and anxiety, and low levels of helping behaviors. In infancy however, there is very little research in this area. Additionally, these results were observed in the 3-month data only, an age at which the regulatory behaviors and cognitions needed to control the personal distress reaction caused by an emotionally distressing situation are still very immature. Thus HR acceleration in the current sample could indicate a stronger sensitivity to another's emotions, leading to higher empathic responding later in life given that regulatory behaviors are developed.

An additional finding of the present study is a negative relationship between intensity of distress, maternal negative affect, and permissive parenting behaviors. Infants with higher intensity of distress also tended to have mothers with lower scores on both the negative affect scale and the permissive parenting scale. This is in conjunction with the above results regarding HR acceleration. Perhaps a more intense response to an emotionally distressing event (as measured by both HR acceleration and intensity of distress) indicates a higher sensitivity to another's emotions. This sensitivity then is related to positive indicators of parenting as seen through a demonstration of follow-through, self-confidence, discipline for misbehavior (low permissive parenting scores) and less negative affect in the mother. This finding continues to support the theory that maternal interactions in infancy have a strong influence on the child's socioemotional development (Campos & Sternberg, 1981; Meltzoff, 2011).

Also demonstrated in the present study, duration of distress was negatively related to maternal interpersonal sensitivity, permissive parenting, authoritarian parenting, and the parental distress subscale of the PSI. In other words, the children with a longer duration of distress also had mothers with lower interpersonal sensitivity, permissive and/or authoritarian parenting styles, and overall distress scores. This finding also revealed a strong predictive relationship between parental distress and authoritarian parenting in particular for duration of distress.

These results can be interpreted in one of two ways. First, the negative relationship between duration of distress, permissive and authoritarian parenting behaviors, and parental distress could indicate that a longer duration of distress, or a higher sensitivity to another's distress, is related to and influenced by positive, supportive maternal behaviors. Recall that the permissive parenting scale includes subscales of lack of follow-through, ignoring misbehavior, and lack of self-confidence. The authoritarian parenting scale includes subscales of verbal hostility, corporal punishment, non-reasoning/punitive actions, and directiveness. The mother that does not demonstrate follow-through or self-confidence, is verbally hostile, and uses corporal punishment with her child is likely not creating a safe environment for the socioemotional development of their child. This could influence the development of emotional sensitivity of the child in a negative way.

The second interpretation is regarding the negative relationship between duration of distress and maternal interpersonal sensitivity. This seems counterintuitive to what was previously discussed; however a possible explanation is that a lack of interpersonal sensitivity in the mother is likely to create disengagement toward the infant. This disengagement could create a stressful environment for the infant, and negatively influence the development of emotion regulation. Also, this finding was found at 6 months of age (all other relationships with duration of distress were found at 9 months), an age in which emotion regulation is still very underdeveloped. The stress of having a disengaged, insensitive mother could lead to a dysregulation of emotional responding and thus longer durations of distress. This explanation, too, supports the importance of mother-child interactions at very young ages.

BS cortisol levels showed very few relationships with any of the cognitive variables at 6 and 9 months, however, relatively strong negative relationships were found at both ages between cortisol and two subscales of the Parenting Stress Index (PSI): parent-child dysfunctional interaction (6 months) and parental distress (9 months). In other words, infants with lower levels of BS cortisol, also tended to have mothers who scored high on both the parental distress subscale and the parent-child dysfunctional interaction subscale. This finding seems counterintuitive; the natural inclination for interpretation is that the mother's increased stress levels would create more stress, and thus more cortisol, in the infant. However, the inverse relationship found between the mother's stress and the infant's cortisol is not novel. The patterns of cortisol reactivity to stress are anything but simple and straightforward. As mentioned in the section on cortisol and emotion above, chronic stress typically results in a down regulation of the HPA axis, including BS cortisol levels (Miller et al., 2007), as the body's attempt to cope with prolonged, uncontrollable stress (Hek et al., 2013) and to prepare one's self for a stressful event. In the present sample, this can be seen through the relationship of overly stressed, and likely disengaged, mothers and the down regulation of cortisol in their child at 6 and 9 months of age.

Finally, latency to distress showed many strong relationships to maternal variables. Mother's expectations of her child, maternal depression, permissive and authoritarian parenting, parent-child dysfunctional interactions, and parent-child role responsibilities all demonstrated positive relationships with latency to distress. In other words, a shorter latency to distress (or higher sensitivity) is related to lower maternal expectations of her child, lower maternal depression, lower scores on permissive and authoritarian parenting scales, lower parent-child dysfunction in the relationship, and lower child responsibilities. The combination of parent-child role responsibilities and parent-child dysfunctional interactions had particularly strong predictive powers of latency to distress. Additionally, the combination of depression and authoritarian parenting had strong predictive power for latency to distress. These findings are in conjunction with the previous findings suggesting that a low stress and engaging, positive mother-child environment is very important to help cultivate emotional sensitivity in the child. These findings continue to stress the importance of maternal interactions in infancy on the socioemotional development of the child.

As these results indicate, mother-child interactions are highly influential in the child's socioemotional development; however, genes are also a strong contributing factor. In the current sample, all infants were living with their biological parents, therefore, the gene x environment interaction is likely highly influential in this sample. The mothers contribute to the genetics of the child and this could be a strong influence on the child's emotional responding. For example, if a mother is highly emotionally regulated, the child will likely have tendencies toward high emotion regulation due to genetics, but also observe highly regulated behaviors by the mother and learn a similar response. On the other hand, if a mother is emotionally dysregulated, this not only creates a stressful environment for the child, but the child also likely has genes to contribute to emotionally dysregulated characteristics.

In summary, the majority of these findings support the idea that stronger emotional responding in infancy (as indicated by BS HR, HR acceleration, latency to distress, and duration, and intensity of distress) is influenced by and can be predicted by positive maternal behaviors (as indicated by positive, supportive parenting behaviors, and the lack of negative affect). The relationship between cortisol and dysfunctional parent-child interactions potentially indicates the child's physiological coping response to the chronic stress of a disengaged parent. In infancy, the importance of mother-child interactions in the social, emotional, and physical development of the child cannot be overstated. The current study demonstrates the significance of a positive, supportive mother-child environment.

Limitations

The connections between emotion and cognition in the present study, though existent, are relatively weak, particularly at 3 and 6 months of age. In fact, there were no significant correlations found between emotional and cognitive variables, only one weak pattern (using OOM analyses) at 3 months, and only one correlation and two relatively weak OOM patterns at 6 months. There are many possible explanations for the lack of strong correlations between emotional and cognitive measures at 3 and 6 months. The first is the general fussiness of the infants. At such young ages, it can be difficult to reliably collect data. While efforts were taken to soothe the infant during the appointment (infants were fed during the appointment when necessary, the parents were asked to schedule the appointment to avoid a typical nap time, etc.), the procedure was relatively time consuming and many of the infants were fussy during one or more of the procedures. In some cases, this led to missing data or potentially a skew in the EC results, as the infant could have been distressed for reasons other than listening to the recorded cries. The general fussiness of the infant could also relate to temperament, which was not assessed in the present study.

Another explanation for the lack of significant correlations at 3 and 6 months of age could be that the relationship between cognition and emotions is not yet developed enough to be detected. While EC is no doubt present at these ages and even younger (Simner, 1971), and cognitions such as attention (Reynolds & Richards, 2008) and NP (Fagan, 1984) can also be reliably measured at these ages, the correlation between the two may not be strong enough to be detected until the abilities are more fully developed.

Another possible limitation of the current study is that it was conducted on a very low-risk sample with regards to demographics and parenting behaviors. The current sample included a large majority of Caucasian, married, and very highly educated mothers, and all children were being raised by their birth parents. This lack of variability and general low-risk could influence the child's socioemotional development and emotional responding. As mentioned above, both genes and environment are highly influential in a child's early development and the mother is contributing to both. Thus if there is little variability and very low risk, the current analyses may not be assessing 1) the true relationship between EC, cognition, and maternal factors that is present in the general population and 2) the effects of high-risk parenting on early socioemotional development.

The current study may not have assessed the most appropriate measures for detecting the relationship between cognition and emotion so early in life. There may be other cognitive variables that would be more closely related to EC in infancy other than NP or memory. Additionally, at older ages, what is measured is typically labeled *empathy*, not *EC*. As discussed previously, it is thought that EC could be seen as a precursor to empathy due to the underdevelopment of theory of mind and other cognitive functions, however, there is the possibility that what is being measured in infancy is not, in fact, the same process as what is measured at older ages. Thus additional longitudinal research is needed to assess the continuity of EC in infancy and empathy in childhood in order to confidently make the assumption that the same processes are being measured at both ages.

Conclusion

The present study aimed to address the potential relationship between EC and cognition in early infancy. The findings support the hypothesis that a connection between emotion and cognition (though weak at times) can be demonstrated at very early ages, most notably though HR-defined attentional phases. Later in childhood, this connection is essential for empathic and prosocial behaviors, thus the detection of it in infancy has important implications for later empathy development. Additional longitudinal research is necessary in order to confidently connect the findings from the current study to those found in toddlerhood.

The second hypothesis of the present study stated that emotional response variables would follow a similar trajectory over time. This was supported through the findings that duration of distress, BS HR, and difference in HR all followed a similar trajectory over time, especially from 6 to 9 months of age. Gender differences were found indicating that females, on average, demonstrated stronger emotional responding as well as the consistency of cognitive variables over time. Both of these findings are consistent with the current infant literature.

Finally, through exploratory analyses, very important relationships were discovered regarding maternal influences on emotional responding. Though not part of the original hypotheses, the strength of the predictive values of positive parenting behaviors demonstrate the relationship that mother-infant interactions have on socioemotional development during the very early years of life.

The implications of the present study suggest that there are many factors that can influence the development of EC in very early infancy including both cognitive development and mother-infant experiences. However, the importance of mother-infant interactions is emphasized above that of cognitive development suggesting that at such early ages, social interactions are much more influential in shaping the socioemotional development of the infant, potentially leading to empathic and prosocial behaviors later in life.

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APPENDICES

APPENDIX A

Tables

Table 1

Descriptive Statistics for Emotional Variables

	3 Months		6 Months		9 Months	
Measure	*N*	*M (SD)*	*N*	*M (SD)*	*N*	*M (SD)*
Latency	28	14.68 (20.05)	32	7.94 (8.56)	26	7.62 (10.73)
Duration	30	156.47 (77.67)	37	203.57 (90.91)	36	152.86 (112.45)
Intensity	30	25.83 (15.61)	37	28.49 (18.85)	36	23.83 (19.51)
BS HR	27	154.84 (9.39)	34	140.60 (13.24)	32	128.67 (15.30)
Diff HR	27	2.08 (10.62)	29	3.04 (9.92)	32	11.63 (14.68)
BS Cortisol			32	0.22 (0.15)	26	0.21 (0.15)

Note. Latency units of measurement: seconds; Duration units of measurement: seconds; Intensity units of measurement: 0-75 scale; Baseline heart rate (BS HR) units of measurement: beats per minute (BPM); Difference in heart rate (Diff HR) units of measurement: BPM; Baseline (BS) cortisol units of measurement: units per mililiter. All values represent raw, unstandardized scores.

Table 2

Descriptive Statistics for Cognitive Variables

	3 Months		6 Months		9 Months	
Measure	*N*	*M(SD)*	*N*	*M (SD)*	*N*	*M (SD)*
Tot Look Dur	34	139.55 (137.49)	36	47.70 (32.80)	33	31.30 (10.44)
Avg Look	33	18.97 (17.01)	35	6.91 (4.66)	34	5.85 (2.34)
Num Looks	36	6.69 (2.95)	36	7.53 (4.82)	34	6.09 (2.37)
% OR	36	0.29 (0.27)	36	0.36 (0.26)	34	0.40 (0.27)
% SA	36	0.54 (0.25)	36	0.56 (0.26)	34	0.50 (0.24)
% AT	36	0.17 (0.14)	36	0.08 (0.09)	34	0.10 (0.13)
NP	32	0.51 (0.19)	36	0.59 (0.18)	33	0.57 (0.12)

Note. Total duration of looking (Tot Look Dur) units of measurement: seconds; Average duration of looking (Avg Look) units of measurement: seconds; Percentage of time in Orienting (% OR), Sustained Attention (% SA), and Attention Termination (% AT) units of measurement: percentage of total looking time; Novelty preference units of measurement: percentage of looking time to novel stimulus. All values represent raw, unstandardized scores.

Table 3

Correlations Among Emotional and Cognitive Variables at 3 Months of Age

	Latency	Duration	Intensity	BS HR	Diff HR	Tot Look Dur	Avg Look Dur	# Looks	%OR	%SA	%AT	NP
Latency		-.352	-.506**	-.228	-.291	-.227	-.175	.091	.211	-.173	-.095	-.293
Duration			.737**	.094	.264	-.110	.112	-.098	.055	-.077	.039	-.352
Intensity				.098	.341	.007	.006	-.005	-.145	.145	.020	-.190
BS HR					-.386*	-.020	-.281	-.188	.360	-.303	-.219	.059
Diff HR						-.207	-.221	.140	-.080	.121	-.052	.006
Tot Look Dur							.842**	.306	-.436**	.316	.288	-.047
Avg Look Dur								-.011	-.429*	.192	.499**	-.126
# Looks									-.069	.044	.057	.106
%OR										-.865**	-.413*	.051
%SA											-.099	-.001
%AT												-.099
NP												

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Note. Latency, Duration, and Intensity = of distress during the emotional contagion paradigm. Tot /Avg Lk Dur = total/ average look duration. # Looks = number of looks. %OR, %SA, and %AT = heart rate-defined phases of attention. NP = novelty preference.

Table 4

Correlations Among Emotional and Cognitive Variables at 6 Months of Age

	Latency	Duration	Intensity	BSHR	DiffHR	BS Cort.	Tot Lk Dur	Avg Lk Dur	# Looks	Avg Lk Dur Δ 3-6 Months	% OR	% SA	%AT	NP
Latency		-.131	.026	.085	.075	.076	.053	.059	-.050	-.205	.267	-.217	-.145	-.213
Duration			.646**	.201	-.085	-.417*	.112	-.058	.204	-.088	-.028	-.002	.088	.208
Intensity				.173	.412*	-.273	-.219	-.131	-.146	.001	-.019	.037	-.051	.198
BS HR					-.539**	.009	.062	.179	-.029	-.109	-.090	.102	-.036	.053
Diff HR						-.101	-.231	-.202	-.098	.025	.267	-.269	-.013	-.073
BS Cort.							-.234	-.062	-.183	.125	.194	-.044	-.412*	-.310
Tot Lk Dur								.559**	.435**	-.312	-.080	-.075	.449**	.231
Avg Lk Dur									-.306	-.082	.157	-.249	.247	.333
# Looks										-.448**	-.035	-.013	.139	.021
Avg Lk Dur Δ 3-6 Months											-.183	.187	-.011	-.200
% OR												-.941**	-.224	.084
% SA													-.119	-.203
% AT														.321
NP														

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Note. Latency, Duration, and Intensity = of distress during the emotional contagion paradigm. BS HR/ Cort. = Baseline heart rate/ cortisol. Tot /Avg Lk Dur = total/ average look duration. Avg Lk Dur Δ 3-6 Months = average look duration change from 3 to 6 months. # Looks = number of looks. %OR, %SA, and %AT = heart rate-defined phases of attention. NP = novelty preference.

Table 5

Correlations Among Emotional and Cognitive Variables at 9 Months of Age

	Latency	Duration	Intensity	BS HR	Diff HR	BS Cort.	Tot Lk Dur	Avg Lk Dur	# Looks	Avg Lk Dur Δ3-6M	% OR	% SA	%AT	NP
Latency		-.335	-.216	.171	-.020	.106	-.147	.058	-.134	.125	.105	-.380	.462*	.020
Duration			.801**	-.030	.234	.179	-.281	.041	.074	-.078	-.209	.304	-.124	-.050
Intensity				-.095	.552**	.196	-.134	.002	-.122	-.246	-.071	.216	-.240	-.071
BS HR					-.361*	.203	-.306	-.178	-.126	.467**	.018	.064	-.149	-.071
Diff HR						.193	.129	.021	.094	-.183	-.036	.127	-.155	-.091
BS Cort.							-.347	-.333	-.057	-.101	.232	-.082	-.300	.019
Tot Lk Dur								.622**	.352*	-.020	-.346*	.305	.149	.178
Avg Lk Dur									-.093	.179	-.374*	.284	.250	-.055
# Looks										-.052	-.233	.239	.045	.056
Avg Lk Dur Δ 3-6 M											-.032	.060	-.042	.098
% OR												-.872**	-.470**	-.265
% SA													-.024	.202
% AT														.169
NP														

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Note. Latency, Duration, and Intensity = of distress in the emotional contagion paradigm. BS HR/ Cort. = Baseline heart rate/ cortisol. Tot /Avg Lk Dur = total/ average look duration. Avg Lk Dur Δ 3-6 M = average look duration change from 3 to 6 months. # Looks = number of looks. %OR, %SA, and %AT = heart rate-defined phases of attention. NP = novelty preference.

Table 6

Correlations Among Latency to Distress at 3, 6, and 9 Months of Age

	Latency 3 Months	Latency 6 Months	Latency 9 Months
Latency 3 Months		-.230	.157
Latency 6 Months			-.076
Latency 9 Months			

Table 7

Correlations Among Duration of Distress at 3, 6, and 9 Months of Age

	Duration 3 Months	Duration 6 Months	Duration 9 Months
Duration 3 Months		-.090	-.152
Duration 6 Months			.222
Duration 9 Months			

Table 8

Correlations Among Intensity of Distress at 3, 6, and 9 Months of Age

	Intensity 3 Months	Intensity 6 Months	Intensity 9 Months
Intensity 3 Months		-.291	-.020
Intensity 6 Months			.342*
Intensity 9 Months			

*. Correlation is significant at the 0.05 level (2-tailed).

Table 9

Correlations Among Baseline Heart Rate at 3, 6, and 9 Months of Age

	BS HR 3 Months	BS HR 6 Months	BS HR 9 Months
BS HR 3 Months		-.013	-.045
BS HR 6 Months			.202
BS HR 9 Months			

Table 10

Correlations Among Difference in Heart Rate at 3, 6, and 9 Months of Age

	Difference HR 3 Months	Difference HR 6 Months	Difference HR 9 Months
Difference HR 3 Months		-.063	-.329
Difference HR 6 Months			.449*
Difference HR 9 Months			

*. Correlation is significant at the 0.05 level (2-tailed).

Table 11

Correlations Among Baseline Cortisol at 6 and 9 Months of Age

	BS Cortisol 6 Months	BS Cortisol 9 Months
BS Cortisol 6 Months		.126
BS Cortisol 9 Months		

Table 12

Correlations Among Total Look Duration at 3, 6, and 9 Months of Age

	Total Look Duration 3 Months	Total Look Duration 6 Months	Total Look Duration 9 Months
Total Look Duration 3 Months		.389*	.104
Total Look Duration 6 Months			.275
Total Look Duration 9 Months			

*. Correlation is significant at the 0.05 level (2-tailed).

Table 13

Correlations Among Average Look Duration at 3, 6, and 9 Months of Age

	Average Look Duration 3 Months	Average Look Duration 6 Months	Average Look Duration 9 Months
Average Look Duration 3 Months		.341	.146
Average Look Duration 6 Months			.247
Average Look Duration 9 Months			

Table 14

Correlations Among Number of Looks at 3, 6, and 9 Months of Age

	Number of Looks 3 Months	Number of Looks 6 Months	Number of Looks 9 Months
Number of Looks 3 Months		-.186	-.348*
Number of Looks 6 Months			.145
Number of Looks 9 Months			

*. Correlation is significant at the 0.05 level (2-tailed).

Table 15

Correlations Among Heart Rate-Derived Attention at 3, 6, and 9 Months of Age

	% OR 3 Months	% SA 3 Months	% AT 3 Months	% OR 6 Months	% SA 6 Months	% AT 6 Months	% OR 9 Months	% SA 9 Months	% AT 9 Months
% OR 3 Months		-.865**	-.413*	-.103	.015	.247	.108	.122	-.435*
% SA 3 Months			-.099	.056	-.004	-.145	-.030	-.135	.300
% AT 3 Months				.104	-.022	-.230	-.138	.016	.252
% OR 6 Months					-.941**	-.224	.271	-.206	-.184
% SA 6 Months						-.119	-.235	.169	.178
% AT 6 Months							-.132	.130	.037
% OR 9 Months								-.872**	-.470**
% SA 9 Months									-.024
% AT 9 Months									

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 16

Correlations Among Novelty Preference at 3, 6, and 9 Months of Age

	Novelty Preference at 3 Months	Novelty Preference at 6 Months	Novelty Preference at 9 Months
Novelty Preference at 3 Months		-.333	-.176
Novelty Preference at 6 Months			-.086
Novelty Preference at 9 Months			

Table 17

Correlations Among Latency to Distress and AAPI-2 Scores

	Latency at 3 Months	Latency at 6 Months	Latency at 9 Months	Expectations of Children	Empathy Towards Children's Needs	Use of Corporal Punishment as a Means of Discipline	Parent-Child Role Responsibilities	Children's Power and Independence
Latency at 3 Months		-.230	.157	.401*	.247	.048	.107	.197
Latency at 6 Months			-.076	.039	-.003	.076	.069	-.113
Latency at 9 Months				.223	.311	.305	.392*	.127
Expectations of Children					.638**	.574**	.515**	.392*
Empathy Towards Children's Needs						.518**	.505**	.434**
Use of Corporal Punishment as a Means of Discipline							.533**	.311
Parent-Child Role Responsibilities								.294
Children's Power and Independence								

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 18

Correlations Among Duration of Distress and AAPI-2 Scores

	Duration 3 Months	Duration 6 Months	Duration 9 Months	Expectations of Children	Empathy Towards Children's Needs	Use of Corporal Punishment as a Means of Discipline	Parent-Child Role Responsibilities	Children's Power and Independence
Duration 3 Months		-.090	-.152	-.048	-.074	-.169	-.047	-.222
Duration 6 Months			.222	.125	.017	-.069	.120	-.167
Duration 9 Months				-.100	-.283	-.299	-.007	-.090
Expectations of Children					.638**	.574**	.515**	.392*
Empathy Towards Children's Needs						.518**	.505**	.434**
Use of Corporal Punishment as a Means of Discipline							.533**	.311
Parent-Child Role Responsibilities								.294
Children's Power and Independence								

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 19

Correlations Among Intensity of Distress and AAPI-2 Scores

	Intensity at 3 Months	Intensity at 6 Months	Intensity at 9 Months	Expectations of Children	Empathy Towards Children's Needs	Use of Corporal Punishment as a Means of Discipline	Parent-Child Role Responsibilities	Children's Power and Independence
Intensity at 3 Months		-.291	-.020	-.113	-.074	-.022	-.116	-.168
Intensity at 6 Months			.342*	.066	-.090	-.044	.014	-.225
Intensity at 9 Months				.043	-.164	-.108	-.141	.018
Expectations of Children					.638**	.574**	.515**	.392*
Empathy Towards Children's Needs						.518**	.505**	.434**
Use of Corporal Punishment as a Means of Discipline							.533**	.311
Parent-Child Role Responsibilities								.294
Children's Power and Independence								

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 20

Correlations Among Baseline Heart Rate and AAPI-2 Scores

	BS HR 3 Months	BS HR 6 Months	BS HR 9 Months	Expectations of Children	Empathy Towards Children's Needs	Use of Corporal Punishment as a Means of Discipline	Parent-Child Role Responsibilities	Children's Power and Independence
BS HR 3 Months		-.013	-.045	-.012	-.018	-.004	-.179	-.099
BS HR 6 Months			.202	-.245	-.116	-.031	.005	-.164
BS HR 9 Months				.288	.462**	.312	.395*	.268
Expectations of Children					.638**	.574**	.515**	.392*
Empathy Towards Children's Needs						.518**	.505**	.434**
Use of Corporal Punishment as a Means of Discipline							.533**	.311
Parent-Child Role Responsibilities								.294
Children's Power and Independence								

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 21

Correlations Among Difference in Heart Rate and AAPI-2 Scores

	Diff HR 3 Months	Diff HR 6 Months	Diff HR 9 Months	Expectations of Children	Empathy Towards Children's Needs	Use of Corporal Punishment as a Means of Discipline	Parent-Child Role Responsibilities	Children's Power and Independence
Diff HR 3 Months		-.063	-.329	-.070	.151	-.083	.099	.166
Diff HR 6 Months			.449*	.068	-.027	-.179	-.243	.077
Diff HR 9 Months				.034	-.201	-.189	-.307	-.122
Expectations of Children					.638**	.574**	.515**	.392*
Empathy Towards Children's Needs						.518**	.505**	.434**
Use of Corporal Punishment as a Means of Discipline							.533**	.311
Parent-Child Role Responsibilities								.294
Children's Power and Independence								

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 22

Correlations Among Baseline Cortisol and AAPI-2 Scores

	BS Cortisol 6 Months	BS Cortisol 9 Months	Expectations of Children	Empathy Towards Children's Needs	Use of Corporal Punishment as a Means of Discipline	Parent-Child Role Responsibilities	Children's Power and Independence
BS Cortisol 6 Months		.126	.036	.232	.199	-.001	.077
BS Cortisol 9 Months			-.091	.141	-.150	.018	-.331
Expectations of Children				.638**	.574**	.515**	.392*
Empathy Towards Children's Needs					.518**	.505**	.434**
Use of Corporal Punishment as a Means of Discipline						.533**	.311
Parent-Child Role Responsibilities							.294
Children's Power and Independence							

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 23

Correlations Among Latency to Distress and PSI Scores

	Latency 3 Months	Latency 6 Months	Latency 9 Months	Parental Distress	Parent-Child Dysfunctional Interaction	Difficult Child	PSI Total Stress
Latency 3 Months		-.230	.157	.034	-.030	-.174	.061
Latency 6 Months			-.076	-.209	-.107	.014	-.151
Latency 9 Months				.145	.629**	-.103	-.068
Parental Distress					.256	.572**	.806**
Parent-Child Dysfunctional Interaction						.256	.015
Difficult Child							.774**
PSI Total Stress							

**. Correlation is significant at the 0.01 level (2-tailed).

Table 24

Correlations Among Duration of Distress and PSI Scores

	Duration 3 Months	Duration 6 Months	Duration 9 Months	Parental Distress	Parent-Child Dysfunctional Interaction	Difficult Child	PSI Total Stress
Duration 3 Months		-.090	-.152	.160	.183	.068	.075
Duration 6 Months			.222	-.053	.241	-.115	-.029
Duration 9 Months				-.381*	.008	.062	-.195
Parental Distress					.256	.572**	.806**
Parent-Child Dysfunctional Interaction						.256	.015
Difficult Child							.774**
PSI Total Stress							

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 25

Correlations Among Intensity of Distress and PSI Scores

	Intensity 3 Months	Intensity 6 Months	Intensity 9 Months	Parental Distress	Parent-Child Dysfunctional Interaction	Difficult Child	PSI Total Stress
Intensity 3 Months		-.291	-.020	.260	.168	.194	.195
Intensity 6 Months			.342*	-.091	-.010	.220	.200
Intensity 9 Months				-.235	.060	.201	.039
Parental Distress					.256	.572**	.806**
Parent-Child Dysfunctional Interaction						.256	.015
Difficult Child							.774**
PSI Total Stress							

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 26

Correlations Among Baseline Heart Rate and PSI Scores

	BS HR 3 Months	BS HR 6 Months	BS HR 9 Months	Parental Distress	Parent-Child Dysfunctional Interaction	Difficult Child	PSI Total Stress
BS HR 3 Months		-.013	-.045	.153	-.152	.086	.219
BS HR 6 Months			.202	-.021	.040	-.158	-.132
BS HR 9 Months				-.159	-.008	-.218	-.226
Parental Distress					.256	.572**	.806**
Parent-Child Dysfunctional Interaction						.256	.015
Difficult Child							.774**
PSI Total Stress							

**. Correlation is significant at the 0.01 level (2-tailed).

Table 27

Correlations Among Difference in Heart Rate and PSI Scores

	Diff HR 3 Months	Diff HR 6 Months	Diff HR 9 Months	Parental Distress	Parent-Child Dysfunctional Interaction	Difficult Child	PSI Total Stress
Diff HR 3 Months		-.063	-.329	-.426*	.062	-.301	-.563**
Diff HR 6 Months			.449*	-.004	-.181	.276	.274
Diff HR 9 Months				.091	.111	.275	.311
Parental Distress					.256	.572**	.806**
Parent-Child Dysfunctional Interaction						.256	.015
Difficult Child							.774**
PSI Total Stress							

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 28

Correlations Among Baseline Cortisol and PSI Scores

	BS Cortisol 6 Months	BS Cortisol 9 Months	Parental Distress	Parent-Child Dysfunctional Interaction	Difficult Child	PSI Total Stress
BS Cortisol 6 Months		.126	-.237	-.381*	-.297	-.193
BS Cortisol 9 Months			-.470*	.164	-.160	-.331
Parental Distress				.256	.572**	.806**
Parent-Child Dysfunctional Interaction					.256	.015
Difficult Child						.774**
PSI Total Stress						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 29

Correlations Among Latency to Distress and PSDQ Scores

	Latency 3 Months	Latency 6 Months	Latency 9 Months	Authoritarian	Authoritative	Permissive
Latency 3 Months		-.230	.157	.167	-.046	.360
Latency 6 Months			-.076	-.182	-.245	-.208
Latency 9 Months				.425*	.012	.485*
Authoritarian					-.392*	.467**
Authoritative						.223
Permissive						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 30

Correlations Among Duration of Distress and PSDQ Scores

	Duration 3 Months	Duration 6 Months	Duration 9 Months	Authoritarian	Authoritative	Permissive
Duration 3 Months		-.090	-.152	.204	.146	.146
Duration 6 Months			.222	-.006	-.103	-.011
Duration 9 Months				-.420*	-.085	-.544**
Authoritarian					-.392*	.467**
Authoritative						.223
Permissive						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 31

Correlations Among Intensity of Distress and PSDQ Scores

	Intensity 3 Months	Intensity 6 Months	Intensity 9 Months	Authoritarian	Authoritative	Permissive
Intensity 3 Months		-.291	-.020	.019	.220	.130
Intensity 6 Months			.342*	-.086	-.258	.023
Intensity 9 Months				-.258	-.228	-.387*
Authoritarian					-.392*	.467**
Authoritative						.223
Permissive						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 32

Correlations Among Baseline Heart Rate and PSDQ Scores

	BS HR 3 Months	BS HR 6 Months	BS HR 9 Months	Authoritarian	Authoritative	Permissive
BS HR 3 Months		-.013	-.045	.063	-.281	-.461*
BS HR 6 Months			.202	.108	-.008	.076
BS HR 9 Months				.132	-.009	.138
Authoritarian					-.392*	.467**
Authoritative						.223
Permissive						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 33

Correlations Among Difference in Heart Rate and PSDQ Scores

	Diff HR 3 Months	Diff HR 6 Months	Diff HR 9 Months	Authoritarian	Authoritative	Permissive
Diff HR 3 Months		-.063	-.329	.068	.164	.020
Diff HR 6 Months			.449*	-.057	-.149	-.065
Diff HR 9 Months				-.271	-.122	-.235
Authoritarian					-.392*	.467**
Authoritative						.223
Permissive						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 34

Correlations Among Baseline Cortisol and PSDQ Scores

	BS Cortisol 6 Months	BS Cortisol 9 Months	Authoritarian	Authoritative	Permissive
BS Cortisol 6 Months		.126	.042	.116	-.127
BS Cortisol 9 Months			-.146	-.088	-.338
Authoritarian				-.392*	.467**
Authoritative					.223
Permissive					

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 35

Correlations Among Latency to Distress and SCL-90 Scores

	Latency at 3 Months	Latency at 6 Months	Latency at 9 Months	Interpersonal Sensitivity Scale	Depression Scale	Anxiety Scale
Latency at 3 Months		-.230	.157	.255	.302	.026
Latency at 6 Months			-.076	-.280	-.213	-.202
Latency at 9 Months				.327	.410*	.275
Interpersonal Sensitivity Scale					.886**	.814**
Depression Scale						.835**
Anxiety Scale						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 36

Correlations Among Duration of Distress and SCL-90 Scores

	Duration at 3 Months	Duration at 6 Months	Duration at 9 Months	Interpersonal Sensitivity Scale	Depression Scale	Anxiety Scale
Duration at 3 Months		-.090	-.152	-.211	-.173	.053
Duration at 6 Months			.222	-.416*	-.133	-.233
Duration at 9 Months				-.221	-.200	-.292
Interpersonal Sensitivity Scale					.886**	.814**
Depression Scale						.835**
Anxiety Scale						

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 37

Correlations Among Intensity of Distress and SCL-90 Scores

	Intensity at 3 Months	Intensity at 6 Months	Intensity at 9 Months	Interpersonal Sensitivity Scale	Depression Scale	Anxiety Scale
Intensity at 3 Months		-.291	-.020	-.076	-.124	.087
Intensity at 6 Months			.342*	-.293	-.258	-.331*
Intensity at 9 Months				-.137	-.234	-.305
Interpersonal Sensitivity Scale					.886**	.814**
Depression Scale						.835**
Anxiety Scale						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 38

Correlations Among Baseline Heart Rate and SCL-90 Scores

	BS HR 3 Months	BS HR 6 Months	BS HR 9 Months	Interpersonal Sensitivity Scale	Depression Scale	Anxiety Scale
BS HR 3 Months		-.013	-.045	-.097	.022	.081
BS HR 6 Months			.202	-.002	.021	.038
BS HR 9 Months				.182	.235	.218
Interpersonal Sensitivity Scale					.886**	.814**
Depression Scale						.835**
Anxiety Scale						

**. Correlation is significant at the 0.01 level (2-tailed).

Table 39

Correlations Among Difference in Heart Rate and SCL-90 Scores

	Diff HR 3 Months	Diff HR 6 Months	Diff HR 9 Months	Interpersonal Sensitivity Scale	Depression Scale	Anxiety Scale
Diff HR 3 Months		-.063	-.329	-.135	-.093	-.078
Diff HR 6 Months			.449*	-.073	-.153	-.146
Diff HR 9 Months				.029	-.106	-.185
Interpersonal Sensitivity Scale					.886**	.814**
Depression Scale						.835**
Anxiety Scale						

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 40

Correlations Among Difference in Heart Rate and SCL-90 Scores

	BS Cortisol 6 Months	BS Cortisol 9 Months	Interpersonal Sensitivity Scale	Depression Scale	Anxiety Scale
BS Cortisol 6 Months		.126	.057	-.174	-.114
BS Cortisol 9 Months			-.157	-.152	-.206
Interpersonal Sensitivity Scale				.886**	.814**
Depression Scale					.835**
Anxiety Scale					

**. Correlation is significant at the 0.01 level (2-tailed).

Table 41

Correlations Among Emotional Variables and PANAS at 3 Months

	Latency 3 Months	Duration 3 Months	Intensity 3 Months	BS HR 3 Months	Diff HR 3 Months	Positive Affect 3 Months	Negative Affect 3 Months
Latency 3 Months		-.352	-.506**	-.228	-.291	.120	.126
Duration 3 Months			.737**	.094	.264	.209	-.231
Intensity 3 Months				.098	.341	-.051	.117
BS HR 3 Months					-.386*	-.025	.210
Diff HR 3 Months						-.038	-.161
Positive Affect at 3 Months							-.446**
Negative Affect at 3 Months							

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 42

Correlations Among Emotional Variables and PANAS at 6 Months

	Latency 6 Months	Duration 6 Months	Intensity 6 Months	BS HR 6 Months	Diff HR 6 Months	BS Cortisol 6 Months	Positive Affect 6 Months	Negative Affect 6 Months
Latency 6 Months		-.131	.026	.085	.075	.076	-.054	-.223
Duration 6 Months			.646**	.201	-.085	-.417*	-.064	-.176
Intensity 6 Months				.173	.412*	-.273	-.077	-.353*
BS HR 6 Months					-.539**	.009	-.156	-.008
Diff HR 6 Months						-.101	-.164	-.147
BS Cortisol 6 Months							.198	.127
Positive Affect 6 Months								-.183
Negative Affect 6 Months								

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 43

Correlations Among Emotional Variables and PANAS at 9 Months

	Latency 9 Months	Duration 9 Months	Intensity 9 Months	BS HR 9 Months	Diff HR 9 Months	BS Cortisol 9 Months	Positive Affect 9 Months	Negative Affect 9 Months
Latency 9 Months		-.335	-.216	.171	-.020	.106	-.047	.118
Duration 9 Months			.801**	-.030	.234	.179	-.187	-.010
Intensity 9 Months				-.095	.552**	.196	-.066	-.042
BS HR 9 Months					-.361*	.203	-.029	.202
Diff HR 9 Months						.193	-.010	-.155
BS Cortisol 9 Months							-.155	-.281
Positive Affect 9 Months								-.070
Negative Affect 9 Months								

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 44

Multiple Linear Regression for Duration of Distress at 9 Months of Age

	B	***SE***	***β***	***t***	***p***
Constant	851.743	221.204		3.850	.001
Parental Distress	-5.056	2.127	-.352	-2.377	.024
Authoritarian	-132.531	49.823	-.394	-2.660	.012

Table 45

Multiple Linear Regression for Latency to Distress at 9 Months of Age

	B	***SE***	***β***	***t***	***p***
Constant	-24.741	7.172		-3.450	.002
Parent-Child Role Responsibilities	2.339	.915	.366	2.556	.018
Parent-Child Dysfunctional Interaction	.907	.212	.613	4.278	.000

Table 46

Multiple Linear Regression for Latency to Distress at 9 Months of Age

	B	***SE***	***β***	***t***	***p***
Constant	-50.902	25.421		-2.002	.058
Depression Scale	8.854	4.398	.360	2.013	.057
Authoritarian	12.495	5.933	.377	2.106	.047

APPENDIX B

Figures

Multi-Unit Frequency Histogram

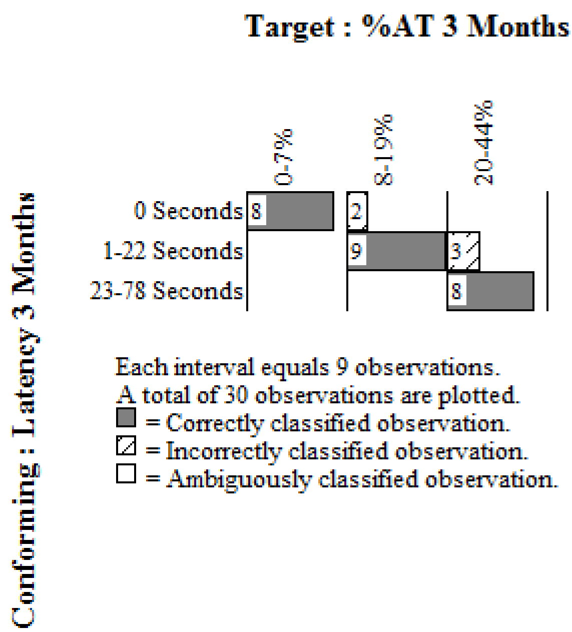


Figure 1. An example multi-unit frequency histogram (multigram) based on contrived data for 3-month latency to distress and %AT.

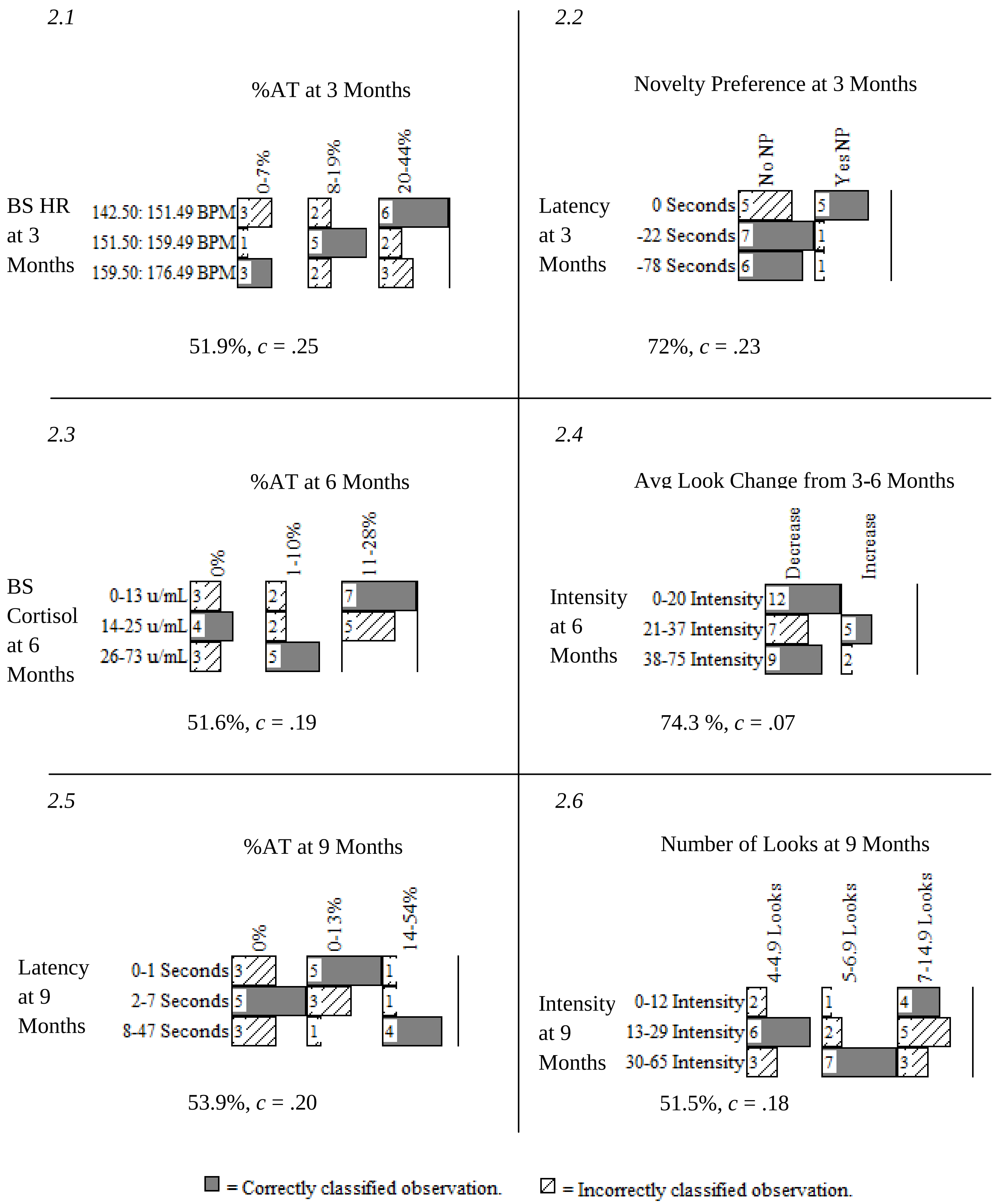


Figure 2. Multigrams for Hypothesis 1. PCC and *c*-values are given below each figure.

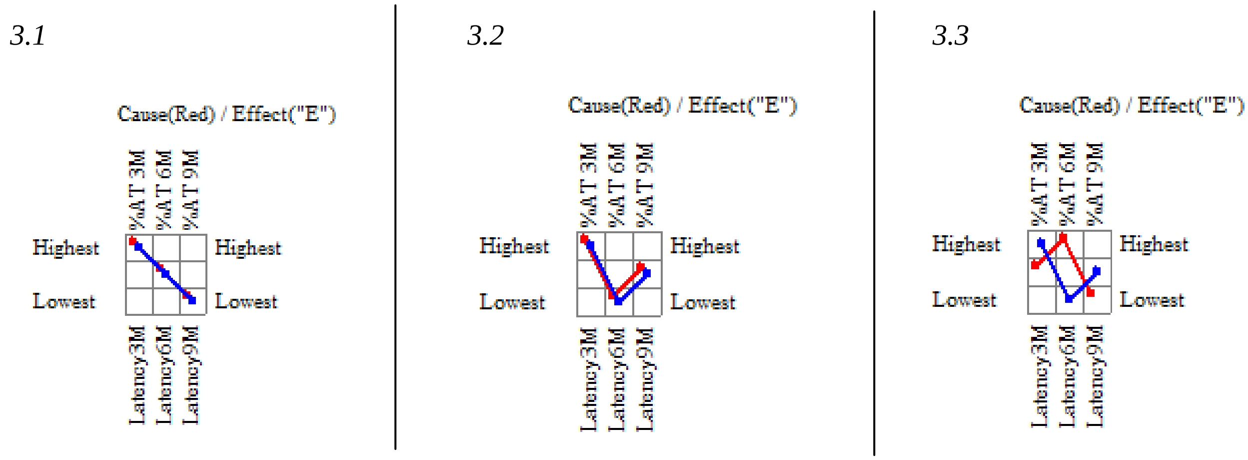
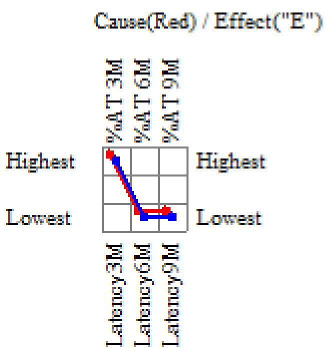


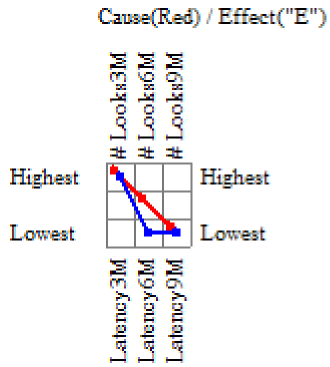
Figure 3. Figure 3.1 illustrates an individual match between %AT and latency to distress patterns from 3 to 9 months. Figure 3.2 illustrates a similar, but non-linear match. Figure 3.3 illustrates a poor match.

4.1



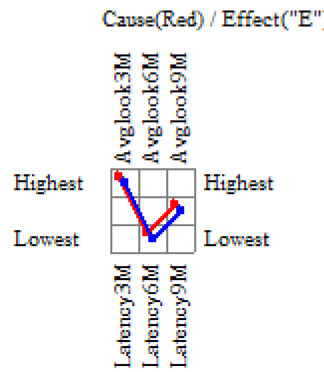
50.8%, *c* = .10

4.2



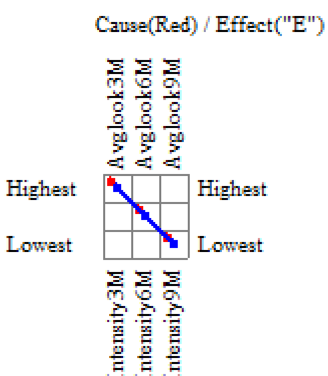
50.8%, *c* = .08

4.3



56.8%, *c* = .02

4.4



52.5%, *c* = .17

Figure 4. Examples of typical individual observations found for the majority of matching patterns. Overall PCC and c-values are given below each figure.

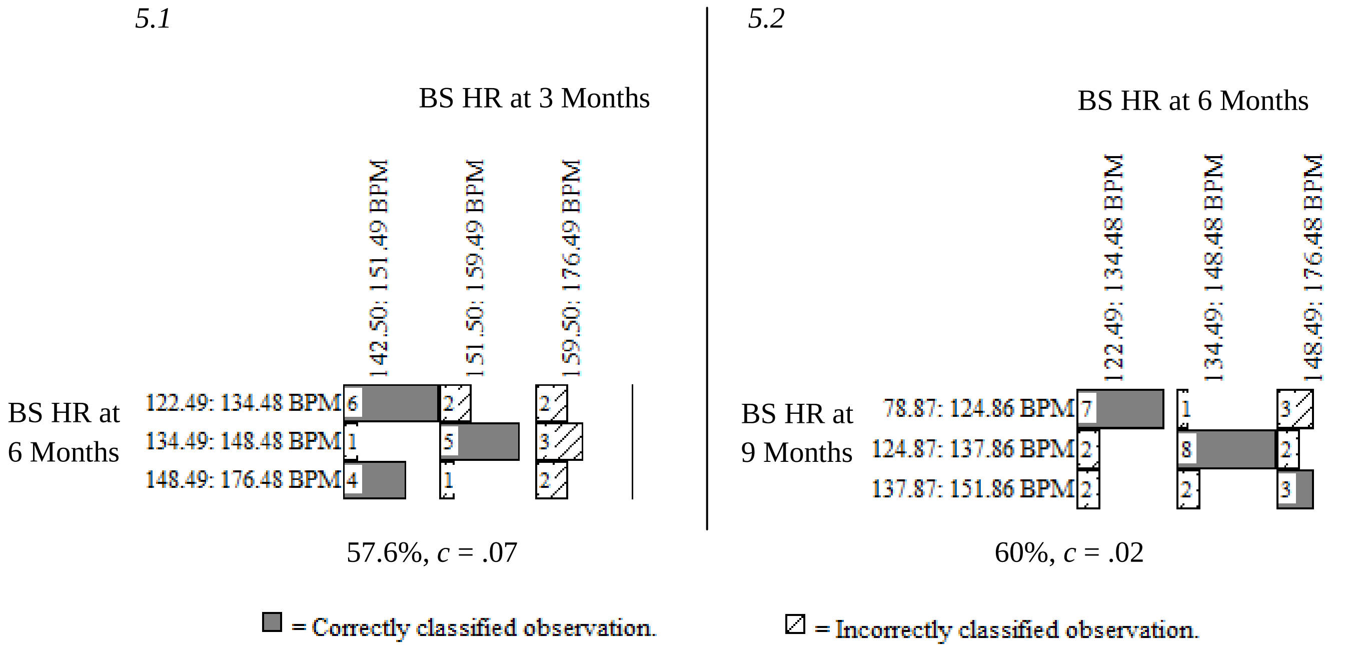


Figure 5. Multigrams for Hypothesis 2. PCC and *c*-values are given below each figure.

APPENDIX C

Institutional Review Board Approval

VITA

Janna M. Colaizzi

Candidate for the Degree of Psychology

Master of Science

Thesis: THE RELATIONSHIP BETWEEN EMOTIONAL CONTAGION AND COGNITIVE DEVELOPMENT IN EARLY INFANCY

Major Field: Lifespan Developmental Psychology

Biographical:

Education:

Completed the requirements for the Master of Science in Psychology at Oklahoma State University, Stillwater, Oklahoma in July 2013.

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