

ABSTRACT

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According to several theorists, infants form mental representations and memories of their social-emotional interactions (e.g., Bowlby, 1969/1982), but very few studies have investigated these claims. Across two studies, I hypothesized that 10-month-old infants would form representations and memories of their social-emotional interactions. In Study 1, infants ($N = 24$) were familiarized to a positive and negative puppet and their representations and memories were assessed with visual-paired comparison (VPC) and forced-choice tests. Ten minutes after their interactions, but not immediately after, significantly more infants chose the positive puppet ($17/24$, $p = .030$). To better understand these results, I conducted another study in which infants ($N = 32$) were randomly assigned to be familiarized to either a positive and neutral puppet or a negative and neutral puppet. In the positive condition infants were more likely to choose the positive puppet immediately after ($12/16$, $p = .038$), but not 10 minutes after the interactions, whereas in the negative condition infants' choices were at chance – but older infants were more likely choose the neutral puppet ($M_{diff} = 11.50$ days, $p = .022$). In both studies, no effects emerged with infants' preferential looking. Overall, the results indicated that infants' representations and memories of their brief social-emotional interactions were stronger for positive than negative interactions. Results are discussed with regard to existing theory and research and the negativity bias hypothesis.

INFANTS' REPRESENTATIONS AND MEMORIES OF THEIR
SOCIAL-EMOTIONAL INTERACTIONS

By

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Dedication

I would like to dedicate this work to my son, Andrew,
who has shown me, firsthand, that infants are capable of a great many things.

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Chapter 1: Introduction

Recent theory and research have focused attention on the important interplay between cognitive and social domains of development (see Calkins & Bell, 2010). In particular, the field of social cognitive development highlights the role of mental representations (i.e., cognitions) in social development by studying “children’s processing and understanding of the (social) world across development” (Olson & Dweck, 2008, p. 195). This mental processing and understanding of the social world begins in infancy when infants form representations and memories of social interactions (see Rochat & Striano, 1999).

During infancy, emotionally salient interactions with caregivers are thought to provide a foundation for children’s subsequent social and cognitive development (Bowlby, 1969/1982, 1973; Nelson, 1999; Saarni, Campos, Camras, & Witherington, 2006; Shonkoff & Phillips, 2000; Thompson, 2006). Several theorists and mounting empirical evidence suggest that infants, within their first year, are capable of forming lasting mental representations of these social-emotional interactions (e.g., Beebe & Lachmann, 1988; Bowlby, 1969/1982, 1973; Craik, 1943; Main, Kaplan, & Cassidy, 1985; Stern, 1985). For example, Craik (1943) proposed that infants form mental models that are representations of reality and use these models to predict the likely outcome of events. Bowlby (1969/1982, 1973) later applied this concept to infant-caregiver relationships, arguing that infants form what he called *internal working models* of their caregivers’ likely behavior based on their repeated interactions with caregivers (for a comprehensive theoretical and empirical review of the cognitive capacities relevant to

forming IWMs of attachment figures during the first year of life, see Appendix A).

Similarly, Stern (1985) proposed that infants remember their interactions with others and that their representations of the interactions become generalized over time to predict how future interactions will unfold. In summary, several theoretical positions point to the ability of infants to mentally represent and remember their interactions with others.

Although the idea that infants form mental representations of their social interactions is not new, Johnson and colleagues (2010) noted that “it has only been in more recent years that cognitive developmentalists have devised methods capable of tapping into the mental models of preverbal infants – social or otherwise” (p. 809). These new experimental methods make it possible to explore questions regarding infants’ representations and memories of their social-emotional interactions in ways that are not possible with correlational designs. Emerging research has provided evidence that preverbal infants form rich representations of the social world (see Johnson & Chen, 2011; Rochat, 1999; Tomasello, Carpenter, Call, Behne, & Moll, 2005; Wellman, 2002).

In this study, I sought to understand whether infants form mental representations and memories of their social-emotional interactions. This manuscript is organized into four chapters: the introduction, then two chapters detailing the research goal, method, results, and discussion of the two empirical studies, and lastly, the general discussion. I begin the first chapter, the introduction, with a review of evidence that infants mentally represent the social interactions of others. Next, I review the more limited evidence that infants are capable of representing and remembering their own social-emotional interactions. Third, I describe evidence that infants have a negativity bias that may affect how infants represent and remember their social-emotional interactions. Finally, I

describe a set of two studies designed to address gaps in the literature to gain a better understanding of infants' representations and memories of their social-emotional interactions. Next, I detail the design, results, and discussion for each of the studies including descriptions of the participants, procedures, and measures in chapters 2 through 3. I conclude with chapter 4, the general discussion, which synthesizes the results of the two present studies and provides recommendations for future research.

Infants' Mental Representations of Others' Social Interactions

Several studies indicate that infants, at least by the second half of the first year, are capable of forming mental representations of the social interactions of others (see Tomasello, 1999; see also Rochat & Striano, 1999, for a discussion of “the 9-month cognitive revolution”). For example, the results of a pair of studies showed that infants represented the relationship between two agents (self-propelled circles) engaged in a social interaction (Rochat, Striano, & Morgan, 2004). In the initial experiment, infants were habituated to a social interaction between a “chaser” and a “chasee.” After habituation, infants were shown a display where the agents (identified by different colors) switched roles. The authors argued that because the new display was perceptually similar to the first display, infants who merely represented the perceptual features of the display would not show renewed interest (i.e., dishabituate) to the new display, whereas infants who represented the relationship between the characters would show increased interest to the switched-role display. The results showed that 8- to 10-month-old infants, but not 3- to 7-month-old infants, interpreted the new display as novel. The follow-up experiment confirmed that the perceptual features, such as movement and color, could not account for infants' renewed interest after habituation. These experimental results suggest that

infants represented the relational interaction between the two characters, not just the visual display of any agent chasing another agent.

In another study, Premack and Premack (1997) showed that infants represented the social interaction between agents who have either helped or hindered another agent. Twelve-month-old infants viewed a computer-animated display where an agent (a self-propelled circle) either helped or hindered another agent pass through a hole. After familiarization, infants' looking times were assessed when they watched a display where the familiarized agent hit the other character. Infants who had been habituated to the helping event looked longer during the test than infants who had been habituated to the hindering event. These findings suggest that the helping agent's later anti-social behavior violated the infants' expectations, whereas the hindering agent's later anti-social behavior did not violate the infants' expectations, indicating that the infants formed a mental representation of these social interactions that contained information about the social partner's likely behavior.

In a set of related studies, Kuhlmeier, Wynn, and Bloom (2003) and Hamlin, Wynn, and Bloom (2007) familiarized infants to a display where an agent (a self-propelled shape) was either helped or hindered in its goal to climb a hill. In later test events, 10- and 12-month-old infants, but not 6-month-old infants, looked longer when the circle approached the hinderer, but not when it approached the helper, suggesting that approaching the hinderer violated the infants' expectations. Six-month-old infants understood the helping and hindering acts as evidenced by their robust preference to choose the helper over the hinderer and neutral agents, as well as a neutral agent over the hinderer, but did not form an expectation about the circle's likely behavior. Extending

this work, Hamlin and Wynn (2011) showed that infants represent these helping and hindering social behaviors across a variety of situations. When infants saw a puppet either help or hinder another puppet open a box or play with a ball, they preferred the helper over the hinderer (5- and 9-month-old infants were tested in a choice paradigm, whereas 3-month-old infants were tested in a preferential looking test, also called a visual paired comparison; see also Hamlin, Wynn, & Bloom, 2010). Thus, infants mentally represent the quality of other people's social interactions. These studies show that after only minimal exposure to a social interaction, infants as young as 3 months of age are capable of mentally representing the quality of social interactions. It is not until the second half of the first year, however, that infants are capable of using their representations to predict another's social behavior in new situations.

Although these studies show that infants are capable of representing important aspects of others' social interactions, they cannot speak to infants' ability to represent their own social interactions. Given the importance of infants' own social-emotional interactions in development (e.g., Saarni et al., 2006; Shonkoff & Phillips, 2000; Thompson, 2006), it is necessary to explore infants' representations memories of their own social partners. Furthermore, as Rochat and Striano (1999) noted, "infants do not develop a social understanding by merely engaging in social 'voyeurism'...rather...they learn by engaging in reciprocal exchanges with others" (p. 4). Thus, I turn now to evidence that infants represent and remember their own reciprocal, emotional exchanges with others.

Infants' Mental Representations and Memories of their own Social-Emotional Interactions

Given the importance of infants' own social-emotional experiences, it is surprising that so few studies have directly assessed whether infants represent and remember their own social-emotional interactions. To my knowledge, only three experimental studies have examined this question, each of which is reviewed below.

In the first study to demonstrate infants' lasting representations of their emotional experiences, seven-month-old infants were randomly assigned to either a "rousing," positively valenced interaction with a puppet or a neutral, non-emotionally valenced interaction with a puppet (Nachman, Stern, & Best, 1986). Infants' preferential looking between the familiar puppet and a novel puppet was then tested after a 2-minute delay and a 1-week delay. At the 1-week delayed test, infants in the neutral condition looked longer at the novel puppet and displayed no positive affect, whereas infants in the positive condition looked longer at the familiar puppet and smiled toward the puppet. The novelty preference demonstrated by infants in the neutral condition is consistent with the majority of infant memory research that does not contain emotional valence (see Pascalis & de Haan, 2003, for a review). The familiarity preference demonstrated by infants in the positive condition shows that novelty/familiarity preferences are reversed when emotional valence is attached to the to-be-remembered information. These findings indicate that infants have the capacity to remember positive aspects of their interactions with others over substantial delays. Interestingly, infants at the 2-minute delay showed no preferential looking in either condition. This is likely due to the fact that novelty and familiarity preferences often compete after short delays when infants are still processing and consolidating the presented information (Pascalis & de Haan, 2003).

In another study, four- to five-month-old infants were presented simultaneously with two adult strangers on video screens (Bigelow & Birch, 1999). One of the strangers was interacting contingently with the infant via live video feed, whereas the other stranger was interacting non-contingently because it was a tape recorded feed from a different infant-stranger interaction. During a familiarization period, infants spent more time looking at the contingent stranger and displayed more positive affect toward the contingent stranger. Six days later, infants returned to the laboratory and were shown a similar display of the same two strangers; this time, however, both strangers acted contingently. As this test session progressed, infants preferred to look at the adult who had acted contingently in the first session and displayed more positive affect toward that adult, relative to the adult who had previously interacted in a non-contingent manner. Again, this study indicates that infants form lasting representations of their positive interactions. If infants had no memory of the earlier interactions, then they would have displayed no preference during the test because both adults acted contingently. It is unclear, however, from this design whether infants formed a representation of the non-contingent (more negative) interaction because they spent little time interacting with that adult during the first visit. It is possible that infants simply remembered interacting with the contingent adult and therefore preferred that adult during the second interaction. It is also possible that infants remembered the non-contingent adult and therefore avoided that adult during the second interaction.

Similarly, Bornstein, Arterberry, & Mash (2004) tested infants' long-term memory for a social-emotional interaction by varying the adult partner's contingent behavior. At 5 months of age, a group of infants in what was termed the "experience

condition” participated in the still-face procedure (Tronick, 1989) with an unfamiliar female adult. The still-face procedure involves interrupting a contingent face-to-face interaction with a facial display of flat affect; infants typically respond robustly to the still-face with negative affect and motor reactivity (Mesman, van IJzendoorn, & Bakermans-Kranenburg, 2009). As such, infants interacted with an adult in a positive (contingent) interaction that then became negative (still-face). Fifteen months later, infants returned to the laboratory and their looking time was measured while viewing recorded videos of three women (one of whom they had seen in the 5-month still-face procedure). These “experience condition” infants were compared to another group of 20-month-olds who had not participated in the still-face procedure at 5 months (“no experience condition”). Children in the experience condition looked significantly less at the familiar woman compared to the two new women. Based on the differential looking pattern, the authors concluded that the infants retained a memory for the single, unique emotional interaction over a long delay. These findings, however, can be interpreted in a more parsimonious way. As the authors noted, it is possible that the novelty preference exhibited by children in the experience condition reflects simply the visual recognition of a familiar person, with no memory for the emotional, interactive components of the first encounter. This alternate explanation cannot be disentangled without a comparison group of infants who, at 5-months, could have been familiarized with the stranger in non-valenced interaction (e.g., presentation of the person’s face) or in an only positively valenced interaction (e.g., an interaction without the still-face). Looking times from these infants could then be compared to determine whether it was the emotional aspect, or just the familiarity of the woman, during the initial interaction that guided the novelty

preference. These additional conditions would also allow researchers to disentangle how infants remember both positive and negative social interactions.

These three studies demonstrate the remarkable ability of infants to remember single emotional interactions over delays ranging from 6 days to 15 months. It cannot be determined from these studies, however, whether infants represent and remember their positive *and* negative emotional interactions because none of the studies systematically compared infants' representations and memories of positive, negative, and neutral emotional interactions.

Evidence for a Negativity Bias in Infants' Representations of Emotional Information

It is surprising that no study has yet to systematically test infants' representations and memories of both their positive and negative interactions. Theorists have suggested that infants represent and remember both kinds of experiences (e.g., Beebe & Lachmann, 1988; Bowlby, 1969/1982, 1973; Craik, 1943; Main, Kaplan, & Cassidy, 1985; Stern, 1985). For example, Bowlby (1969/1982, 1973) theorized that infants form mental representations of their sensitive and insensitive caregivers. By representing both types of interactions with caregivers, infants would be better able to predict their caregivers' likely behavior. As such, infants should be capable of representing and remembering their positive and negative interactions, but these claims have yet to be experimentally tested.

Another line of theory and research, however, indicates that infants may display a negativity bias when representing and remembering emotional information. The negativity bias hypothesis suggests that infants "learn from, and use negative information far more than positive information" (Vaish, Woodward, & Grossmann, 2008, p. 208). This hypothesis is relevant when considering whether and how infants represent and

remember their social-emotional interactions because it suggests that infants would be biased to represent and remember their negative interactions to a greater extent than their positive interactions. If this is the case, then negative interactions may have a greater impact than positive interactions on infants' relationships with caregivers and on infants' own social-emotional development.

Evidence that infants have a negativity bias has come mainly from a reexamination of the findings from the large body of infant social referencing literature (Vaish et al., 2008). Many social referencing studies evaluated infants' approach behavior toward ambiguous stimuli after adults showed either positive or negative emotion toward the stimuli. These studies indicated that infants' approach behavior differed under these two conditions, suggesting that infants learn from the emotional displays of their social partners, both positive and negative. Vaish and colleagues (2008) noted that when social referencing studies included a neutral emotional condition, interesting patterns emerged: Infants often avoided ambiguous stimuli toward which adults had shown negative emotion, but did not necessarily approach or choose stimuli toward which adults had shown positive emotion. In fact, infants' approach behavior under positive and neutral conditions was often equal, suggesting that infants did not learn from or use the positive emotional information. There are two possible explanations for why infants may learn from and use negative information received from their social partners more than positive information. First, infants may have a negativity bias because learning from signs of threat offers an adaptive advantage (Cacioppo, Gardner, & Berntson, 1999; Vaish et al., 2008). For instance, negative information signals to infants that there is something harmful in the environment that should be avoided. Infants who learned from this

information would have an adaptive advantage over infants who did not learn from this information because they would not approach harmful people or objects. On the other hand, positive information signals to infants that everything is safe. When the environment is safe, infants can proceed with their behavior as they wish. Second, infants may have a negativity bias because negative information is more novel than positive information and thus becomes more salient than positive information.

If the negativity bias hypothesis is correct, then infants would represent and remember their negative interactions to a greater extent than their positive interactions. To date, none of the three studies examining infants' representation and memories of their own social-emotional interactions (Bigelow & Birch, 1999; Bornstein et al., 2004; Nachman et al., 1986) has included all the necessary conditions to test for a negativity bias (i.e., positive, negative, and neutral interactions; see Vaish et al., 2008). The findings of those three studies, however, have been interpreted as evidence that infants remember both positive (Bigelow & Birch, 1999; Nachman et al., 1986) and negative (Bornstein et al., 2004) aspects of their social-emotional interactions (but see descriptions and limitations of these studies reviewed above).

The only relevant studies that included all the necessary conditions to test the negativity bias hypothesis are two studies that examined infants' representations of *others'* social interactions. The first of these studies found no support for the negativity bias hypothesis (Hamlin et al., 2007). In this study, after observing the social interactions of others, 6- and 10-month-old infants preferred to choose a positive puppet over a negative puppet, a positive puppet over a neutral puppet, and a neutral puppet over a negative puppet. This pattern of findings suggests that infants equally use negative and

positive information when forming representations about the social interactions of others. The second study, however, found support for the negativity bias hypothesis (Hamlin et al., 2010). In contrast to the findings from the choice paradigm with 6- and 10-month-old infants (Hamlin et al., 2007), this study found that after observing the social interactions of others, 3-month-old infants looked significantly longer at a neutral puppet than a negative puppet, but looked equally long at a positive puppet and a neutral puppet. These findings support the hypothesis that infants are biased to “learn from, and use negative information far more than positive information” (Vaish et al., 2008, p. 208) when representing the social interactions of others because they did not develop a preference between the positive and neutral puppet.

Given this limited and mixed evidence, it is unclear whether to expect a negativity bias in infants' representations and memories of their own social-emotional interactions. The theoretical argument on which the present study is based suggests that infants represent and remember both positive and negative aspects of their interactions with others. Nonetheless, it is possible that although infants represent and remember both types of interactions, they build stronger and more robust representations and memories of their negative interactions.

Present Studies

Given the theory and supporting research indicating that infants mentally represent and remember their social-emotional interactions, this research had two aims. The first aim was to identify whether infants form initial representations of their own social-emotional interactions, both positive and negative. The second aim was to determine whether infants remember their own social-emotional interactions, both

positive and negative. To address these aims, I conducted a set of two related studies. Participants were 10-month-old infants. Given that these were the first studies to assess infants' representations and memories of their own positive and negative interactions, I chose this age because previous research has shown that infants of this age (or younger) have the cognitive ability to represent and remember important aspects of both others' and their own social-emotional interactions (e.g., Hamlin & Wynn, 2011; Nachman et al., 1986; see also Rochat & Striano, 1999). In each of the studies, puppets were used as the social partners for two reasons. First, puppets allow for a more standardized procedure than human partners because the use of puppets controls for differences in people's facial expressions and visual attention. Second, puppets have been used consistently in the literature to test infants' mental representations of social and emotional interactions (e.g., Hamlin et al., 2010; Nachman et al., 1986). During the positive interaction, a puppet gave the infant a toy and interacted in a contingent, positive manner, whereas in the negative interaction, a puppet took a toy away from the infant and interacted in a punitive manner.

Across these studies, I hypothesized that infants would represent and remember their social-emotional interactions as evidenced by their subsequent choice between two emotionally valenced social partners and preferential looking between the two emotionally valenced social partners immediately after their interactions and after a 10-minute delay (see Table 1 for a list of the study hypotheses and research questions).

Chapter 2: Study 1

Research Goal and Hypotheses

Study 1 was designed to test infants' immediate representation and later memory for their social-emotional interactions. In this study, each infant interacted with a positive and a negative social-emotional interaction partner. Immediately following these interactions, infants' representations were assessed using a preferential looking test (i.e., visual paired comparison; VPC) and a choice paradigm. These outcome measures were then repeated after a 10-minute delay to test for evidence that infants remembered the interactions. Based on the theoretical position that infants form representations and memories of their own social-emotional interactions and the related research reviewed above, I hypothesized that infants would choose the positive social partner more often than the negative partner because they prefer positive social partners in both the immediate (Hypothesis 1a) and the delayed tests (Hypothesis 1b; see Table 1 for a summary of study hypotheses and research questions). With regard to the preferential looking test, I expected that infants would show differential looking patterns toward the two puppets, such that, consistent with previous research (e.g., Bigelow & Birch, 1999; Hamlin et al., 2010; Nachman et al., 1986), infants would prefer to look at the positive puppet during the immediate (Hypothesis 2a) and delayed tests (Hypothesis 2b).

Additionally, given the potential for individual differences in how infants react to the positive and negative interactions, I tested whether infants' emotional intensity during the interactions played a role in infants' representations and memories of the interactions. It may be that infants' perception of the interactions (assessed by their emotional reactions) more strongly predicts their choice and preferential looking than the objective

valence of the interactions as positive, negative, or neutral. For example, some infants may not find the toy removal to be as negative as other infants who may become very upset. As such, I explored the research question: Does the intensity of infants' emotional reactions during the social-emotional interactions affect infants' representations and memories of their social-emotional interactions? Stated alternatively, do infants' perceptions of the social-emotional interactions predict above and beyond or interact with the objective valence of the interaction to predict infants' subsequent choice behavior (Research Question 1a) and preferential looking (Research Question 1b) between the two social partners?

Method

Participants. Participants were 24 (15 female) full-term, 10-month-old infants ($M_{age} = 10.07$ months, $SD = .25$, range: 9.67 – 10.47 months). An additional seven infants were tested, but excluded due to infant fussiness, failure to make a discernable choice during test, parental interference, and procedural error. Infants were recruited via (a) the Maryland Infant & Child Studies Database which utilizes mailings and follow-up phone calls, (b) flyers posted in the community, (c) an online “participate in research” form on the laboratory website, and (d) participant referrals. Infants received a certificate of participation and a small gift. The University's Institutional Review Board (IRB) approved recruitment procedures and study protocols (see Appendix B).

Infants were racially and ethnically diverse (50% White/Caucasian; 29% Bi-racial [including White/Black, White/Asian, White/Hispanic, and Black/Hispanic]; 17% Black/African-American/African, and 4% Asian/Pacific Islander). The majority of infants

lived with both married parents (96%), and had parents that had completed at least a Bachelors degree (92% of mothers and 83% of fathers).

Apparatus and stimuli. In the testing room infants were seated on their parent's lap at a table facing a commercially available puppet theater with a curtain (approximately 30 inches away, see Figure 1). The walls of the testing room were covered with black curtains to minimize distractions. One camera was located below the puppet stage facing the infant to capture the infants' behavior and attention. Another camera was located behind the infant facing the puppet stage to capture the displays that the infant is seeing. The two videos were combined with editing software in a picture-in-picture display via computer recording behind the black curtains. A third camera was mounted at the side of the puppet theater to capture the infants' behavior during the choice tests (see below).

Social partners were two commercially available puppets: a brown bear and a yellow bear (see Figure 2). These puppets were chosen because they appeared sufficiently visually distinct in color and facial features to facilitate discrimination of the two puppets when they are not both present, but sufficiently similar in size and shape so that neither one would attract more visual attention than the other. Pilot testing confirmed that infants did not have a consistent preference between these two puppets. During this pilot test, 21 out of 24 infants made a clear choice between the two puppets, which was defined as the first single puppet the infant touched while looking at that puppet. Of the 21 infants who made a clear choice, 11 (52.4%) chose the yellow bear (binomial test, $p = 1.00$), indicating that overall, infants did not have a preference toward one puppet. I also analyzed whether infants' demonstrated a side bias during their baseline choices. Infants

did not have an overall side preference during this baseline choice: 11 of 21 infants (52.4%) chose the puppet on the experimenter's right hand (binomial test, $p = 1.00$). Finally, there was no relation between puppet choice and side choice (Fisher exact probability test, $p = 0.39$). Thus, the puppets are assumed to be exchangeable. The puppets interacted with the infants in a toy exchange game (detailed below) using a commercially available, age-appropriate, attractive toy (see Figure 2).

Procedure. Infants were brought to the laboratory by their parent(s). Informed consent was obtained. There was a brief warm-up period in the waiting area while parents completed informed consent. The purpose of this warm-up period was to get infants acquainted and comfortable with the new situation and experimenter B, who later presented the puppets for the infant to choose. When the experimenter and the parent believed that the infant was comfortable and had interacted with the experimenter, the experimenter escorted the parent and infant into the testing room.

There was a practice choice game before the interactions began with different puppets that paralleled the later choice test. The purpose of this practice game was four-fold. First, the game allowed infants to become more comfortable and familiar with the experimenter. Second, the game introduced infants to puppets, which was important because several parents who participated during pilot testing reported that their children had never before seen puppets. Third, the game allowed infants to practice reaching for puppets on both sides of the presentation. Fourth, the game allowed infants to learn that when they make a choice they obtain the chosen puppet and that the other puppet becomes no longer available. For this practice game, the parent sat facing 90 degrees from the puppet stage. Experimenter B presented a series of three unique puppet pairings

to the infant with four puppets. These four puppets (gray mouse, brown monkey, gray bunny, and brown fox; see Figure 3) were similar in size to the social partners used in the study (yellow and brown bear). For each trial, Experimenter B showed the infant the two choices initially out of the infants' reach, maintaining her attention on the infant, gently shook the choices, and said, "Look." Once the infant had looked at each choice, the experimenter said, "Which one do you want?" The experimenter waited until the infant looked at the experimenter and then moved the puppets forward. It was required that the infant look at the experimenter during the prompt because it was possible that infants would simply choose the puppet they were looking at when the experimenter moved the puppets forward. Pilot testing indicated that the prompt from the experimenter, "Which one do you want?," was sufficient to draw the infants' attention back to the experimenter before the puppets were moved forward. After the infant touched the first puppet, the experimenter removed the other option from the infant's sight and allowed the infant to play with the chosen puppet for 15 seconds. For the first trial, one puppet was presented on the experimenter's right hand. For the second trial, another puppet was presented on the experimenter's left hand. These trials provided practice reaching to each side. Then, for the third trial, the two puppets were presented together. This three trial procedure was repeated with a second set of puppets. Lastly, the three trial procedure was repeated with one puppet from the first set and one puppet from the second set (see Appendix D for the full procedural details of this practice choice game).

Next, parents faced the puppet stage with their infants on their laps. Infants participated in a baseline 30-second visual paired comparison (VPC) to obtain a measure of baseline looking preference to the two study puppets (Brown vs. Yellow Bear) and a

measure of side bias (see Appendix E). Starting side of the puppets was counterbalanced between infants and sides were switched at the mid-way point within presentations (15 seconds). Puppets bounced slightly up and down for 5 seconds, then slightly side to side for 5 seconds, and then remained still for 5 seconds while presented on each side.

Then, infants participated in the social-emotional interactions with the puppets. One puppet acted as a positive social partner and the other puppet acted as a negative social partner. First, an experimenter gave the infant the toy to play with for 30 seconds. Then, the first puppet entered from behind a curtain. Experimenter A acted as the puppeteer while Experimenter B remained blind to the identity of the puppets. The order of the positive puppet (First vs. Second), the identity of the positive puppet (Brown vs. Yellow), and the side of the positive puppet during test events (Left vs. Right) was counterbalanced across infants. If the positive puppet appeared first, it interacted with the infant in a positive, contingent manner (on subsequent trials, the positive puppet gave the infant the toy and interact in a positive, contingent manner). The negative puppet took the toy away from the infant and interacted in a negative, punitive manner (for full procedural details including timing and prototypical script, see Appendix F).

The trials varied slightly across infants because the goal was to provide each infant with a positive and negative interaction with the puppet. For some infants, a positive interaction was slower paced with low intensity positivity, whereas for others, a positive interaction was fast paced and more active. The puppeteer followed a set script, with slight modifications to ensure that the interaction was contingent and positive. For the negative interaction, the goal was to provide a negative interaction with the puppet. If, however, infants became very upset, they were unable to continue in the study. As such,

negative interactions were also tailored so that infants were not so upset that they were crying and needed to stop. Positive and negative puppets alternated in three trials each.

The procedure for this alternating toy exchange game was based on the toy retraction task from the Laboratory-Temperament Assessment Battery (Goldsmith & Rothbart, 1999) which is a well-used, validated assessment for eliciting negative affect (i.e., frustration/anger) from infants of this age (see Appendix G). During the toy retraction task, an infant's mother allows her infant to play with a toy for 15 seconds and then removes the toy from the infant's reach but keeps the toy in sight for 15 seconds. This set is then repeated for a total of three times. These standard procedures were modified for use with alternating puppets and lengthened (from 15 seconds to 40 seconds) to provide more time for the infant to identify the partner and to establish an interaction between the puppets and the infant. Given that the goal of this study was to provide infants with a first-person interaction, rather than a third-party observation, trials were added if infants had yet to interact or engage with the puppets after the first three trials. If infants had not reached for the toy or the puppets, vocalized toward the puppet, or reacted emotionally to the puppets, on at least 2 of the trial, then additional trials were added to ensure that all infants interacted with the puppets at least twice. This contingency plan ensured that all infants had an interaction regardless of individual differences in processing time or temperament (e.g., "slow-to-warm-up" babies; Thomas & Chess, 1977). To be included in the study, infants were required to interact on at least 2 trials of each positive and negative valence. This familiarization procedure was chosen as opposed to an habituation procedure because infants may look away from the negative trials sooner than the positive trials and because if infants become habituated to the

positive puppet, then they are no longer interested in engaging with the positive puppet and thus, the positive puppet would no longer be considered positive.

This final procedure for the toy exchange game was determined after testing versions of the game during a pilot testing phase. In consultation and collaboration with my advisor, Jude Cassidy, and in consultation with an expert in field of infants' negative reactivity using Lab-TAB tasks, Cindy Stifter, I altered my original procedure in several ways to create a procedure that was successful at providing the majority of infants with a positive and negative social-emotional interaction. First, the initial toy exchange game alternated in only 15-second trials (following the Lab-TAB toy retraction procedure; Goldsmith & Rothbart, 1999) rather than 40-second trials. The 15-second trials were insufficient to establish a social interaction. On some negative trials, this timing was insufficient to take the toy away from the infant if the infant was seated farther back or struggled against the toy removal. Second, the initial procedure had no contingency plan to add trials if infants failed to interact on the first three trials. A few infants never accepted the toy from the puppets or never played with the toy in between the positive and negative puppets. When an infant never plays with the toy, then the negative puppet never directly takes the toy away from the infant, but rather, picks up a toy on the table that the infant is not interested in and holds it. After adding the contingency plan, one infant failed to interact on the first three trials. Two additional trials were added for that infant and the infant interacted on those trials (i.e., the infant accepted the toy from the puppet and was using the toy when the negative puppet took the toy away). Third, in order to increase the negativity of the toy removal, infants were allowed to play with the toy for 30 seconds before the puppets began interacting with them. This time was

included to allow infants who may be slow-to-warm-up (Thomas & Chess, 1977) to explore the toy and become fully interested in the toy. Then, when the negative puppet took this toy away, infants would find it more frustrating than if they had yet to play with the toy. Fourth, in order to increase the infants' enjoyment of the positive interactions, the positive puppet was altered from being overly positive during the entire trial to be contingent upon the infants' behavior to create a more fluid turn-taking interaction. For example, some infants began a sharing game with the positive puppet taking turns handing the toy to the puppet and accepting the toy from the puppet with delight at each turn (with the positive puppet saying "Thank you" and "Here you go"), whereas other infants shake the toy up and down (with the positive puppet mimicking the motions and saying, "Yay, listen to that"). Lastly, the negative puppet was altered to be more forceful by taking the toy sooner in the interaction and saying more negative phrases. After reviewing video from before and after these changes, we were confident that these adjustments were successful at providing the majority of infants with both a positive and negative interaction (note, however, that 2 of 26 infants were too upset to participate. One infant became upset and began crying when the first puppet emerged from behind the curtain. After several attempts with breaks in between, the infant was still too upset to participate in the interactions. The other infant was slow-to-warm-up to the experimenters. The parents reported that the infant was often wary of strangers and new situations. This infant became upset and began crying after the toy removal. After several attempts with breaks in between, the infant was still too upset to participate in the interactions.).

After the interactions, infants were given an immediate visual paired comparison (VPC) test (15 seconds; side of each puppet will be counterbalanced across infants; see Appendix E) followed by a forced choice test between the two puppets (see Appendix D). For the VPC test, puppets were presented at the puppet theater. For the choice test, parents turned 90 degrees away from the puppet theater, facing a sidewall, as in the practice game. Experimenter B, who conducted the practice game and was blind to the identity of the two puppets, presented the puppets on her hands initially out of the infants' reach, saying "Look" and gently shaking the puppets. Infants were required to look at each puppet and the experimenter prompted the infant, "Which one do you want?" and then moved the puppets within the infant's reach (see Appendix D for full details of the choice test).

Next, infants and their parents had 10 minutes of playtime in another room with set of three infant toys. Lastly, infants returned to the puppet theater with their parents to participate in a VPC and choice test identical to the one conducted immediately after the interactions.

Measures

Choice. Infants' choice between the two puppets was coded as the first puppet intentionally touched (i.e., touched while looking at or had looked at immediately prior to the touch). The presenting experimenter judged infants' choices in real-time during the choice test. Once infants made a choice between the two puppets, the experimenter removed the unselected puppet from the infants' sight. Coders were blind to the valence of the puppets. A second researcher who was blind to the valence of the puppets viewed each participants' video of the choice test procedures to ensure that the presenting

experimenter followed the procedure accurately and judged infants' choice correctly. Based on this viewing, four infants were excluded from the study.

Preferential looking. Infants' looking during the baseline, immediate, and delayed VPC tests were coded continuously from videos using INTERACT software to obtain measures of gaze duration in seconds. Coders were blind to the valence of the puppets. Infants' direction and duration of gaze were coded as looking at the left puppet or looking at the right puppet. These codes were then matched with information on which side the positive and negative puppets were presented, resulting in two scores for each VPC test: Looking toward the positive puppet and looking toward the negative puppet expressed in duration of seconds. Inter-rater reliability between two coders was assessed on 100% of cases using intra-class correlations. Reliability was high (ICC = .95). Disagreements were be averaged.

Emotionality during the interactions. The intensity of infants' emotionality during the positive and negative social-emotional interactions was coded in every 5-second segment for positivity and negativity across 3 modalities each: facial expression, physicality, and vocalizations. The intensity for each modality was rated on a scale from 0 (none/neutral) to 3 (high). For example, intensity of positive facial expressions was coded as 0 (none/neutral), 1 (mild: such as a brief, closed mouth smile), 2 (medium: such as an open mouth smile or longer mild smile), or 3 (high: such as large open smile). Similarly, negative facial expressions were coded from 0 (none/neutral), 1 (mild: one facial region shows codeable engagement, such as a furrowed brow), 2 (moderate: two facial regions show codeable engagement, such as brows and eyes or mouth), or 3 (high: all 3 facial regions show codeable engagement, such as brow, eyes, and mouth). The full

coding manual and scales are presented in Appendix H. These scales are modified versions of the scales from the Lab-TAB coding for the toy retraction task and joy episodes (Goldsmith & Rothbart, 1999; see Appendix G). The Lab-TAB scales were modified to reflect the subtle emotional shifts that occur in this procedure when full intensity crying is not codeable, and to include multiple negative emotions (anger, fear, and sadness) in one scale.

Infants' emotionality scores for the positive and negative modalities were summed separately across the positive and negative trials, separately, resulting in 4 scores: positivity during positive social partner, negativity during positive social partner, positivity during negative social partner, negativity during negative social partner, and/or positivity during neutral social partner, and negativity during neutral social partner.

Although coders were necessarily aware of the interactions that the infants were participating in, they were blind to all other details of the participants. For example, coders were not aware of which puppet the infants chose during test events. Inter-rater reliability between 2 coders was assessed on 25% of cases in each study using intra-class correlations. Reliability was high for the both negativity (ICC = .92) and positivity (ICC = .95). Disagreements were resolved by conferencing with the graduate student team leader who was also blind to other information about the participants.

Visual attention during the interactions. Coders who were blind to the valence of the interaction and the information about the infants' subsequent choices coded infants' visual attention during the social-emotional interactions. Using INTERACT software to obtain measures of gaze duration in seconds, coders examined where infants were

looking during the interactions and marked when infants were looking forward at the puppet. Reliability was assessed on 71% cases and was high (ICC = .98).

Results

Preliminary analyses

Violations from normality. Continuous outcome variables (i.e., looking time toward the positive and negative puppet in the immediate and delayed tests) were examined for violations from normality. I conducted the one-sample Kolmogorov-Smirnov test of normality to examine each of the variables. None of the distributions for the continuous outcome variables differed significantly from a normal distribution: Immediate test ($M_{pos} = 6.03$, $SD = 1.91$, $KS = .46$, $p = .98$; $M_{neg} = 5.58$, $SD = 2.72$, $KS = 1.07$, $p = .21$) and delayed test ($M_{pos} = 6.36$, $SD = 2.43$, $KS = .73$, $p = .66$; $M_{neg} = 6.25$, $SD = 3.22$, $KS = .94$, $p = .34$). As such, looking time scores were kept in the original scale (i.e., seconds) and were not transformed. Subsequent analyses were based on the normal distribution.

Side bias. In order to investigate whether infants displayed a baseline side bias while looking toward the puppets, I compared their total looking time to the right side ($M = 13.49$, $SD = 3.65$) to their total looking time to the left side ($M = 13.70$, $SD = 4.99$) during the baseline VPC with a paired-samples t-test. There was no evidence that infants were biased to look to one side over the other, $t(23) = -0.13$, $p = .896$.

Infants' behavior during the social-emotional interactions. In order to ensure that infants were engaged in the social-emotional interactions, I examined infants' visual attention during the social-emotional interactions and their emotional reactions to the social-emotional interactions.

Visual attention. Means and standard deviations of infants' visual attention during the social-emotional interaction are presented in Table 2. A repeated-measures analysis with the within-subjects factors of Puppet (Positive vs. Negative) and Trials (1 vs. 2 vs. 3) were entered as predictors of infants' visual attention during the social-emotional interactions. Overall, infants spent more total time looking at the negative puppet than the positive puppet during the interactions as evidenced by a main effect of Puppet, $F(1,23) = 9.58, p = .005$. As such, infants' visual attention during the interactions will be examined as a potential confound in the principal analyses. For each puppet, infants spent less time looking at the puppet with each additional trial as evidenced by the main effect of Trials, $F(2,46) = 1.66, p < .001$, and the lack of the Puppet \times Trials interaction, $F(2, 46) = .061, p = .94$.

Emotion. In order to understand infants' emotional reactions to the puppets, I conducted a repeated measures analysis with the within-subjects factors of Puppet (Positive vs. Negative), Emotion (Positivity vs. Negativity), and Trials (1 vs. 2 vs. 3) entered as predictors of infants' emotionality during the social-emotional interactions. There was a main effect of Puppet, $F(1, 23) = 4.90, p = .037$, that was qualified by the two-way interaction between Puppet and Emotion, $F(1, 23) = 31.45, p < .001$. The lack of an effect for Trials or any interactions including Trials indicated that infants displayed similar levels of emotionality as the trials progressed. Each puppet interaction elicited the intended emotion: the interaction with the negative puppet elicited more negativity ($M_{diff} = 12.25, SE = 2.60, p < .001$) and less positivity ($M_{diff} = -6.40, SE = 1.50, p < .001$) from infants than the positive puppet, the level of negativity was higher than positivity with the negative puppet ($M_{diff} = 10.18, SE = 2.98, p = .002$), and the level of positivity was higher

than negativity with the positive puppet ($M_{diff} = 8.47, SE = 1.70, p < .001$) (see Figure 4). The main effect of Puppet alone would have been interpreted as infants expressing more emotional intensity during the negative interaction than the positive interaction, but after taking into account the valence of the observed emotions with the two-way interaction, that pattern no longer held. Examining the levels of congruent and incongruent emotionality in the interaction contexts demonstrated no difference in the intensity of the infants' emotionality in the two valenced conditions: the amount of negativity expressed during the negative puppet interaction was not significantly different from the amount of positivity expressed during the negative puppet interaction ($M_{diff} = 3.78, t(23) = 1.31, p = .20$), nor was the amount of positivity expressed during the negative puppet significantly different from the amount of negativity expressed during the positive puppet ($M_{diff} = 2.07, t(23) = 1.74, p = .09$). Although, overall, the results indicated that the infants' emotional reactions were congruent with of the assigned valence of the puppets, there was variation in the intensity with which individual infants expressed these emotions (see Figure 4). Thus, infants' emotionality will be used a predictor of choice and looking time outcomes in testing research question 1a and 1b.

Principal data analysis.

Choice. In order to test the hypothesis that infants are more likely to choose the positive puppet in the immediate (Hypothesis 1a) and delayed tests (Hypothesis 1b), I conducted 2 one-tailed binomial tests, testing whether the number of infants who chose the positive puppet was greater than chance (50%; i.e., 12/24 infants). Contrary to Hypothesis 1a, only 15 of 24 infants (62.5%) chose the positive puppet in the immediate test, which was not significantly different from chance ($p = 0.15$). In support of

Hypothesis 1b, 17 of 24 infants (70.8%) chose the positive puppet in the delayed test, which was significantly different from chance ($p = 0.03$). Thus, a significant effect was observed in the delayed test only.

To address Research Question 1a, I tested whether individual differences in infants' emotionality during the interactions predicted infants' choices in the immediate and delayed tests. I conducted two logistic regressions, one for each test, with infants' emotionality scores as the predictors. The results indicated that infants' observed emotionality was not related to their choice in either the immediate or delayed choice test as evidenced by non-significant main effects for each of the emotionality variables. Thus, infants who expressed greater negativity with the negative puppet or more positivity with the positive puppet were no more likely to choose the positive puppet than infants who displayed less strong emotional reactions. The choice effect observed in the delayed test was thus related to the assigned emotional valence, rather than infants' expressed emotion.

Potential confounds. In order to verify that extraneous factors were unrelated to infants' choice behavior and thus, did not confound the results, I conducted two logistic regression analyses, one for each choice test. For each test, infants' age (expressed in number of days old) was entered in Step 1, the counterbalancing factors (side, order, and color of the positive puppet) were entered in Step 2, and infants' visual attention during the interactions (i.e., total duration of seconds spent looking at the positive puppet and the negative puppet during the interactions) was entered in Step 3. As expected, for both the immediate and delayed tests, infants' age, the counterbalancing factors, and infants' visual attention were all unrelated to infants' choices. Thus, although infants spent more

time attending to the negative puppet, this difference in amount of visual exposure was unrelated to their choice behavior.

Preferential Looking. In order to test my hypothesis that infants' looking times would differ between the positive and negative puppet (Hypothesis 2) at both the immediate test and the delayed test (Hypothesis 2a and 2b, respectively), I conducted a Generalized Estimating Equations (GEE) analysis. Looking time was entered as the dependent variable. The predictors were the within-subjects factors of Social Partner (Positive vs. Negative) and Test (Immediate vs. Delayed). The effects of interest were the main effect of Social Partner and the Social Partner \times Test interaction. A significant main effect of Social Partner with no Social Partner \times Test interaction would support Hypothesis 2 by indicating that infants' did not look equally at the two puppets during the test outcomes and that infants' patterns of looking were similar across the immediate and delayed tests.

The results of this analysis provided no support for Hypothesis 2 in either the immediate or delayed test. Neither of the main effects was significant (Test: Wald Chi-square = 2.03, $p = .155$; Partner: Wald = .19, $p = .661$) nor was the Partner \times Test interaction (Wald = .15, $p = .694$). Infants' looking times between the positive and negative puppet were not significantly different in either the immediate ($M_{pos} = 6.04$, $SD = 1.91$; $M_{neg} = 5.58$, $SD = 2.72$; $p = 0.47$) or delayed test ($M_{pos} = 6.36$, $SD = 2.43$; $M_{neg} = 6.25$, $SD = 3.22$; $p = 0.90$).

To address Research Question 1b, I tested whether individual differences in infants' emotionality during the interactions predicted infants' looking time in the immediate and delayed tests. I conducted separate GEE analyses, one for the immediate

test and one for delayed test, in order to reduce the number and complexity of the necessary interactions, thus increasing the power with which to find an effect. For each GEE, Partner (Positive vs. Negative) was entered as a within-subjects variable to the differences in infants' looking time during the VPC test and infants' emotionality scores were entered as between-subjects variables. The effects of interest for each GEE were the two-way interactions between partner and each of the emotionality score variables. If any of these interactions were significant, then it would indicate that infants' emotional experience related to their preferential looking between the two puppets. For the immediate and delayed tests, however, none of the interactions of interest was significant. There were, however, main effects of infants' positive emotionality for both the positive interactions (Wald $\chi^2 = 4.85, p = .028$) and the negative interactions (Wald $\chi^2 = 8.12, p = .004$) on overall looking times that were not present in the delayed test. Greater positive emotionality during the interactions was related to greater overall looking time at the test display, but not at a particular puppet: Puppet \times Emotionality Scores interactions were not significant; all p -values $> .10$. This may reflect infants' greater interest in interacting with puppets overall.

Potential confounds. In order to verify that extraneous factors were unrelated to infants' looking time during test and thus, did not confound the results, I conducted an additional GEE analysis adding the between-subjects factors of infant age, the counterbalancing factors, and infants' visual attention during the interactions. Results of this analysis indicated that, as expected, none of the extraneous factors were related to the infants' looking times during the preferential looking tests. Furthermore, controlling for these variables did not change the significance of the effects of interest.

A negative correlation did emerge between the difference scores in infants' visual attention during the social-emotional interactions (with positive scores indicating greater looking toward the negative puppet than the positive puppet) and the amount of time infants spent looking at the negative puppet during the immediate VPC test ($r = -.418, p = .042$). Thus, infants who spent a greater amount of time attending to the negative as compared to the positive puppet during the social-emotional interactions looked less at the negative puppet during test. Importantly, however, the amount of differential attention during the interactions was not related to infants' looking at the positive puppet during the immediate VPC test ($r = .072, p = .738$). Together, these results show an interesting pattern in infants' attention: infants who showed greater attention to the negative puppet than the positive puppet during the interactions looked away from the negative puppet more during test, yet they did not look longer at the positive puppet. The result is not indicative of a confound because the imbalance in visual attention during the interactions was not related to preferential looking in the VPC test. The fact that infants had greater visual attention to the negative puppet would have been concerning if it had been related to infants looking longer at the positive puppet during the test events because that could be interpreted as a novelty effect (see Pascalis & de Haan, 2003), rather than a preference due to the emotional valence of the puppet. In the results from the overall sample as well as the correlations between individual differences in infants' looking time, there was no evidence of novelty or familiarity effects in infants' preferential looking during test.

Discussion

The goal of Study 1 was to establish, for the first time, whether infants represent and remember their positive and negative social-emotional interactions. This was the first study to include both positive and negative interactions when infants were active participants. Infants were familiarized to a positive and negative puppet in a within-subjects design over 3 alternating interactions for each puppet. Immediately after and 10-minutes after the interactions, infants' preferences were tested in a visual paired comparison and forced-choice test. Although infants did not display a preference in their choices immediate following the interactions, they were more likely to choose the positive puppet after 10 minutes. This finding suggest that infants of this age (10 months) may need time to process and consolidate the information received during brief social-emotional interactions (see also McGaugh, 2000).

The fact that infants showed no preference during the immediate test may seem surprising given that much younger infants (e.g., 6- to 8-month-olds) have demonstrated preferences between puppets they observed help and hinder other puppets (e.g., Hamlin & Wynn, 2011; Hamlin et al., 2011). There are at least three important distinctions between those studies and the current study that may help explain the seemingly inconsistent results. First and foremost, infants in the Hamlin and colleagues' studies were passive observers of the social interactions of others, whereas in this study, infants were active participants in the social interactions. Thus, infants had the ability to – and may have even attempted to – influence the interactions through their reactions, attention, and social bids (e.g., smiling, reaching toward the puppets, protest vocalizations). Moreover, these active interactions in addition to tapping into infants' views of social

partners and relationships in general (as Hamlin's studies address), also tap into infants' views of the self. Second and relatedly, the interactions in this study were designed to elicit positive and negative emotion from the infant participants, whereas this was not the goal in Hamlin's studies. It is possible, however, that infants in Hamlin's studies were experiencing emotions as a result of viewing the interactions. They may have felt vicarious emotional states from seeing the puppets help and hinder each other or developed emotional feelings toward each of the puppets. Thus, it is unknown to what extent infants' emotions played a role in the difference between these sets of studies. Nonetheless, it is possible that different processes underlie the social evaluations made while observing others versus interacting with others, particularly when infants are emotionally engaged in the interactions. Infants may need time to recover emotionally after an initial bombardment of social-emotional information and return to a baseline state to demonstrate their preference. A similar pattern of results occurred in Nachman et al.'s (1986) study in which infants showed no visual preference between a positive, familiar puppet and a novel puppet two minutes after they interacted with the positive puppet, but looked significantly longer at the positive puppet one week later. These results mesh more generally with research on memory and emotion by supporting the idea that memories are consolidated slowly over time, and specifically that emotional arousal enhances memory consolidation (see McGaugh, 2000). For example, adult's recognition for emotionally arousing words was better after a delay than immediately after presentation (Sharot & Phelps, 2004). Together, these results suggest that when infants are engaged in their own social interactions, they need time emotionally to return to a baseline, unaroused state in order to evaluate the interaction.

Additionally, infants in the Hamlin and colleagues' studies were habituated to the social interactions that they observed (witnessing between 8 and 15 trials), whereas infants in the current study were familiarized to the puppets in a set number of trials (i.e., three 40-second interactions for each puppet). The infant-controlled habituation technique is tailored to each infant by continually showing the display until infants reduce their overall attention to the display to half of their original looking time (see Colombo & Mitchell, 2009). Researchers using habituation can be relatively confident that each infant has encoded and processed the display because infants are no longer interested in the display and the number of trials was tailored to each infant to account for individual differences in processing speed. In the current study, however, it would have been inappropriate to habituate infants to the positive and negative interactions. If infants habituated to these emotional and personal interactions, then the valence of the interactions could have been lost. For example, consider what the experience would be of an infant who initially had a positive emotional interaction with a puppet, but then became bored and uninterested in the interaction (i.e., habituated to the interaction). It is unlikely that this infant would hold a positive representation of the puppet under those conditions. Moreover, adding additional negative trials could have produced too much negative emotion in infants causing them to become too upset to participate in the test events. Nevertheless, it may be that three brief interactions were insufficient for infants to form a complete representation of these complex interactions at the immediate test (for reviews on factors affecting infants' memory development, including encoding time and individual differences in processing speed, see Colombo & Mitchell, 2009; Hayne, 2004; Rose, Feldman, & Jankowski, 2004). It is possible that infants were still forming their

representations of the puppets. It is important to remember that infants were tested immediately after the emotional interactions ended with only a 10-second delay, similar to what occurred between the positive and negative interactions during familiarization, in the same room as the interactions took place. When the puppets were presented for the outcome tests, infants may have continued adding information about the puppets into their representation while the test events took place. This would explain why the effect was only observed in the delayed test. The 10-minute delay period, which occurred in a different room, may have allowed infants mentally to process and consolidate their representation of the puppets because it was clear that the interactions had ended and they were not adding information to the representation. Alternatively, it was possible that the 10-minute delay with a parent-child toy-play session could have interfered with infants' abilities to consolidate the memory. This was not the case in this study and is consistent with the results of another study with 20-month-old infants showing no difference in their deferred imitation performance after 10-12 minute filled versus unfilled delay conditions (Bauer, Van Abbema, & de Haan, 1999).

The idea that infants' individual processing speed might relate to their ability to form representations and memories of the puppets is also highlighted by the result that infants who initially chose the positive puppet were more likely to chose the positive puppet again, but this pattern of consistent choice was not observed for the negative puppet. Thus, a set of infants consistently chose the positive puppet, which could reflect random variation and error or could point to a sub-set of infants who were able to form immediate representations and later memories of these social-emotional interactions. Perhaps due to differences in infants' processing speed, three interactions were sufficient

for some infants to form representations, whereas other infants may have needed more trials (see Colombo & Mitchell, 2009; Hayne, 2004; Rose et al., 2004). Aware of this possibility from the design phase of the study, I created a protocol whereby infants would receive additional interaction trials if it was evident that had not yet interacted with the puppet (e.g., never accepting the toy from the positive puppet, sitting still and watching the puppets). One infant required an additional trial, thus ensuring that all participants interacted with the puppets on at least 2 trials. Aside from establishing that protocol, there is no other way to determine whether each infant received sufficient exposure to the puppets in order to form a representation. I did, however, test to see if any demographic or other study variables related to the infants' choices and none of the tested demographic variables (i.e., infant age, sex, and having an older sibling) or study variables (i.e., infants' visual attention during the social-emotional interactions) could account for the difference between these groups of infants.

Although unrelated to infants' choice or their preferential looking during test, it is interesting to note that infants spent more time looking at the negative puppet during the interactions than the positive puppet. This can be explained simply by the fact that when interacting with the positive puppet, infants have access to a toy (most infants are holding the toy) and thus, spend time looking at the toy. Considering that the positive and negative interactions are equal in length, time looking at the toy is by default time taken away from looking at the puppet. It is also possible, however, that this difference reflects an important difference in understanding infants' social-emotional interactions. One explanation could be that infants likely have less experience in this kind of negative interaction which makes the interaction more novel and difficult to process, thus

requiring more of their attention (see Vaish et al., 2008). Another explanation for this greater attention toward the negative puppet could be based on infants' wariness and attention to negative information. Regardless of the novelty of the negative interaction, infants may be biased to attend to negative information because of an evolutionary advantage from attending to threatening stimuli (Vaish et al., 2008). The more parsimonious explanation in the present study is related to the location of the toy in the two conditions. The design of this study does not allow for a test of these two alternate hypotheses that are unrelated to the overall goal of the study. Researchers who are interested in understanding this phenomenon could design positive and negative interactions without the reliance on a toy exchange to appropriately test these possible explanations.

It was surprising that there were no differences in infants' looking time toward the positive and negative puppet during the immediate or delayed VPC tests. I had hypothesized that infants would look longer at the positive puppet than the negative puppet based on the idea that their experiences would lead them to prefer the positive puppet and that infants look longer at stimuli that they prefer. Moreover, after seeing that infants chose the positive puppet more often than chance in the delayed test, I expected that they would have looked longer at the positive puppet in the delayed VPC test, at least. This was not the case however and individual differences in looking time during the VPC tests were unrelated to infants' choices; that is, infants did not look longer (or shorter) at the puppet they subsequently chose. It is possible that infants' attention during the VPC tests was drawn toward both puppets simultaneously due to a preference for the positive puppet *and* wariness of the negative puppet. Thus, infants may have represented

and remembered both puppets, yet under these conflicting attention biases, demonstrated a null effect. This explanation fits even with the choice outcomes: Although their attention may have been drawn by both puppets, when forced to choose between the two puppets, infants chose the preferred, positive puppet. Wariness of the negative puppet may have drawn infants' attention, but would not translate into their choice of the negative puppet.

Lastly, the consistent pattern of infants' emotionality during the interactions and the fact that infants' individual emotional experience did not relate to their subsequent choice or looking behavior suggests that infants experienced the interactions with the puppets as appropriately positive and negative, as assigned, despite outward differences in their emotional reactions. The intensity of infants' responses may be related to their underlying temperament (see Zetner & Shiner, 2012). For example, infants who responded with less negativity and positivity may have less reactive temperaments than other infants, but they still had the experience of interacting with negative and positive social partners.

In summary, the results of study 1 suggest that infants form representations and memories of their social-emotional interactions as evidenced by their choices. It is unknown from this study alone, however, whether infants remembered *both* the positive and negative interactions. Their choice of the positive puppet could have been due to (a) remembering and liking the positive puppet with no memory of the negative puppet, (b) remembering and disliking the negative puppet with no memory of the positive puppet, or (c) remembering both the positive and negative interactions thus being drawn toward choosing the positive puppet and away from choosing the negative puppet

simultaneously. Furthermore, the lack of differences in infants' looking times toward the two puppets in the VPC tests could reflect competing attentional biases to look at both puppets due to their respective emotional valence. In order to clarify these possibilities, a neutral puppet interaction would be necessary. Study 2, described next in chapter 3, was conducted to address these and additional research questions.

Chapter 3: Study 2

Research Goal and Hypotheses

There are several possibilities that could explain why infants in Study 1 chose the positive puppet over the negative puppet. It may be that infants remembered the positive interaction to a greater extent than the negative interaction and therefore, they chose the positive puppet more often than the negative puppet. Alternatively, it is possible that, consistent with the negativity bias hypothesis, infants remembered the negative interaction to a greater extent than the positive interaction and therefore, they avoided choosing the negative puppet. Lastly, it could be that infants remembered both the positive and negative interactions and therefore, they preferred to choose the positive puppet while they also avoided choosing the negative puppet. Furthermore, the finding that infants did not show a visual preference between the positive and negative puppet in study 1 could be because their visual attention was simultaneously pulled toward both puppets. These possibilities were considered in Study 2 by adding a neutral interaction to contrast infants' behavior against the two emotionally valenced interactions. Infants were randomly assigned to exposure to either (a) a positive social-emotional interaction and a neutral interaction ("positive condition"), or (b) a negative social-emotional interaction and a neutral interaction ("negative condition"). The addition of this neutral interaction provided the necessary conditions to test the negativity bias hypothesis and determine whether infants represent and remember both the positive and negative interactions.

In Study 2, infants' initial representations and memory were assessed using a choice paradigm and preferential looking test immediately following the interactions and after a 10-minute delay because the results of Study 1 indicated that participating in the

initial test event was not related to subsequent performance. Thus, by testing infants with both the immediate and delayed test, I was able to test whether a similar pattern emerged with an effect only emerging after the delay.

Based on theory that infants form representations and memories of their social-emotional interactions, I hypothesized that infants in the positive condition would choose the positive social partner more often than the neutral partner (Hypothesis 3a) because infants prefer positive interaction partners (e.g., Bigelow & Birch, 1999; Hamlin et al., 2007; Nachman et al., 1986). Furthermore, I predicted that infants in the negative condition would choose the neutral partner more often than the negative partner (Hypothesis 3b) because infants avoid negative social partners (e.g., Bigelow & Birch, 1999; Bornstein et al., 2004; Hamlin et al., 2007). As such, I hypothesized that infants' would not demonstrate a negativity bias, but rather, infants would learn from both kinds of emotional interactions. If, however, infants chose randomly within the positive condition, but chose the neutral puppet more often than chance in the negative condition, then this pattern would be taken as evidence that infants have a negativity bias when representing and remembering their own interactions. Within the preferential looking test, I expected that infants would show differential looking patterns toward the two puppets, such that infants in the positive condition will look longer at the positive puppet (Hypothesis 4a), whereas infants in the negative condition will look longer at the neutral puppet (Hypothesis 4b). As such, I did not hypothesize that there would be a negativity bias in infants' looking time after the interactions either. If, however, infants look equally long at the two puppets within the positive condition, but look longer at the neutral

puppet in the negative condition (e.g., Hamlin et al., 2010), then this pattern will be taken as evidence that infants have a negativity bias.

Additionally, given the potential for individual differences in how infants react to the positive and negative interactions, I tested whether infants' emotional intensity during the interactions played a role in infants' representations and memories of the interactions. It may be that infants' perception of the interactions (assessed by their emotional reactions) more strongly predicts their choice and preferential looking than the objective valence of the interactions as positive, negative, or neutral. For example, some infants may not find the toy removal to be as negative as other infants who may become very upset. As such, I explored the research question: Does the intensity of infants' emotional reactions during the social-emotional interactions affect infants' representations and memories of their social-emotional interactions? Stated alternatively, do infants' perceptions of the social-emotional interactions predict above and beyond or interact with the objective valence of the interaction to predict infants' subsequent choice behavior (Research Question 1a) and preferential looking (Research Question 1b) between the two social partners?

Method

Participants. Participants were 32 (14 female) full-term, 10-month-old infants ($M_{age} = 9.93$ months, $SD = .28$, range: 9.4 – 10.6 months). An additional 4 infants were tested, but excluded due to infant fussiness, failure to make a discernable choice during test, and parental interference. As in study 1, infants were recruited via (a) the Maryland Infant & Child Studies Database which utilizes mailings and follow-up phone calls, (b) flyers posted in the community, (c) an online “participate in research” form on the

laboratory website, and (d) participant referrals. Infants received a certificate of participation and a small gift. The University's Institutional Review Board (IRB) approved recruitment procedures and study protocols (see Appendix B).

Infants were racially and ethnically diverse (65.6% White/Caucasian; 9.4% Bi-racial [including White/Black, White/Asian, and White/Hispanic]; 18.8% Black/African-American/African, 3.1% Asian/Pacific Islander, and 3.1% Hispanic/Latino). The majority of infants lived with both married parents (84.4%), and had parents that had completed at least a Bachelors degree (87.5% of mothers and 75% of fathers).

Apparatus and stimuli. The apparatus of the puppet stage and stimuli (Brown and Yellow Bear and the toy) were the same as in Study 1.

Procedure. In contrast to Study 1, infants in Study 2 were randomly assigned to a Positive/Neutral or Negative/Neutral condition. In this study, a neutral puppet was contrasted with either a positive or negative puppet during the social-emotional interactions, the VPC, and the choice tests. As in Study 1, the positive puppet gave the infant the toy and interacted positively and contingently with the infant whereas the negative puppet took the toy away and interacted negatively and punitively. The neutral puppet was present for the same amount of time as the valenced character, but interacted minimally with the infant (see Appendix F). Based on the finding from Study 1 that infants delayed tests were not influenced by their immediate tests, infants were given the VPC and choice test immediately after the interactions and after a 10-minute delay. An experimenter who was blind to the identity of the puppets administered the choice test. The warm-up, practice choice game, baseline VPC, social-emotional interactions, and 10-minute playtime remained the same.

Measures

Choice. As was the case for study 1, infants' choice between the two puppets was coded as the first puppet intentionally touched (i.e., touched while looking at or had looked at immediately prior to the touch). The presenting experimenter judged infants' choices in real-time during the choice test. Once infants made a choice between the two puppets, the experimenter removed the unselected puppet from the infants' sight. Coders were blind to the valence of the puppets. A second researcher who was blind to the valence of the puppets viewed each participants' video of the choice test procedures to ensure that the presenting experimenter followed the procedure accurately and judged infants' choice correctly. Based on this viewing, two infants were excluded from the study.

Preferential looking. As was the case in study 1, infants' looking during the baseline, immediate, and delayed VPC tests were coded continuously from videos using INTERACT software to obtain measures of gaze duration in seconds. Coders were blind to the valence of the puppets. Infants' direction and duration of gaze were coded as looking at the left puppet or looking at the right puppet. These codes were then matched with information on which side the positive and negative puppets were presented, resulting in two scores for each VPC test: Looking toward the positive puppet and looking toward the negative puppet expressed in duration of seconds. Inter-rater reliability between two coders was assessed on 69% of cases using intra-class correlations. Reliability was high ($ICC = .96$). Disagreements were averaged.

Emotionality during the interactions. As was the case in study 1, the intensity of infants' affect during the positive, negative, and neutral social-emotional interactions was

coded for every 5-second segment for positivity and negativity across 3 modalities each: facial expression, physicality, and vocalizations. The intensity for each modality was rated on a scale from 0 (none/neutral) to 3 (high). The full coding manual and scales are presented in Appendix H. Infants' emotionality scores for the positive and negative modalities were summed separately across the positive, negative, and neutral trials, separately, resulting in 4 scores: positivity during valenced social partner, negativity during valenced social partner, positivity during neutral social partner, negativity during neutral social partner.

Although coders were necessarily aware of the interactions that the infants were participating in, they were blind to all other details of the participants. For example, coders were not aware of which puppet the infants chose during test events. Inter-rater reliability between 2 coders was assessed on 25% of cases in each study using intra-class correlations. Reliability was high for both the negativity (ICC = .89) and the positivity (ICC = .95) scales. Disagreements were resolved by conferencing with the graduate student team leader who was also blind to other information about the participants.

Visual attention during interactions. Coders who were blind to the valence of the interaction and the information about the infants' subsequent choices coded infants' visual attention during the social-emotional interactions. Using INTERACT software to obtain measures of gaze duration in seconds, coders examined where infants were looking during the interactions and marked when infants were looking forward at the puppet. Reliability was assessed on 84% cases and was high (ICC = .97). Disagreements were averaged.

Results

Preliminary analyses

Violations from normality. Continuous outcome variables (i.e., looking time toward the valenced puppet and the neutral puppet in the immediate and delayed tests) were examined for violations from normality. I conducted the one-sample Kolmogorov-Smirnov test of normality to examine each of the variables. None of the distributions for the continuous outcome variables differed significantly from a normal distribution: Immediate test ($M_{val} = 4.95$, $SD = 1.91$, $KS = .63$, $p = .82$; $M_{neut} = 5.04$, $SD = 2.45$, $KS = .69$, $p = .73$) and Delayed test ($M_{val} = 5.61$, $SD = 2.20$, $KS = 1.01$, $p = .23$; $M_{neut} = 5.50$, $SD = 2.10$, $KS = .85$, $p = .46$). As such, looking time scores were kept in the original scale (seconds) and were not transformed. Subsequent analyses were based on the normal distribution.

Side bias. In order to investigate whether infants' displayed a baseline side bias while looking toward the puppets, I compared their total looking time to the right side ($M = 13.68$, $SD = 4.23$) to their total looking time to the left side ($M = 12.86$, $SD = 3.86$) during the baseline VPC with a paired-samples t-test. There was no evidence that infants were biased to look to one side over the other, $t(31) = 0.66$, $p = .51$.

Infants' behavior during the social-emotional interactions. In order to ensure that infants were engaged in the social-emotional interactions, I examined infants' visual attention during the social-emotional interactions and their emotional reactions to the social-emotional interactions.

Visual attention. Means and standard deviations of infants' visual attention during the social-emotional interactions are presented in Table 4. A repeated-measures

analysis with the between-subjects factor of Condition (Positive vs. Negative) and the within-subjects factors of Puppet (Valenced vs. Neutral) and Trials (1 vs. 2 vs. 3) were entered as predictors of infants' visual attention during the social-emotional interactions. The results indicated that although infants in the negative condition looked generally longer during the interactions as evidenced by a significant main effect of Condition, $F(1,30) = 14.53, p = .001$, infants in both conditions spent more total time looking at the valenced puppet than the neutral puppet (main effect of Puppet: $F(1,30) = 30.63, p < .001$). Additionally, for all interactions, infants spent less time looking toward the puppets (both valenced and neutral in both conditions) as the trials progressed, as evidenced by the main effect of Trials: $F(2,29) = 17.49, p < .001$. The difference between infants' visual attention to the valenced puppet and the neutral puppet was similar in the two conditions as evidenced by the lack of any two-way interactions with Condition or the three-way Condition \times Puppet \times Trial interaction.

Emotion. In order to understand infants' emotional reactions to the puppets, I conducted a repeated measures analysis with the within-subjects factors of Puppet (Neutral vs. Valenced), Emotion (Positivity vs. Negativity), and Trials (1 vs. 2 vs. 3) and the between-subjects factor of Condition (Positive vs. Negative) entered as predictors of infants' emotionality during the social-emotional interactions. The only significant effect was the Puppet \times Emotion \times Condition three-way interaction, $F(1, 30) = 46.21, p < .001$ (see Figure 5). The lack of an effect for Trials or any interactions including Trials indicates that infants displayed similar levels of emotionality as the trials progressed.

The results indicated that each valenced puppet elicited the intended emotion more strongly than the neutral puppet. In the positive condition, the amount of positivity

during the positive interaction was significantly higher than the amount of positivity displayed during the neutral interaction ($M_{diff} = 7.17$, $SE = 1.56$, $p < .001$). In the negative condition, the amount of negativity during the negative interaction was significantly higher than the amount of negativity displayed during the neutral interaction ($M_{diff} = 5.58$, $SE = 1.91$, $p = .008$). Looking across conditions, the level of positivity and negativity displayed with the neutral puppet in the negative condition did not differ significantly from the levels displayed with the neutral puppet in the positive condition (Positivity: $M_{diff} = 1.89$, $SE = 2.87$, $p = .514$; Negativity: $M_{diff} = -.88$, $SE = 2.56$, $p = .734$), suggesting that the neutral puppet interaction was perceived similarly by infants in each condition despite being contrasted with a different emotionally valenced puppet. Additionally, there was no difference in the intensity of infants' valence-consistent emotionality. That is, the level of positivity during the positive interactions did not differ significantly from the level of negativity during the negative interactions ($M_{diff} = 2.52$, $p = .48$). Together, these results indicated that infants displayed appropriate levels of congruent emotion in the interactions.

Unexpectedly, however, infants in the negative condition displayed elevated levels of incongruent emotionality during the valenced puppet as compared to infants in the positive condition. The amount of negativity displayed during the positive puppet was low and displayed less variability ($M = 1.71$, $SD = 2.19$), whereas the amount of positivity displayed during the negative puppet was moderate and displayed more variability ($M = 6.50$, $SD = 7.81$). In order to better understand this result, I viewed the video of all infants who displayed high levels of positivity during the negative interaction. Four infants had positivity scores that were greater than 1 SD above the

mean (i.e., greater than 14.31) during the negative interaction. I consistently observed these infants reach for the toy while smiling and then return to neutral (or sometimes negative) emotional states when they were unsuccessful at obtaining the toy and the puppet retracted from the infants while stating phrases in a very negative tone, for example, “No,” “Mine,” and “Not for you.” This kind of interaction resulted in these infants receiving high scores for positivity during the negative condition, but the examination of the video demonstrated that the end result of the interaction the infant has with the puppet was not positive. This experience was captured by the negativity scale under physicality where coders evaluated how often and how intense infants reach for the toy without obtaining the toy. Even with the physicality code contributing to the level of negativity, the level of positivity in these infants’ facial expressions resulted in a higher positivity scores than I would have expected for the negative interaction. Three of these infants also displayed high levels of positivity in the neutral condition, which may reflect a characteristic of their temperament. Excluding the four infants with uncharacteristically high levels of positivity during the negative puppet resulted in a clear emotional profile for the negative condition in which the amount of positivity was significantly lower than the amount of negativity during the negative puppet ($M_{diff} = 2.50, p = .04$). Excluding these infants, however, had no effect on any of the study outcomes (e.g., 2 of these infants chose the neutral puppet and 2 chose the negative puppet); they were, therefore, maintained in the analyses.

Principal analyses

Choice. In order to test the hypothesis that in both the immediate and delayed tests, infants would be more likely to chose the positive puppet in the positive condition

(Hypothesis 3a) and the neutral puppet in the negative condition (Hypothesis 3b), I first conducted an overall one-tailed binomial test where these choices (i.e., those that would confirm the hypotheses) were designated as a success (coded as 1 vs. 0). Overall, collapsing across conditions, infants were slightly more likely than chance to succeed in the immediate test (21 out of 32 infants, 65.6%, $p = 0.055$), but not in the delayed test (14 out of 32 infants, 43.75%, $p = 0.298$). The effect observed in the immediate test was driven by infants' choices in the positive condition as evidenced by binomial tests within each condition: 12 out of 16 infants (75%; $p = .038$) chose the positive puppet in the positive condition, whereas only 9 of 16 infants (56.25%; $p = .401$) chose the neutral puppet in the negative condition. In the delayed test, the rate of success in both conditions was not significantly different from chance (9 out 16 infants chose the neutral puppet in the negative condition, $p = .401$; 5 out of 16 infants chose the positive puppet in the positive condition, $p = .961$ [note: the result in the positive condition could be stated alternatively as 11 out of 16 infants chose the neutral puppet in the delayed test, but this result is still not significantly different from chance. Thus, infants did not reliably switch their choices after the delay, but rather responded at chance]).

To address Research Question 1a, I conducted two logistic regressions (one for each choice test) to test whether individual differences in infants' emotionality during the interactions predicted infants' choices in the immediate and delayed tests. In each regression, the predictors of interest were entered in a hierarchical fashion: Step 1 included the main effect of condition, Step 2 included the four infant emotionality scores (positivity during the valenced puppet, negativity during the valenced puppet, positivity during the neutral puppet, and negativity during the neutral puppet), and Step 3 included

the two-way interaction between each of the emotionality scores and condition. None of the main effects or interactions was significant with infant emotionality indicating that infants' expressed emotion during the interactions did not relate to their subsequent choices during the test events.

Potential confounds. In order to verify that extraneous factors were unrelated to infants' choice behavior and thus, did not confound the results, I conducted two logistic regression analyses, one for each choice test. For each test, condition was entered in Step 1, infants' age (expressed in number of days old) was entered in Step 2, the counterbalancing factors (side, order, and color of the valenced puppet) were entered in Step 3, and infants' visual attention during the interactions (i.e., total duration of seconds spent looking at the valenced puppet and the neutral puppet during the interactions) was entered in Step 4.

As expected, for the immediate and delayed test, neither the counterbalancing factors nor infants' visual attention during the interactions predicted infants' choices. Unexpectedly, for the immediate test (but not the delayed test), infants' age significantly predicted success ($B = .133$, $SE = .061$, $p = .03$, Wald $\chi^2 = 4.694$, $\text{Exp}(B) = 1.142$). To clarify this result, I conducted an independent samples t-test: Infants who succeeded in the immediate test ($M_{age} = 300.67$, $SD = 7.54$) were, on average, 7.93 days older than those who did not succeed ($M_{age} = 292.73$, $SD = 7.73$), $t(30) = 2.78$, $p = .009$. This age-related difference, however, held only for the negative condition. That is, as compared to infants who did not succeed, infants who succeeded in the negative condition were more likely to be older ($M_{diff} = 11.50$ days, $p = .022$), whereas infants who succeeded in the positive condition were not significantly different in age ($M_{diff} = 2.5$ days, $p = .48$). In

sum, in the immediate test, age was positively related to success in the negative condition, but not in the positive condition.

Preferential looking. In order to test my hypothesis that infants' looking times would differ between the valenced and neutral puppets (Hypothesis 4) at both the immediate test and the delayed test, I conducted a Generalized Estimating Equations (GEE) analysis. For the GEE analysis, Condition assignment (Positive vs. Negative) was entered as a between-subjects factor and Test (Immediate vs. Delayed) and Puppet (Valenced vs. Neutral) were entered as within-subjects factors. In this analysis, the effect of interest is the Puppet \times Condition interaction because looking times to the two puppets should differ as a function of the random assignment into the positive or negative condition and differ according to whether infants are looking at the valenced or the neutral puppet. A significant Puppet \times Condition interaction will support Hypothesis 6 that looking times vary as a function of condition and valence.

The results of this analysis provided no support for Hypothesis 6 in either the immediate or delayed test for either condition (Hypothesis 4a and 4b). Infants' looking times between the valenced and neutral puppet were not significantly different in either condition for either the immediate or delayed test (see Table 5; mean differences between the neutral and valenced puppet in both conditions ranged from .29 to .51, all p -values $>$.51).

To address Research Question 1b, I tested whether individual differences in infants' emotionality during the interactions predicted infants' looking time in the immediate and delayed tests. I conducted another GEE analysis with infants' emotionality scores as additional predictors in a full factorial model. The effects of

interest would be the three-way interactions including condition, puppet, and any of the emotionality scores. This result would indicate that infants' emotionality predicted the amount of time they spent looking at the puppets during the VPC test differentially for the negative and positive condition. I hypothesized that infants would look longer toward the neutral puppet in the negative condition and the positive puppet in the neutral condition. As reported above, that hypothesis was not supported, but it was possible that although the assigned valence of the puppet did not affect infants' looking times, their individual emotional experience with the puppet may have predicted their looking times. For example, infants who reacted more positively to the positive puppet may have looked longer toward the positive puppet than the neutral puppet as compared to those who reacted less positively, especially considering that some infants displayed higher levels of incongruent emotions during the interactions. Yet none of the effects of interest was significant in predicting infants' looking times. Infants spent equal amounts of time looking toward the two puppets at test regardless of how they reacted during the initial interactions.

Potential confounds. To examine potential confounds, a third GEE analysis was conducted by including the counterbalancing factors (side, order, and color of the success puppet), infant age (expressed as days old), and infants' visual attention to the valenced and neutral puppets during the social-emotional interactions. As expected, none of these factors predicted infants' looking times in the immediate or delayed preferential looking tests as evidenced by non-significant main effects and non-significant interactions with Condition assignment. Controlling for these factors did not change the significance of the effects of interest.

Discussion

The main goal of Study 2 was to clarify whether infants were drawn toward the positive puppet or whether they were avoiding the negative puppet in order to more fully understand the nature of infants' representations and memories of their social-emotional interactions. As such, a neutral puppet was introduced. This is the first study to systematically test the differences between positive, negative, and neutral interactions in understanding infants' representations and memories of their own social-emotional interactions. Infants were randomly assigned to the positive or negative condition, where they met the assigned valenced puppet and a neutral puppet in a between-subjects design over 3 alternating interactions for each puppet. Following the interactions, infants' preferences were tested in a visual paired comparison and forced-choice test. I hypothesized that infants would be more likely to choose the positive puppet in the positive condition and the neutral puppet in the negative condition. Although I hypothesized that infants would be equally likely to represent and remember both kinds of emotional interactions, the design of this study also allowed for a test of the negativity bias hypothesis by testing whether infants were more likely to learn from their negative social interactions.

As evidence that infants formed initial representations of their social-emotional interactions, an effect emerged between infants' choices in the immediate choice test, but not the delayed choice test. This effect, however, was observed only in the positive condition. After interacting with a positive and neutral puppet, infants were more likely to immediately choose the positive puppet. Interestingly, however, this representation did not seem to endure across 10 minutes. After the 10-minute delay, infants' choices

appeared random. This pattern indicates that infants were initially represented their positive interaction, but considering how the neutral puppet provided no negative experience and no threat to the infant, it is likely that the saliency of the difference between the two puppets dissipates over time. As such, the immediate desire to continue interacting with the positive puppet compared to the neutral puppet seems to fade over time. Once removed from the initial interactions by time and space (i.e., infants participated in a 10-minute free play session with their parents in another room), infants see the two puppets, positive and neutral, as equal potential social partners.

It was surprising though that the effect was observed in the positive condition only. The fact that a choice effect was observed in the positive, but not negative condition is more understandable when considering the emotional profile of the negative condition compared to the positive puppet. As compared to the negative condition, the positive condition more clearly elicited the intended emotions, however, the direction of the emotional pattern in the negative condition it would still suggest that infants would choose the neutral puppet. It is understandable though to suspect that infants may not consider a neutral interaction to be significantly better than a negative interaction of this nature. It may be difficult for infants to make a comparison between these two characters because they have less experience participating in negative and neutral interactions. Based on their past experiences, infants appear to expect a “positive status quo” (Vaish et al., 2008) that is challenged by these two social interactions. Infants may search for positive aspects in the interactions in order to confirm their expectations. This may explain why infants’ expressed moderate levels of positivity even in the negative interactions.

Interestingly, age was related to infants' choices in the negative condition only. That is, infants who chose the neutral puppet over the negative puppet were more likely to be older. Paired with the results that infants in the positive condition were more likely to choose the positive puppet, these findings suggest that it may be easier for infants to represent these brief positive social-emotional interactions than negative interactions. Again, the observed emotional profiles indicate that the difference between the positive and neutral puppet was more apparent. It may be that only the older infants were able to understand the distinction between the negative and neutral interactions. This age effect could represent general age-related increases in processing speed that allow infants to process the negative information more quickly (for reviews on factors that affect infants' memory performance, see Colombo & Mitchell, 2009; Hayne, 2004; Rose et al., 2004). The negative interactions may have more complex elements for infants to process than the positive interactions. For instance, interacting with the negative puppet could elicit generalized distress in addition to specific feelings of frustration, anger, sadness and disappointment (see Bennett, Bendersky, & Lewis, 2005), whereas the positive interactions elicit happiness. Moreover, infants likely have less experience in this kind of negative interaction, making it more novel and difficult to process. Alternatively, this age effect could represent an important developmental trend whereby infants' representational and memory capacities for negative social-emotional information shifts between 9 and 10 months. I selected the 9 ½ to 10 ½ month age range because it was a time frame within the first year of life that was after the so-called "nine-month revolution" (Tomasello, 1999). The "nine-month revolution" is characterized by important advances in social cognition, relationship understanding, and triadic

interactions. Thus, 9 ½ to 10 ½ months represented a time that one could reasonably expect infants to be able to form representations and memories of their social-emotional interactions. It is possible, however, that normal variation in when infants reach the 9-month-revolution played a role in this memory affect. Furthermore, research indicates that other developmental milestones, particularly crawling, relate to infants' memory (Herbert, Gross, & Hayne, 2007). Thus, future research should collect data on infants' motor development to better understand individual differences in memory performance.

Two additional factors that may be particularly relevant to individual differences in how infants interacted with and perceived the neutral partner – specifically, when paired with the negative partner – are temperament and experiences with caregivers. Research indicates that temperamentally exuberant children are more positive and sociable with strangers than other children, whereas temperamentally inhibited children are more shy and anxious in social settings (e.g., Fox, Henderson, Rubin, Calkins & Schmidt, 2001; Stifter, Putnam, & Jahromi, 2008). These temperamental differences could relate to how infants perceive the neutral puppet, particularly when the neutral puppet is paired against the negative puppet. For example, given their sociable nature, exuberant children may not experience the negative condition as negatively as other infants. They may be more willing to seek a connection with the negative puppet and more inclined to perceive the toy removal as a game, thus making the distinction between the two puppets less salient. Alternatively, given their shy and reactive nature, inhibited children may view the neutral puppet more negatively than other children, which would also make the distinction between the neutral and negative puppet less salient. Thus, it

may only be infants with average temperaments who perceive a salient difference between the negative and neutral puppets.

In addition, infants' experiences with their own caregivers may have played a role in how they interacted with and perceived these social partners. Research indicates that parents' expressions of emotion and responses to their children's emotions are important in children's emotion understanding and social relationships. For example, children learn about emotional expression through modeling their parents' emotional behavior (Denham, Mitchell-Copeland, Strandberg, Auerbach, & Blair, 1997). As such, infants with parents who express more negativity may have expressed more negativity during the social-emotional interactions than other infants. Alternatively, given the greater negativity in their home environments, these infants may be more familiar with negative interactions than other infants, and thus, may not react as negatively as infants who are not used to this type of interaction. Parents also socialize their children's emotional expressions by reacting with support or disapproval when their children express positive and negative emotions (Eisenberg, Cumberland, & Spinrad, 1998). Moreover, individual differences in the quality of infants' attachment may relate to the way in which infants represented and remembered these interactions. For example, based on the quality of their attachment-related experiences with their caregivers, infants develop mental models of "how his mother and other significant persons may be expected to behave, how he himself may be expected to behave, and how each interacts with the other" (Bowlby, 1969/1982, p. 354). These expectations then guide infants' thoughts, feelings, and behavior in their social interactions with others (see also Bretherton & Munholland, 2008). For example, securely attached infants, who have generally experienced sensitive,

responsive care, develop positive expectations about relationships; whereas insecurely attached infants who have generally experienced insensitive or inconsistent care, develop negative expectations about relationships. These expectations affect the way infants perceive, process, and remember social interactions (see Dykas & Cassidy, 2011, for a review of the links between attachment and social-information processing). Additionally, insecure attachment has been linked to children's hostile attribution bias, which biases children to see the negativity and interpret hostile intent during ambiguous social contexts (e.g., Raikes and Thompson, 2008; see also, Crick & Dodge, 1994). Thus, infants may have processed the social interactions from this study in line with their attachment-related experiences: insecurely attached infants may have perceived negativity in the neutral interaction and securely attached infants may have perceived positivity in the negative interaction (perhaps expecting the toy removal to be a give-and-take game). Future research should explore relations between individual differences in infants' temperament and parent-child relationship experiences, particularly attachment quality, in order to better understand how infants perceive, represent, and remember these social-emotional interactions.

Although unrelated to any study outcomes, it is interesting to note that infants spent more time looking at the valenced puppets (either positive or negative) during the interactions than the neutral puppet. The neutral puppet moved from side to side and gently shook or bounced to maintain infants' attention. Moreover, the neutral puppet spoke more often if infants started to divert their attention from the display. Even still, infants may have become bored during the neutral interactions. Existing literature suggests that there is motivation for infants to attend to either of the valenced puppets

(see Vaish et al., 2008, for evidence of infants' negativity bias). The negative puppet is holding an attractive toy that was just taken away from the infant and represents a potential threat. Thus, infants would be wise to attend to this character to either gain the toy back or protect themselves from the possibility of threatening actions. The positive puppet, on the other hand, is a helpful, engaging social partner that infants would look at for enjoyment.

Contrary to predictions, there was no difference between infants' looking times toward the puppets in either condition. I had originally hypothesized that infants would have a visual preference for the positive puppet over the neutral puppet and for the neutral puppet over the negative puppet. The lack of a difference between infants' looking toward the positive and negative puppet in Study 1, however, suggested that this hypothesis might not be supported. Rather, it was more likely that infants might look longer toward the valenced puppet over the neutral puppet in both conditions. Yet this alternate pattern did not emerge either. There was no evidence from the VPC tests that infants represented or remembered their social-emotional interactions. Moreover, there was no evidence to support a negativity bias in infants' attention during the test.

Chapter 4: General Discussion

The purpose of these studies was to test whether infants represent and remember their social-emotional interactions. This was the first investigation to systematically compare positive, negative, and neutral interactions. Across these two studies, there was evidence in infants' choices, but not in their looking time, that infants represent and remember aspects of their social-emotional interactions.

The initial pattern of choice results from Study 1 suggested that infants might need time to process and consolidate their representations of their social-emotional interactions. This pattern, however, was not replicated in Study 2 where infants appeared to form initial representations of the positive interaction but their representations did not endure over time. Differences between the two studies may shed light on these seemingly inconsistent results. First, the social-emotional information that infants receive in Study 2 is much simpler than that of Study 1. In Study 2, infants' interactions did not alternate between positive and negative as the trials progress, but rather the interactions alternated between one valence and a neutral interaction. As a result, as compared to the infants in Study 1, the infants in Study 2 experienced less overall emotional intensity. Given that the nature of the social-emotional information is less complex, infants may have been better able to process the information both cognitively and emotionally because they would require less time to return to a baseline emotional state. As such, the representation may have consolidated earlier and with fewer exposures to the puppets.

If, however, the information in Study 2 was simpler for infants to represent, then the question becomes, why did they not seem to remember the positive interaction? Given that the neutral puppet represented neither a threatening nor an attractive option for

infants, it is possible that the represented difference between the two puppets faded over time because it was not a meaningful distinction for infants to hold in their memory. This interpretation seems to contradict the results of two earlier studies that found infant preferences for positive social partners after delays from six days to one week (Bigelow & Birch, 1999; Nachman et al., 1986). Recent research, however, points to the importance of sleep for memory consolidation in children and infants (Wilhelm, Prehn-Kristensen, & Born, 2012). Perhaps if infants were tested again, after sleeping, the memory would endure.

An important issue when examining memory for emotional events is the distinction between valence and intensity. In adults, emotional intensity or arousal – irrespective of the valence of the emotion – activates different neural systems than emotional valence (Colibazzi et al., 2010) and has been shown to predict the richness and specificity of autobiographical memories more so than valence (e.g., Talarico, LaBar, & Rubin, 2004). In one study, however, positive events were remembered equally well whether they were rated with high or low intensity, whereas negative events were remembered well only when they were paired with high intensity (Ford, Addis, & Giovanello, 2012). In the current studies, the results indicated that, overall, infants experienced equal levels of positive and negative emotion during the respective positive and negative interactions. Furthermore, individual differences in infants' emotionality during the interactions were unrelated to infants' subsequent representations and memories. Thus, the results of these studies can be attributed to differences in the valence of the interactions. It is possible, however, that ratings of negative and positive intensity that are based on infants' outward, behavioral manifestation of their emotional

states are not comparable across emotions. Future research could add measures of infants' physiological arousal, such as heart rate, to better evaluate the distinction between valence and intensity. Researchers could also vary the intensity of the negative and positive interactions to test whether high vs. low intensity interactions differ in terms of infants' representations and memories.

It is unknown from this study what aspects of the social-emotional interactions contributed to infants' experience and subsequent representations and memories.

Although the use of puppets removed the possibility that infants would simply remember their social partners facial expressions, the puppets differed in their tone of voice, behavior, and contingency. The goal of this study was not to evaluate these distinct features of interactions. Instead, this study used ecologically valid social-emotional interactions because infants receive diverse information during their interactions with others. Researchers who are interested in infants' intermodal perception and subsequent memory could test the difference between interactions that rely only on the infants' behavior, without vocal information. Such interactions would more closely parallel the work of Hamlin and colleagues (Hamlin & Wynn, 2011; Hamlin, Wynn, & Bloom, 2010), who presented infants with silent interactions between two puppets. It would likely be difficult, however, to elicit the intended emotion from infants without the positive and negative tone of voice. For example, some infants displayed positive affect during the toy removal phase of the negative puppet interaction. Without the associated negative tone of voice, infants may perceive this kind of behavior as a game, rather than a negative event.

It is important to note some additional design aspects of these studies may have impacted infants' ability to remember the interactions. One factor that should have facilitated infants' recall of the interactions was that they were tested in the same room that the interactions took place, as context greatly improves infants' memory recall (e.g., Jones, Pascalis, Eacott, & Herbert, 2011). The length of the delay (10 minutes) and the nature of the delay (filled with a parent-child free-play session) did not appear to interfere with infants' memories in Study 1 where the delay appeared to facilitate consolidation, whereas infants' failed to maintain the memory of the positive puppet in Study 2 (see Bauer et al., 1999; Hayne, 2004). In addition, prior to the choice test in both the immediate and delayed tests occurred after the VPC test. Future studies could conduct the choice test without first conducting a VPC test.

What do these studies tell us about the negativity bias hypothesis? Based on the choice results of Study 2, it is reasonable to assume that infants in Study 1 were biased toward the positive puppet, rather than away from the negative puppet, thus providing no evidence of a negativity bias. In these studies, there was no evidence that infants "learn from, and use negative information far more than positive information" (Vaish et al., 2008, p. 208). Particularly given the result that age was related to infants' choices in the negative condition only, it appears that infants were better able to represent the positive interactions in this study. With regard to infants' looking time in the VPC tests, a negativity bias would have been supported by two potential patterns, neither of which was observed. For example, after completing study 1, it was unknown whether the lack of result between infants' looking at the positive and negative puppet was because infants' attention was simultaneously pulled toward the positive puppet, due to liking, and toward

the negative puppet, due to wariness. If this were the case, then those motivations would have been evident in Study 2 because the valenced puppet (positive or negative) was compared against a neutral puppet, but this was not the case. Again, infants displayed no visual preference.

Together, the results of this study appear to contradict the predictions of the negativity bias hypothesis. Yet the results must be understood in their full context. When formulating the negativity bias hypothesis in development, Vaish and colleagues reviewed the large body of social referencing literature, highlighting infants' propensity to adjust their behavior more consistently after viewing adults' negative emotions toward a third-party object than positive emotions. Their review did not include studies that are similar to the context presented in the present studies: that is, relationship experiences in which the infant is an active participant experiencing positive and negative emotions. Given that the contexts from which the negativity bias hypothesis was proposed are different from the context of this study, it is possible that the current findings are not necessarily a contradiction to the negativity bias hypothesis. It may be that infants use emotional information differently when they are engaged in their own social-emotional interactions than when they are learning from another person's emotional expressions. Moreover, it is important to note that these results must be understood in the context of the two conditions to which infants were randomly assigned: (a) neutral vs. negative or (b) neutral vs. positive. These results may not demonstrate a lack of a negativity bias, but rather, a age-related pattern whereby infants develop the ability to distinguish between negative and neutral interactions. To young infants, neutral interactions may be viewed as negative. Thus, the failure of infants to choose the neutral puppet in the negative

condition might not demonstrate a failure to learn from the negative information, but rather an indication that they failed to distinguish a difference between the negative and neutral interactions. Furthermore, the positive and negative information in Study 2 was presented between-subjects rather than within-subjects. As such, it is unknown whether individual infants would have privileged negative information over positive information if they had participated in both types of emotional interactions. A study that introduces infants to all three puppets or uses a novel puppet during test would help clarify the question of whether infants have a negativity bias in their own social-emotional interactions.

One aspect of the results that could reflect a negativity bias was infants' visual attention during the social-emotional interactions. Infants had greater visual attention to the negative than positive puppet in study 1 and to the valenced than neutral puppet in the negative condition of study 2. There is a parsimonious explanation for both of these results that does not rely on the negativity bias, but these alternate explanations also do not exclude the negativity bias. That is, infants in study 1 looked longer during the negative interactions because their attention was not pulled away by the toy, which they had access to in the positive interactions, and infants in study 2 lost interest in the neutral interactions. The idea that infants lost interest in the neutral interaction was also supported by the finding that they looked longer during the valenced interactions than the neutral interactions in the positive condition. Thus, even when infants had access to a toy, they spent more time looking at the positive puppet than the neutral puppet while they interacted with these social partners. The direction of infants' visual attention with regard to the negative puppet, however, does not contradict the predictions of the negativity bias.

Thus, researchers who are interested in exploring these possibilities could design positive, negative, and neutral interactions that do not rely on a toy.

It was surprising that there were no effects in infants' preferential looking during test, especially given that there were choice preferences. I chose to examine infants' preferential looking and choice outcomes in order to parallel past research and investigate whether the social-emotional interactions differentially affected infants' later behavior. Looking time measures were used in the literature examining infants' memories for their own social-emotional interactions (Bigelow & Birch, 1999; Bornstein et al., 2004; Nachman et al., 1986) and are typically used to test the representations and memories of younger infants (i.e., under 6 months) because it removes the reliance on motor planning and physical capacities that develop later in the first year (e.g., Hamlin & Wynn, 2011). Yet, choice measures were used in the studies examining infants' evaluations of puppet characters that infants observed in third-party interactions and with infants older than 6 months (e.g., Hamlin et al., 2010). It is interesting that the valence of the interactions did not affect infants' subsequent visual preference, but did affect their choices. Future work should use choice outcomes for infants of this age.

Strengths. This study had several strengths over existing research that addressed infants' representations and memories of their social-emotional interactions. First, I systematically compared infants' behavior after interacting with positive, negative, and neutral social partners. Earlier research included only one emotional valence (e.g., Nachman et al., 1986) or exposed infants to social partners who interacted both positively and negatively (e.g., Bornstein et al., 2003). With regard to the former, the results could not be used to assess infants' memories of negative events. With regard to the latter, it is

unclear how infants would be expected to represent an interaction with mixed valences and thus, it is difficult to interpret infants' preferential behavior during tests. Secondly, in this study, I compared infants' preferential choice and looking between two familiar puppets, rather than a novel puppet. Past studies confounded familiarity with emotional valence, thus making it impossible to determine whether the observed effects were due to infants' remembering the emotional aspects of the interactions.

Limitations and Future Research. Like all studies, these studies have some limitations. By using puppet characters, I was able to remove differences related to experimenters' facial expressions and eye gaze during the interactions and have more control over test events with infants' choice. Infants may have more difficulty representing their interactions with puppets, however, because it is a new experience for the infants. Several parents mentioned that their infants had never seen puppets before. Additionally, infants may represent their interactions with puppet characters differently than with human social partners. The benefits of using puppets outweighed the disadvantages for this initial study, but I can only infer that the results would generalize to interactions with humans. Future research should investigate infants' representations and memories of social-emotional interactions with people, like the work of Bornstein and colleagues (2003) and Bigelow and Birch (1999), but with more clearly defined valenced social-emotional interactions and by adding a neutral social interaction. Second, the social-emotional interactions of this study were rather brief. It is possible, particularly given evidence that age was related to infants' choices, that infants would have displayed stronger representations and memories if the interactions had been longer. Relatedly, this study relied on a familiarization procedure, rather than a habituation

procedure, for exposing infants to the social-emotional interactions. Differences in infants' processing speed may have resulted in only some infants being able to form representations and memories (particularly older infants as evidenced in Study 2) of these social-emotional interactions. In future studies, researchers could attempt to account for differences in processing speed by adding interaction trials or testing older infants. Researchers should use caution, however, not to change the valence of the interaction by boring infants or frustrating infants so much that they cannot participate in the outcome measures. If researchers tested infants on a later day, however, the intensity of the negative experience could be greater than it was in the current study because there would be no concern that infants would still be too upset to participate in the outcome measures. Future research should investigate whether the representation solidifies more or fades after a day long delay. A day long delay could potentially allow infants to consolidate the representation more through sleep (e.g., Wilhelm, Prehn-Kristensen, & Born, 2012).

In both studies, infants were only exposed to two different puppets during the social-emotional interactions. The purpose of this was to limit the amount of 'to-be-remembered' information for the infants as to not overload infants' emotional states and memory capacity. It was quite unexpected, however, that infants displayed moderate levels of positive emotion during the negative interaction of Study 2 because that pattern was not observed in Study 1. It may be useful for infants to experience interactions with all three characters – positive, negative, and neutral – as this presentation may allow infants to more clearly differentiate the negative interaction. It could, however, be difficult to test infants' choices among all three puppets. Infants could experience all three interactions, but then be randomly assigned to test events that compare only the

positive and neutral puppet or the negative and neutral puppet. Past studies relied on testing infants' preferences against a novel puppet. Unfortunately, this design confounds emotional valence with familiarity, making it difficult to interpret infants' preferences as demonstrating memory for the emotional aspects of the interaction specifically, rather than simply remembering the puppet itself. Yet, having both positive and negative puppets tested against a novel puppet would help to better understand the novelty or familiarity preferences. Earlier studies that used a novel social partner during test had only exposed infants to one of the valenced interactions, not both (e.g., Nachman et al., 1986; Bornstein et al., 2003). If, however, researchers introduced infants to all three puppet characters, they could test infants' memory for the neutral interaction by pairing it with a novel puppet during test.

Table 1

Summary of Study Hypotheses and Research Questions

Study	Hypothesis #	Descriptions
Study 1	Hypothesis 1:	<p>Infants' choice will differ significantly from chance (50%), such that:</p> <ul style="list-style-type: none"> a. In the immediate choice test, infants will choose the positive puppet more often than chance. b. In the delayed choice test, infants will choose the positive puppet more often than chance.
	Hypothesis 2:	<p>Looking times will vary as a function of valence, such that:</p> <ul style="list-style-type: none"> a. In the immediate visual paired comparison test, infants will look longer at the positive puppet than at the negative puppet. b. In the delayed visual paired comparison test, infants will look longer at the positive puppet than at the negative puppet
Study 2	Hypothesis 3:	<p>Infants' choice will differ significantly from chance (50%), such that:</p> <ul style="list-style-type: none"> a. Infants in the positive condition will choose the positive puppet more often than chance. b. Infants in the negative condition will choose the neutral puppet more than chance.
	Hypothesis 4:	<p>Looking times will vary as a function of condition and valence, such that:</p> <ul style="list-style-type: none"> a. Infants in the positive condition will look longer at the positive puppet than the neutral puppet. b. Infants in the negative condition will look longer at the neutral puppet than the negative puppet.
Studies 1 & 2	Research Questions:	<p>Do infants' emotional reactions during the social-emotional interactions affect their subsequent:</p> <ul style="list-style-type: none"> a. choice behavior? b. preferential looking?

Table 2

Study 1: Infants' visual attention in seconds during the social-emotional interactions

Trials	Positive		Negative	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
1	34.37	7.85	39.65	5.55
2	30.71	9.57	35.92	7.14
3	27.73	10.79	32.26	9.71
Total	93.72	24.33	112.52	16.61

Table 3

Study 1: Infants' choices during the immediate and delayed choice tests

		Delayed Choice		
		Negative	Positive	Total
Immediate	Negative	5	4	9
Choice	Positive	2	13	15
Total		7	17	24

Table 4

Study 2: Infants' visual attention in seconds during the social-emotional interactions

Trials	Negative Condition				Positive Condition			
	Valenced Puppet		Neutral Puppet		Valenced Puppet		Neutral Puppet	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
1	37.84	3.94	33.23	5.93	30.95	7.70	28.25	7.23
2	36.93	5.72	31.17	7.75	28.84	7.59	24.45	8.43
3	35.40	7.22	29.25	8.71	26.19	8.70	19.49	7.41
Total	110.17	13.80	93.64	20.02	87.68	23.02	73.88	21.05

Table 5

Study 2: Mean level of infants' looking time (in seconds) in the VPC tests

Test	Negative Condition				Positive Condition			
	Valenced		Neutral		Valenced		Neutral	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Immediate	5.59	2.05	5.28	2.79	4.31	1.56	4.79	2.13
Delayed	5.93	2.01	5.42	1.72	5.30	2.39	5.59	2.48



Figure 1. Study apparatus for preferential looking test and social-emotional interactions.



Figure 2. Study stimuli (from left to right): yellow bear (10 inch hand puppet), toy for interactions, brown bear (10 inch hand puppet).



Figure 3. The four 10-inch hand puppets used in practice choice game (from left to right): gray mouse, brown monkey, gray bunny, brown fox.

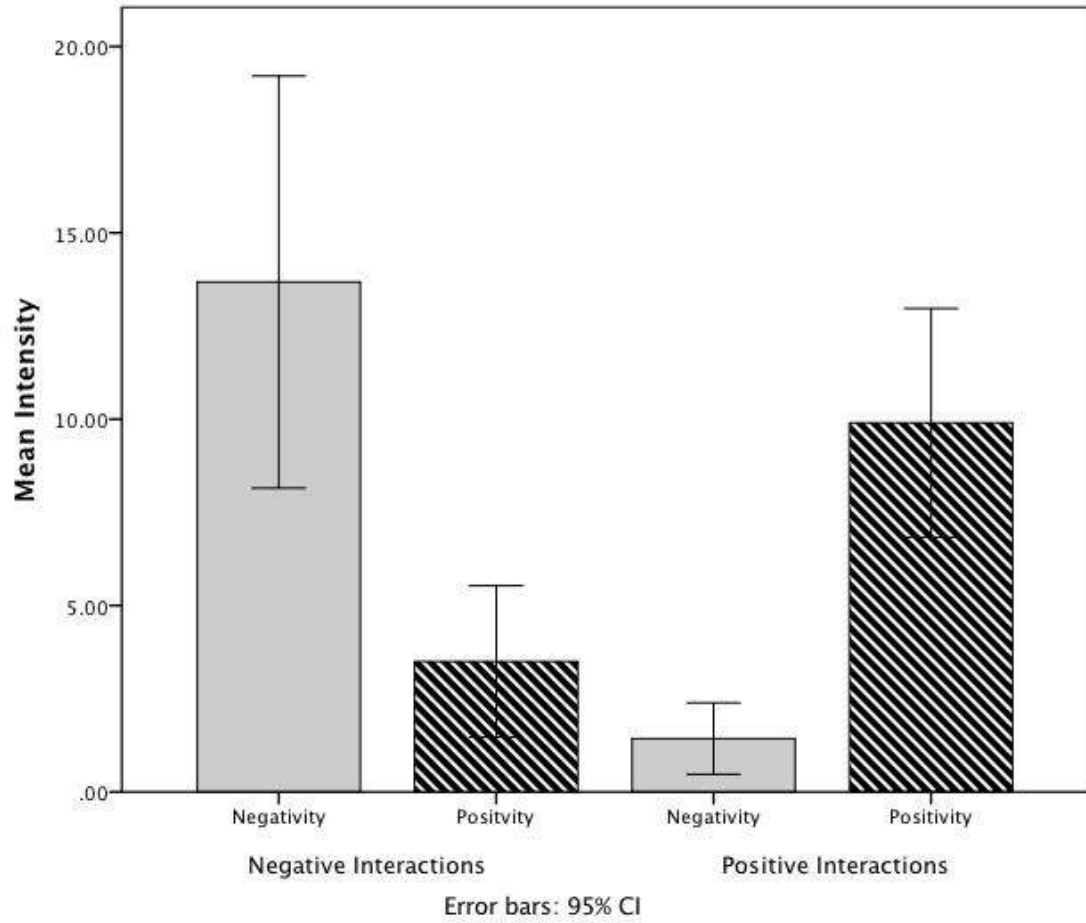


Figure 4. Study 1: Infants' emotional reactions during the social-emotional interactions

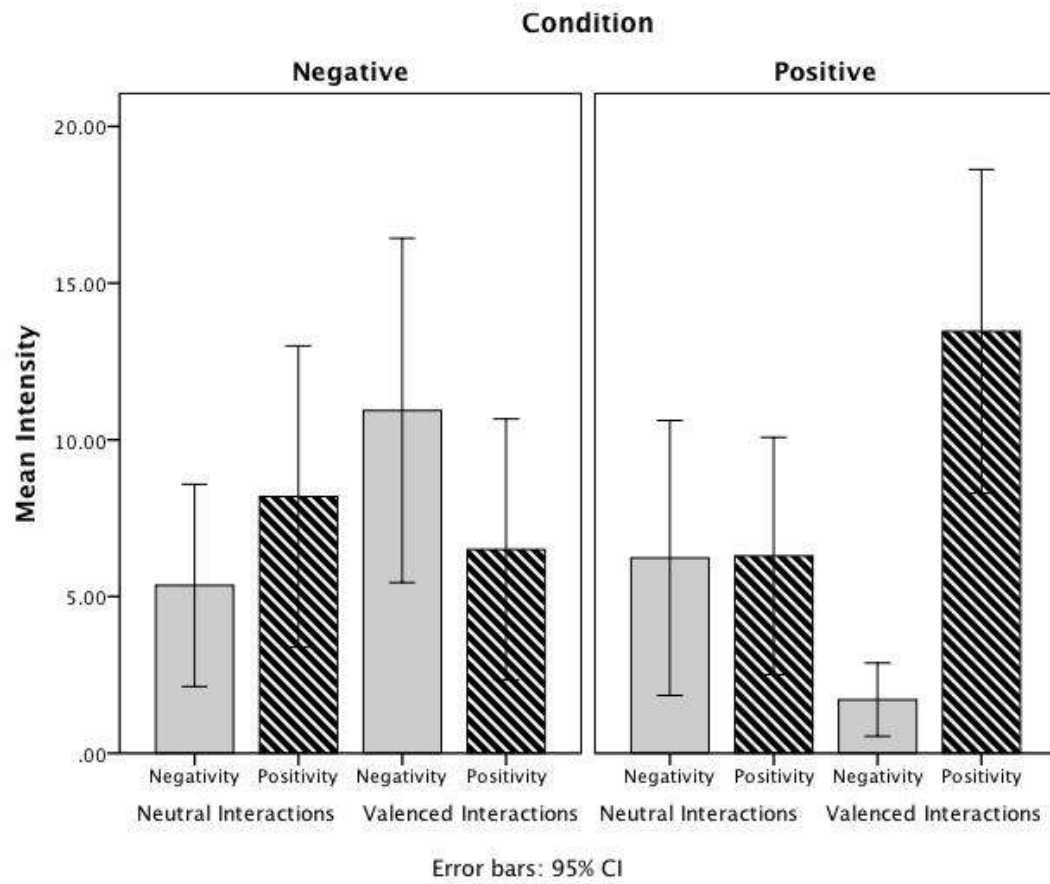


Figure 5. Study 2: Infants' emotional reactions during the social-emotional interactions

Appendix A:

Comprehensive literature review

Infant Capacities Related to Building Internal Working Models
of Attachment Figures: A Theoretical and Empirical Review

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Infant Capacities Related to Building Internal Working Models
of Attachment Figures: A Theoretical and Empirical Review

A crucial development during an infant's first year of life is becoming attached to his or her attachment figures (e.g., mother, father, grandmother; Bowlby, 1969/1982). Decades of research have been devoted to describing attachment development in infants. In 1985, Main, Kaplan, and Cassidy suggested a departure from the research tradition of the time (characterized by behavioral precursors, correlates, and aftereffects of 12-month infant attachment patterns) with "a move to the level of representation." Although this move to the level of mental representation was a departure from the body of empirical work at the time, it was strongly in keeping with Bowlby's (1969/1982, 1973, 1988) theoretical position regarding attachment formation. This publication served as the catalyst that launched research on attachment at the representational level in adults and children old enough to speak. Bowlby hypothesized, however, that *infants* develop relationship representations, called internal working models (IWMs; also called representational models), during the first year of life (see also Main et al., 1985). To date, almost no empirical work has focused on attachment at the level of representation in infancy (yet see, Johnson, Dweck, Chen, Stern, Ok, & Barth, 2010). Thompson (2008) noted that the IWM concept was overlooked for many years as researchers focused on infancy, yet I suggest, as have others (Johnson et al., 2010), that the IWM concept can be studied in infancy. Recent motivation to bridge social-emotional and cognitive development research (e.g., Calkins & Bell, 2010; Olson & Dweck, 2008) along with methodological advances and accumulating research on infant memory and social

cognition permits greater exploration of internal working models of attachment during infancy.

During the first year of life, attachment formation is characterized by both normative and individual differences phenomena. According to attachment theory (Bowlby, 1969/1982, 1973), infants are biologically predisposed to seek proximity and form attachments to their caregivers. Through the process of evolution, humans have developed this adaptive, species-typical behavior to promote protection from predators. The quality of infant attachment, however, varies based in part on the parenting received. When infants' attachment systems are activated, they engage in attachment behaviors designed to promote proximity to caregivers (e.g., crying, signaling, reaching, and crawling). Caregivers, in turn, respond by either (a) allowing access, (b) limiting access, or (c) allowing access only occasionally (Main et al., 1985). Over time, infants learn how their caregivers respond to their attachment signals and adjust their behavior accordingly. Infants whose caregivers allow access will continue to signal their attachment needs in the future – a process akin to positive reinforcement. Infants whose caregivers limit access will cease to exhibit attachment behaviors – a process akin to punishment. Lastly, infants whose caregivers allow access only occasionally will increase their attachment behaviors – a process akin to variable reinforcement. These relationship-specific behavioral patterns are reliably observed during the Strange Situation, a laboratory assessment of attachment quality, at 12 months (Ainsworth, Blehar, Waters, & Wall, 1978).

Notice in this description of attachment formation, I focused on the behavioral aspects of attachment patterns and operant learning processes, making no reference to

infants' higher-order mental representations. Although the behavioral patterns of attachment are often interpreted through the lens of infants' IWMs (e.g., Ainsworth et al., 1978; Main et al., 1985; Waters & Deane, 1985), they can be explained without considering the infants' mental representations because not every aspect of attachment formation occurs at the level of representation. Certainly, the work with primates and other mammals conducted by Harry Harlow (Harlow, 1958), Steve Suomi (Suomi, 2008), Michael Meaney (e.g., Parent et al., 2005), Regina Sullivan (e.g., Moriceau & Sullivan, 2005), and Myron Hofer (Polan & Hofer, 2008) indicates that attachment formation is a dynamic process, occurring at behavioral, physiological, and genetic levels. According to attachment theory, attachment formation in humans is also occurring at the cognitive level while infants form internal working models of other and self in attachment relationships (Bretherton & Munholland, 2008). These models may develop in parallel to, in interaction with, in support of, or as a result of the developments in the other levels, but nonetheless, a key notion of attachment theory is that IWMs are forming during infancy. Research on the cognitive capacities related to attachment in infancy will provide a more comprehensive understanding of attachment formation in general and will allow for tests of a key assumption of attachment theory that infants build IWMs of their attachment figures and the self in the relationship.

Overview

Accordingly, the purpose of this paper is to (a) describe the features and formation of the internal working model from the perspective of attachment theory; (b) identify infant cognitive capacities that are related to the formation of an internal working model of an attachment figure; (c) describe each of the identified capacities, in turn, by

describing the conceptual relation between the capacity and the IWM of an attachment figure, reviewing the empirical literature examining the capacity in the first year of life (see Thompson, Laible, & Ontai, 2003, for a discussion of relevant cognitive capacities during the preschool years), and providing suggestions for future research to examine the capacity in relation to IWMs of attachment figures; and lastly, (d) conclude with a general summary and general recommendations for future directions. In doing so, the goal is not to provide a comprehensive review of each cognitive capacity (especially given that many of these capacities have been comprehensively reviewed elsewhere; e.g., Bauer, 2006, for event memory), but instead to highlight the conceptual relation of each capacity to the internal working model concept and review empirical findings assessing each capacity that relate to the internal working model concept during infancy (I use the terms *infancy* and *infants* to refer to the first year of life). As such, the review of each capacity is intended to be illustrative rather than exhaustive.

Internal Working Models of Attachment

Searching for a definition. In conceptualizing the role of mental representation in attachment formation, Bowlby (1969/1982) was influenced by Piaget's (1952) theory of cognitive representation (e.g., schemas) and borrowed Craik's (1943) idea of mental model building. Craik proposed that individuals create mental models that are perceptions (or representations) of reality to predict the likely outcome of events. These mental models are developed in all domains, including the physical and social world, to allow individuals to generate ongoing predictions of events (Craik, 1943). By having these mental models, the world is seen as a more predictable and understandable place. Bowlby

(1969/1982) proposed that similar mental models are forming about attachment figures and the self in the attachment relationship called internal working models.

For the purpose of this paper, I focus on the formation of IWMs of others – more precisely, the relationship-specific models of individual attachment figures. Models of the self in the relationship are equally important and are developing in concert with models of attachment figures, but will not be addressed here. As children mature, theory and research suggest that these relationship-specific models of self and other become organized and integrated into a general IWM of attachment. This general IWM is then used to guide children's emotions, behaviors, and cognitions in subsequent relationships; consideration of this phenomenon is beyond the scope of this paper (see Main et al., 1985; Thompson, 2006, 2008; Thompson et al., 2003).

Bowlby's formulation of the building, revising, and maintenance of IWMs is distributed across the Attachment Trilogy: Attachment (1969/1982), Separation (1973), and Loss (1980), as well as several other works (Bowlby, 1979, 1988). In his writings, however, Bowlby never offered a single, specific definition of the IWM. Bretherton and Muholland (2008) note that Bowlby's ideas about the "the role of representation in attachment relationships . . . was not a fully worked-out theory, but a promising conceptual framework to be filled in by others" (p. 103). As such, students of attachment theory have offered varied definitions, interpretations, and conceptualizations of IWMs (Bretherton, 2005; Crittenden, 1990; Main et al., 1985; Sroufe, 1996; Thompson, 2006; Weinfield, Sroufe, Egeland, & Carlson, 2008).

Although interpretations of the definition of IWMs have varied in the theoretical and empirical literature, most scholars of attachment theory agree that IWMs are

experience-based mental representations (e.g., Bretherton & Munholland, 2008; Main et al., 1985; see Thompson, 2008, for a discussion on divergent views of the IWM). Some accounts of IWMs include the function of IWMs in generating expectations for caregivers' likely behavior in their definitions (e.g., Sroufe, 1996; Thompson, 2008; Weinfield et al., 2008), whereas others do not, describing expectations as a function or usage of the model, rather than a defining characteristic of the model itself (e.g., Crittenden, 1990; Main et al., 1985). In several of his writings, however, Bowlby highlighted the critical role of expectations in the IWM. For example, Bowlby (1969/1982) stated:

Starting, we may suppose, towards the end of his first year, and probably especially actively during his second and third when he acquires the powerful and extraordinary gift of language, a child is busy constructing working models of how the physical world may be expected to behave, how his mother and other significant persons may be expected to behave, how he himself may be expected to behave, and how each interacts with the other. Within the framework of these working models he evaluates his situation and makes his plans. And within the framework of these working models he evaluates special aspects of his situation and makes his attachment plans. (p. 354)

This quote suggests that Bowlby may have intended to include *expectations for*, not just *representations of* the caregivers' behavior in the IWM. It is also possible, however, that Bowlby's focus on the function of the model was inadvertently intertwined with the definition, especially given that he never fully articulated the definition of the IWM. This alternate view suggests that the IWM is a set of experience-based representations of an

attachment figure's past behavior that then guides the expectations of the attachment figure's subsequent behavior.

Thompson (2008) recently synthesized the varied accounts of IWMs in the literature, acknowledging a "portrayal of IWMs as emerging early in life in the form of rudimentary expectations for the accessibility and responsiveness of caregivers" (p. 350). Given my focus on infancy and the formation of an IWM of an attachment figure, I join Thompson and others (e.g., Weinfield et al., 2008) who, consistent with Bowlby's (1969/1982, 1973) writings, include expectations in their definitions of IWMs. In regard to the IWM of attachment figures, Bowlby (1973) wrote, "In the working model of the world that anyone builds, a key feature is his notion of who his attachment figures are, where they may be found, and how they may be expected to respond" (p. 203).

Following from Craik's (1943) mental model building idea that cognitive models are perceptions of reality, Bowlby suggested that "the varied expectations of the accessibility and responsiveness of attachment figures that different individuals develop during the years of immaturity are tolerably accurate reflections of the experiences those individuals have actually had" (p. 202). Taken together, for the purposes of this paper, I view IWMs of attachment figures as relationship-specific, experience-based expectations for caregivers' likely behavior. In what immediately follows, I provide a more thorough theoretical review of the formation of IWMs in infancy.

The role of experience in forming the IWM. Consistently across his writings, Bowlby acknowledged that infants' actual experiences with attachment figures contribute to the IWM of those attachment figures. IWMs are hypothesized to be the result of repeated, daily, attachment-related experiences with an attachment figure. In order to be

of any real use, infants' models of their caregivers must be based on the actual behavior of their attachment figure during past attachment-related interactions (Bowlby, 1969/1982). It is important to remember that the IWMs of attachment figures are thought to be based on attachment-related experiences (e.g., when the infant is seeking proximity, either when scared, distressed, or needing comfort). Parents also serve as playmates, teachers, and other roles to their children. Interactions during these moments may contribute to the IWM, but are not likely to be the basis for the IWM of attachment. As a result of differing caregiving experiences, infants construct representational models for each of their caregivers based on the experiences they have had with these caregivers (Bowlby, 1979). Infants whose caregivers allow access when the infants seek proximity will develop expectations that their caregivers will allow access in later interactions (which results in secure attachment), whereas infants whose caregivers limit access or inconsistently allow access will develop expectations that their caregivers will subsequently limit access or inconsistently respond, respectively. It is possible that children growing up in the same home, interacting with the same caregivers, may develop different IWMs of these caregivers because they each experience unique interactions with their caregivers and they each construct their own representations about those interactions.

Furthermore, Bowlby suggested that infants develop separate IWMs for each their attachment figures (i.e., the primary and subsidiary attachment figures; Bowlby, 1969/1982). For instance, infants who receive different responsiveness from each of their caregivers (e.g., sensitive responsiveness from their father, but inconsistent responsiveness from their mother) will develop separate models for representing each

caregiver's behavior. Each model will be "tolerably accurate reflections of the experiences those individuals have actually had" with each caregiver (Bowlby, 1973, p. 202). The ability to represent each caregiver separately allows the infant to form accurate expectations in interactions with each caregiver. In addition, infants may develop multiple models for a single attachment figure. This phenomenon has not been well articulated or studied since Bowlby's (1973) original proposition (Thompson, 2008), but Bowlby posits that this is most likely to occur under pathological or emotionally disturbed circumstances, and is beyond the scope of this paper.

Continuity and change. Given that IWMs are "tolerably accurate" perceptions of reality, Bowlby (1969/1982, 1973) suggested that IWMs are constantly being reinforced and updated based on subsequent experience. To the extent that the caregiver's behavior towards the infant changes, so too will the infant's mental representation of that caregiver. As such, IWMs require flexible updating as new experiences are amassed. Much like Piaget's (1952) concept of schemas, new experiences with caregivers must be accommodated or assimilated into the infant's current mental representation of that caregiver. Infants can interpret or re-interpret the new experience to fit into the existing representation, or can change the representation (which is much more difficult, although not impossible). The existing model is used to guide future interactions. To the extent that the model provides accurate prediction of the other person's behavior, the model will remain as is. As the child grows and develops, the nature of the parent-child relationship may change. For instance, parental behavior changes in response to children's locomotor development from learning to crawl and walk (Thompson, 2006). When the child's model of his caregiver is no longer accurate in making predictions, new information will

be incorporated into his model based on the nature of these new interactions. As a result, there may be a time-lag in the accuracy of the IWM as the child undergoes developmental transitions or the parent changes her behavior while the model is updated (Bowlby, 1988; Bretherton & Munholland, 2008). Internal working models can also be revised in the absence of the attachment figure because IWMs are based on infants' experiences of having their attachment figure respond to their attachment signals. When infants' attachment systems are activated, they attempt to seek proximity to their attachment figure. If the attachment figure is absent, then infants' expectations about the availability and accessibility of that figure may be altered (Bretherton & Munholland, 2008; Main et al., 1985)

Although IWMs are expected to lawfully change with changing environments, they become increasingly resistant to change over time. New experiences are often ignored if they are inconsistent with the model as they may be too difficult to assimilate into the existing model (Bowlby, 1980; Cassidy, Ziv, Mehta, & Feeney, 2003). Additionally, unless these new experiences continue frequently, the model will not be changed to accommodate the new information because the interaction may not occur with enough frequency to offer accurate prediction in the future. This is one reason it is believed that parents need only to be "good enough" parents. Some instances of insensitivity are unavoidable and parents cannot attend to their child's every need. If infants regularly receive sensitive responsiveness, they are thought to simply ignore the infrequent instances of insensitivity because, on average, their prediction that their caregiver will respond sensitively is confirmed. Bowlby (1973) borrowed Waddington's

(1957) concept of developmental pathways to illustrate that IWMs become more canalized and resistant to change over time.

Summary. In sum, attachment theory suggests that infants construct internal working models of their attachment figures that are based on their attachment-related interactions in the form of expectations for their caregivers' availability, responsiveness, and likely behavior in novel situations. The IWM concept during infancy is a major tenant of attachment theory that most attachment researchers take for granted by simply assuming that by 12 months, when attachment patterns are reliability observed, infants have developed IWMs of their caregivers (Main et al., 1985). Theorists and researchers assume that the behavioral patterns of secure, insecure-avoidant, and insecure-ambivalent are manifestations of the representations and expectations these infants have formed from past interactions with their caregivers. This pervasive assumption does little to move the field forward and could potentially be false. Attachment formation and individual differences in attachment quality could occur without infant cognition playing a role. To date, very little research has investigated the cognitive aspects of the formation of the IWM in infancy. Several investigations have been conducted with older children and adults shedding light on the existence and utility of IWMs of attachment (for reviews see, Bretherton & Munholland, 2008; Thompson et al., 2003). In fact, a recent special issue of the *Attachment & Human Development* journal (2008) focused on attachment-related mental representations.

In most reviews and empirical examinations of attachment-related mental representations, the general, broad representational model of self and other is studied, rather than children's relationship-specific experiences with and expectations of their

attachment figures (see Thompson, 2006). Furthermore, these studies are mainly correlational, focusing on how individual differences in these models relate to children's subsequent behavior, cognition, and emotion, rather than focusing on the cognitive aspects of the formation of the model. This body of research has significantly contributed to our understanding of IWMs in the childhood, adolescent, and adult years. Now, with advances in the study of infant cognition, the field is more poised than ever to explore the cognitive aspects that relate to the development of infants' IWMs of attachment figures by utilizing controlled laboratory studies and experimental procedures designed to assess infant cognition.

Empirical studies on the IWM in infancy. To my knowledge, only one set of studies has utilized controlled methods for studying infant cognition to investigate infants' internal working models of attachment (Johnson et al., 2010; see also Johnson, 2007, for initial exploratory findings). Johnson et al. (2010) conducted a series of studies relating infants' attachment classifications in the Strange Situation (the gold standard attachment assessment for infants; Ainsworth et al., 1978) to their looking time measures during habituation events designed to assess their expectations for caregivers and infants. Across three studies, infants were habituated to a display of a small circle (meant to represent a child) and a large circle (meant to represent a caregiver) at the bottom of a hill. The infants were repeatedly shown a video of the mother climbing the hill and the child "crying" (pulsating, with audio of infant cry noise) until infants looking time declined to half the original trial (visual habituation paradigm; see Colombo & Mitchell, 2009, for a detailed account of visual habituation paradigms). Infants were then shown test events of the caregiver's behavior (study 1) or the infant's behavior (studies 2 & 3).

Longer looking times during specific test events suggest “surprise” or violation of expectations for the event outcome.

Across these studies, response patterns of the secure, insecure-avoidant, and insecure-ambivalent infants revealed that infants have different expectations for caregivers and infants. Securely attached infants expect caregivers to be responsive and expect infants to approach caregivers. Insecure-avoidant infants expect caregivers to be unresponsive and expect infants to withdraw from caregivers, whereas insecure-ambivalent infants expect caregivers to be unresponsive, but expect infants to approach caregivers. These results indicate that infants with different attachment classifications have different expectations for the responsiveness of caregivers. These results provide promising support for the cognitive level of general attachment representation in infancy. What remains untested are infants' person-specific expectations based directly on past interactive experience.

Cognitive Capacities Related to the IWM

In order to investigate the formation of IWMs, it is important to understand and examine infant cognitive capacities that would be related to building mental representations of a caregivers' likely behavior. Several cognitive capacities are relevant to building an IWM of an attachment figure, including: the capacities to (a) discriminate and recognize individual people, (b) understand the permanence of people, (c) understand the meaning of attachment figures' emotions and behaviors, (d) remember experiences with attachment figures, and (e) generate novel expectations for attachment figures' behavior based on previous experiences with them. These capacities represent a host of seemingly advanced mental processes to support the formation of an IWM. Despite the

dearth of research examining the cognitive aspects of infants' IWMs of attachment relationships, there is substantial work studying infant memory and social cognition suggesting that infants possess cognitive capacities related to building IWMs of others. In the following section, I examine each of these capacities in turn. For each capacity I describe the conceptual relevance of the capacity to the formation of an IWM of an attachment figure, review literature examining each capacity in infancy, and provide suggestions for future research to examine the capacity in relation to an IWM of attachment.

Discrimination and recognition of people. Person discrimination is the ability to distinguish the difference between people (i.e., to tell two or more people apart) and person recognition is the ability to recognize or remember another person that you have seen before. This ability is important for social development in general, but particularly relevant to developing an internal working model of an attachment figure because “in the working model of the world that anyone builds, a key feature is his notion of who his attachment figures are (Bowlby, 1973, p. 203).” Furthermore, in order to develop unique internal working models of each attachment figure, infants would need to discriminate between two or more people. Infants would otherwise be unable to separate the attachment-related experiences with one caregiver from another. Relatedly, infants must be able to remember and recognize familiar people in order to add their new experiences with that person to their existing mental representations. Otherwise, each experience with a caregiver would be as if it was the infant's first experience with that person because the infant would be unable to recognize the caregiver as a familiar person. The capacities to tell people apart and recognize familiar people are thus basic building blocks of the IWM

and should be present early in the first year of life. Recognition implies discrimination because a distinction has been made between a familiar person and an unfamiliar person; discrimination, however, can occur without recognition by simply noticing the difference between two faces.

Human infants seem prepared to obtain information from and about faces immediately after birth; newborn infants have a preference for faces and face-like stimuli (Johnson & Morton, 1991; Mondloch, Lewis, Budreau, Maurer, Dannemiller, Stephens, & Kleiner-Gathercoal, 1999; Simion, Valenza, & Umiltà, 1998) and will imitate facial movements and expressions (Meltzoff & Moore, 1977; Reissland, 1988). Whether these behaviors represent an early face-specific learning module or an innate understanding of faces (see Nelson, 2003, for a review of theoretical positions on face recognition), it is evident that newborn infants have a unique aptitude toward processing faces.

Shortly after birth, infants can already discriminate and recognize their mother's face from an unfamiliar adult's face and prefer looking at their mother's face (Bushnell, 2001; Bushnell, Sai, & Mullin, 1989; Field, Cohen, Garcia, & Greenberg, 1984; Pascalis, de Schonen, Morton, & Deruelle, 1995; Sai, 2005; Slater & Quinn, 2001). The early recognition of their mother's face may result from an early association between their mother's voice and face. Newborn infants prefer their mother's voice to the voice of an unfamiliar adult, which is likely to be based on prenatal exposure and learning of the mother's voice in utero (DeCasper & Fifer, 1980; Fifer & Moon, 1988). Research suggests that postnatal pairing of their mother's voice and face is necessary for infants' subsequent face discrimination and recognition (Sai, 2005). Infants quickly associate their mother's voice, which they learned in utero, with their mother's face supporting

very early visual discrimination and recognition of their mother. Once infants pair their mother's voice and face, they can recognize their mother's face without auditory support (Field et al., 1984; Sai, 2005). Thus, just hours after birth, infants have the capacity to discriminate and recognize their mother – a capacity that they will need to develop an IWM of her.

In addition to discriminating and recognizing their mother, infants should be able to discriminate and recognize other people because they form IWMs about each of their attachment figures (e.g., fathers, grandmothers). Research indicates that infants as young as 1 month old can discriminate between two unfamiliar adult faces (de Haan, Johnson, Maurer, & Perrett, 2001). Whether faces are presented as static images or live models, infants between 3 and 5 months are able to discriminate between unfamiliar adults and recognize familiar adults (Bahrick & Newell, 2008; Blass & Camp, 2004; Otsuka, Konishi, Kanazawa, Yamaguchi, Abdi, & O'Toole, 2009). By 6 months of age, infants are able to recognize familiar faces that were presented and tested at differing rotations (Pascalis, de Haan, Nelson, & de Schonen, 1998) and with differing emotional expressions (Bornstein & Arterberry, 2003). Research indicates that infants are less effective at processing, discriminating, and recognizing male faces compared to female faces, unless, the infants' primary caregiver is their father; when fathers are the primary caregiver, infants prefer male faces over female faces (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002; Ramsey, Langlois, & Marti, 2005). These findings suggest that experience with faces plays a role in the ability to discriminate and recognize familiar faces. With experience, infants become better able at discriminating the differences between faces by using more subtle cues to determine differences (e.g., Bhatt, Bertin,

Hayden, & Reed, 2005; Hayden, Bhatt, Reed, Corbly, & Joseph, 2007) and recognizing familiar faces over longer delays and with less familiarization time (e.g., Bahrnick & Newell, 2008; Rose, Feldman, & Jankowski, 2004).

Infants' recognition and preference for familiar adults can be enhanced through the nature of infant-adult interaction. Blass and Camp (2001) found that 9 and 12-week-old infants developed a preference for a female experimenter who maintained eye contact and delivered a sweet, sucrose solution over an unfamiliar female experimenter. Similarly, Farroni, Massaccesi, Menon, and Johnson (2007) found that direct gaze from an adult supported infants' subsequent recognition of that adult. These interactive components that support face recognition may support infants' ability to identify who their attachment figures are because attachment figures are more likely than other adults to be the ones who are frequently maintaining eye contact with them and feeding them.

Discrimination and recognition of people: Summary and future directions. In summary, the existing research clearly indicates that infants' capacities to discriminate between adults and recognize familiar adults is well established by at least 5 months of age (e.g., de Haan et al., 2001; Pascalis et al., 1995, 1998). Infants' ability to distinguish and recognize their mother develops early in infancy and is evident shortly after birth. This body of research indicates that infants have the capacity to know who their attachment figures are, which is a key notion of the IWM (Bowlby, 1973). These abilities have been extensively studied and recent research is incorporating neuroimaging assessments to further understand infants' discrimination and recognition of familiar adults. For relating this capacity to the IWM of attachment figures, little future work is

necessary. The available data support the claim that infants can discriminate and recognize their caregivers.

Person permanence. In addition to discriminating and recognizing people, the capacity to represent people who are not present is an important cognitive capacity for infants to develop. Person permanence refers to the knowledge that a person continues to exist when he/she can no longer be seen or heard. Although similar to object permanence, person permanence is specific to people instead of objects. Piaget (1954) suggested that people are the first permanent objects for infants because they are simply more interesting than objects. His proposition was based on observations that infants younger than 8 months failed to search for hidden objects, but showed signs of distress and searched for hidden people at this age. He termed this time-lagged phenomenon a *positive decalage* in development. Evidence that infants represent and react to people and objects quite differently from early in development (Ellsworth, Muir, & Hains, 1993; Legerstee, 1991) suggests that infants may come to understand the permanency of people differently from the permanency of objects.

Person permanence is relevant to two aspects of the IWM. First, Bowlby (1973) stated that “a key notion in the internal working model of the world that anyone builds . . . is where [his attachment figures] may be found” (p. 203). If infants do not understand that people continue to exist outside of their own awareness, then infants would not know where to find their attachment figures because, in their minds, their attachment figures have ceased to exist. Additionally, attachment theory suggests that internal working models are updated not only through additional experiences with the caregiver, but also during times of separation when children may attempt to seek proximity to and comfort

from unavailable caregivers (Bowlby, 1973; Bretherton & Munholland, 2008; Main et al., 1985). If in the minds' of infants, people cease to exist when not present, then infants could not update the IWMs of their caregivers in the caregivers' absence because they would never think about these people. As such, the cognitive capacity to understand that people continue to exist is related to forming an IWM.

When using traditional tasks to study object permanence (i.e., search for hidden items), most studies find evidence consistent with Piaget's positive decalage hypothesis (see Krøjgaard, 2005, for a review). Infants between 6 and 14 months search for hidden persons and are often better at finding hidden persons than hidden objects; infants are especially good at finding their mothers (e.g., Bell, 1970; Legerstee, 1994; Slaughter & Boh, 2001). Regardless of whether infants' search for people is evident before their search for objects, the data are clear that infants within the first year of life search for hidden people. The better ability to find their mothers than other persons suggests that by 6 months of age, infants have, in a very literal, experimentally contrived setting, a notion of where their attachment figures may be found.

The research presented above suggests that a positive decalage exists with respect to when infants achieve people and object permanence. This interpretation of these studies, however, has been criticized because of the experimental procedures (i.e., search tasks) used to test infant cognitive capacities. Search tasks not only require knowledge of object/person permanence, but also require memory capacities for remembering where the object/person was hidden, motor capacities for removing the occluder or crawling around the occluder, and additional cognitive capacities to create and select a plan for removing or negotiating the occluder to find the object/person. As such, failure in search

tasks may not represent failures of object permanence, but failures of more advanced means-end cognitive-motor abilities. In fact, studies using newer methods for studying infant cognition, such as visual preference techniques and the violation-of-expectation method, suggest that infants as young as 3 months of age demonstrate knowledge of object permanence (e.g., Aguiar & Baillargeon, 2002; see Baillargeon, 2002, for a review).

Considering that object permanence is evident by 3 months of age, several possibilities exist about the development of person permanence. First, Piaget's notion of a positive decalage for person and object permanence could still be possible with infants developing person permanence earlier than 3 months. Second, it is possible that person permanence develops in parallel and along the same time course of object permanence. Third, person permanence may develop after object permanence. Lastly, person permanence may not be a distinct ability, but rather a manifestation of object permanence, where the permanency of people and objects is the same capacity. These last two possibilities seem unlikely given the considerable evidence that infants represent, understand, and behave toward people and objects very differently (e.g., Ellsworth et al., 1993; Legerstee, 1991). In order to decipher these possibilities, researchers need to utilize the same methods that researchers testing object permanence have benefited from in tests of person permanence. To date, however, there are no published studies on person permanence using visual preference techniques or the violation of expectation method.

Person permanence: Summary and future directions. In sum, research indicates that infants search for hidden persons (especially their mothers) at approximately 6 months of age suggesting that infants have a concept of person permanence. These data

indicate that infants have the capacity to know where their attachment figures may be found, which is a key notion of the IWM (Bowlby, 1973). This knowledge may then serve as a building block for creating changes to the internal working model during periods of separation. It is possible that person permanence is achieved earlier in development than is evident from search tasks; future research using infant looking time measures is necessary to establish how early the capacity is evident. Future research designed from the perspective of attachment theory should experimentally test whether infants' representations of people can be changed in their absence.

Understanding interactions with caregivers. Infants' ability to know who their attachment figures are (e.g., discrimination and recognition capacities) and where they may be found (e.g., person permanence) provides a foundation for subsequent learning about their attachment figures (Bowlby, 1973). Infants' ability to understand their interactions with their caregivers, specifically to understand their caregivers' emotions and intentions, will allow infants to form more accurate representations of their attachment-related interactions and expectations for their caregivers likely behavior.

Understanding other people's emotions. During interactions with others, adults convey important information through their emotional expressions. A key task for infants to develop is the ability to discriminate among the many emotional expressions of others and to understand that these different expressions convey different meaning (Stern, 1974). These abilities are important for the formation of the infants' internal working model of their caregiver. According to Bowlby (1973), IWMs are based on infants' repeated attachment-related experiences with their caregivers. Attachment-related experiences are often highly emotionally charged -- times when the infant is scared,

upset, hurt, distressed, and in need of comfort (Bowlby, 1969/1982). The caregivers' response to infants' attachment signals, whether caregivers are welcoming, angry, or fearful, should contribute to the infants' IWM. For instance, a mother who is uncomfortable with closeness may reluctantly pick up her distressed infant and display her discomfort and disdain while holding her infant. Although the infant is experiencing being held by mother while distressed, the mother's emotional reaction is quite different from that of a mother who welcomes and comforts her distressed infant. According to attachment theory, the internal working models that these two infants develop of their mothers should be quite different. This would only be possible if infants can appreciate the emotional reactions of others as meaningfully distinct.

Emotion discrimination. Considerable research indicates that even young infants can discriminate the major emotions, but that with development, infants become better at discriminating additional emotions and at recognizing similarities between different faces expressing similar emotions (see Nelson, 1987, and Walker-Andrews, 1997, for reviews). In studies of emotion discrimination, infants are habituated to a person's face displaying an emotional expression. After infants are habituated to the image, a new image is shown with a different emotional expression. Infants who can discriminate between the emotional expressions demonstrate renewed visual interest for the new stimulus. By 4 months of age, infants can discriminate among happy, angry, surprised, fearful, and sad expressions (e.g., Barrera & Maurer, 1981; Bornstein & Arterberry, 2003; Nelson, 1987; Young-Brown, Rosenfeld, & Horowitz, 1977). By 6 months of age, infants recognize similar emotions despite changes in intensity or age and gender of the model (e.g., Bornstein & Arterberry, 2003).

Emotion meaning. Emotional expressions are not simply visual stimuli to be differentiated. The studies reviewed above indicate that infants are highly skilled at detecting the difference between other people's facial expressions, but people's expressions convey a wealth of information about the people expressing them such as their motivations, goals, current dispositions, intentions, and future behavior (Walker-Andrews, 1997). Once the emotion is discriminated, the meaning of the emotion must be understood in order to be of any use to the observer (in this case, the infant).

Several studies show that young infants respond in meaningfully different ways and affectively match the different facial expressions of others (e.g., Bigelow, 1998; Cohn & Tronick, 1987; see also Mesman, van IJzendoorn, & Bakermans-Kranenberg, 2009, for a meta-analysis of the still-face procedure). For example, infants as young as 2.5 months expressed unique behavioral responses when viewing their mothers' live displays of joy, sadness, and anger (Haviland & Lelwica, 1987). During happy and angry expressions, infants' behavioral responses matched the affect of the mother's emotion, indicating that infants may feel their mother's emotions. Similarly, Montague and Walkers-Andrews (2001) found that 4-month-olds produced unique looking patterns and behavioral responses to each emotional expression of an unfamiliar experimenter. From baseline, infants' looking time initially increased and then decreased across trials for fearful expressions, consistently increased across trials for angry expressions, and decreased across trials for sad expressions. In addition, although infants in this study did not affectively match the emotions, their movements and emotional liability differed for each emotion.

In addition to differentially responding to others' emotions, infants use adults' emotional responses to learn about ambiguous objects and events in their environment. For example, 12-month-olds saw an experimenter direct either positive, negative, or neutral affect toward a target object and ignore a distracter object. In later play sessions, infants in the negative condition subsequently avoided the target toy and displayed more negative affect than infants in the other emotional conditions (Mumme & Fernald, 2003). Infants also use the emotional information provided by others about objects to make inferences about how those people will behave in subsequent interactions with the objects. Barna and Legerstee (2005) exposed 9- and 12-month-old infants to either a Happy or Unhappy person who looked at an object and said either "Ooo, I like objects" or "Oh, I don't like objects," respectively. Then, infants were habituated to a display of that person holding the object, but the person's face was obscured. After habituation, infants were shown either the person holding the object with a happy expression (consistent event for the happy pretrial) or an unhappy expression (inconsistent event for the Happy pretrial). Infants look significantly longer at the inconsistent events, suggesting that they understood the person's emotional feeling toward the object and expected the person to show consistent emotions when holding the target object.

Not only do infants use available social information to interpret situations, but considerable research now indicates that infants actively seek such information through referential looking as young as 7 months of age (e.g., Baldwin & Moses, 1996; Stirano & Rochat, 1999, 2000). This research consistently shows that infants look toward adults in the environment and – particularly in ambiguous settings – behave as a function of the emotional signals that the adult conveys (e.g., Feinman & Lewis, 1983; Gunnar & Stone,

1984; see also Carver & Cornew, 2009). The visual cliff is an apparatus commonly used in studies to evaluate infant social referencing. In these studies, infants are placed on one side of a divide and an adult (either mother or experimenter) is on the other side of the divide. The distance and height of the divide can be visually manipulated such that infants clearly know it is safe, clearly know it is unsafe, or are unsure if it is safe to cross. Studies show that when infants are unsure if it is safe to cross, they will cross if their mother signals safety, but will not cross if their mother expresses fear (e.g., Sorce, Emde, Campos, & Klinnert, 1985). Using a socially ambiguous event (as opposed to an environmentally ambiguous event), Striano and Vaish (2006) found that 7- and 9-month-old infants looked toward an adult experimenter's face during an ambiguous interaction (when she teased the infants with a toy), but not when her actions were clear (she gave the toy to the infants). Furthermore, in the ambiguous interactions, both 7- and 9-month-olds looked longer at the adult when her expression was neutral than when it was happy. The authors suggested that the infants may have been searching the experimenter's face for information to interpret these ambiguous interactions and may have needed more time to interpret her behavior when paired with a neutral expression.

Infants' also engage in social referencing during distressing situations. Striano and Rochat (2000) found that between 7 and 10 months of age, infants develop selective social referencing. The researchers exposed 7- and 10-month-old infants to a mechanical barking dog while an experimenter either looked toward the infant or looked away. Seven-month-olds referenced the experimenter after the dog barked in both the looking toward and looking away conditions, whereas 10-month-olds referenced the experimenter after the dog barked only in the looking toward condition. These results suggest that

infants in this age range seek out the emotional signals of social partners and that by 10 months of age, infants can appreciate the subtlety in the availability of adults during distressing situations.

Emotion understanding: Summary and future directions. Taken together, these studies on infant emotional discrimination and emotion meaning suggest that within the first year of life, infants are able to decode a wealth of information from people's emotional expressions that would contribute to the development of more accurate internal working models of others. Infants actively seek and use other people's emotional expressions as social information to make sense of the world. Infants understand that other people's emotions convey meaning and use that information to navigate their environments. Infants also appreciate that people act in accord with their emotional displays and look at people's faces to assist in interpreting people's ambiguous actions. These abilities would allow infants to develop complex internal working models of others based on their interactions. Future research should explore infant understanding of other people's emotional signals specifically as they relate to the infant's attachment signals.

Understanding other people's intentions. Understanding the intentions of others is an important development during childhood that supports survival, social affiliation, and culture (Tomasello, Carpenter, Call, Behne, & Moll, 2005). By recognizing that other people's behavior is not random, but that it is instead executed with specific goals in mind, children can better understand people's current behaviors and their likely behavior in the future. In this section, I focus on infants' understanding that other people act intentionally (as opposed to randomly) and infants' ability to determine another person's intention.

Understanding that other people act intentionally and determining what those intentions are would support the formation of an accurate IWM. Infants who understand that caregivers' responses to their attachment signals are not random, but are executed intentionally, will be better able to accurately represent their own past experiences and predict their caregiver's future behavior. For example, parents who are uncomfortable with closeness and infant dependency may respond to their infants' distress by distracting them with toys or telling their infants that they are fine while failing to comfort them. Both behaviors, although quite distinct from each other perceptually, signal to the infant that the parent does not intend to directly soothe the infant. If infants can ascertain the intentions that underlie their caregivers' behavioral responses, then they can develop more accurate representations and expectations for their caregivers' likely behavior. In addition, individual caregivers vary in their responsiveness across time and context. Caregivers might have the intention of comforting their infant, but be unable to respond sensitively due to environmental constraints (e.g., driving a car) or inability to ascertain the infants' needs. Infants who can decipher the difference between their caregivers' intentional insensitivity from accidental or unavoidable insensitivity can make better sense of their caregiver's behavior and make more accurate predictions in the future. A caregiver who accidentally or unintentionally acts insensitively should not be expected to be insensitive in the future, whereas a caregiver who intentionally responds in an insensitive way would be expected to be so in the future. One reason why infants might ignore their caregiver's model-inconsistent behavior is that they recognize the unintentional nature of these uncommon instances. It is important, therefore, to uncover

the intentions of other people to develop accurate representations of their general behavioral patterns and their specific behaviors.

Infants' understanding of others as intentional agents has been well studied in the social cognitive literature and reviewed extensively (see Tomasello et al., 2005; Woodward, 2009; Woodward, Sommerville, Gerson, Henderson, & Buresh, 2009). As Woodward (2009) noted, research using diverse methodologies converges on the notion that infants do not simply view others' actions as chaotic movements, but rather that infants understand others' actions "as structured with respect to external goals and objects of attention (p. 228)." Studies assessing infants' looking times during familiarization and habituation suggest that infants, beginning between 5 and 6 months, understand actions as goal-directed rather than random (e.g., Legerstee, Barna, & DiAdamo, 2000; Woodward, 1998). Specifically, infants encode the end goal-state as important to the adult rather than the specific nature of the movement made to achieve that goal (e.g., Carpenter, Call, & Tomasello, 2005; Csibra, 2008). Several of these looking time studies are reviewed later in the section on expectations; I turn now to studies employing other techniques to assess infants' understanding of others' intentions.

In a series of studies, Behne, Carpenter, Call, and Tomasello (2005) assessed 6-, 9-, 12-, and 18-month-old infants' reactions to conditions in which an experimenter ceased giving toys to the infant because she was either "unable" or "unwilling" to do so. The unable adult began to hand the infant a toy and then she accidentally dropped the toy, whereas the unwilling adult began to hand the infant a toy and then pulled the toy back. In both conditions the infants did not receive the toy, but the adult's behavior was quite different. Starting at 9 months of age, compared to infants in the "unable" condition,

infants in the “unwilling” condition responded with more negativity and frustration. These results indicate that infants can interpret other people’s intentions and are more forgiving of accidental mishaps than intentional withholding.

Studies with older infants and toddlers also indicate that children understand the distinction between adults’ intentional and accidental actions. In some of the first such studies, 14-month-olds were more likely to imitate the actions of an adult when the action was marked as intentional (“There!”) rather than accidental (“Whoops!”; Carpenter, Akhtar, & Tomasello, 1998) and 18-month-olds were more likely to imitate the goal-directed aspects of an action (i.e., pushing a button) rather than the accidental actions when the adult failed (Meltzoff, 1995). In these two studies, younger infants were not tested, but follow-up studies have demonstrated that 12-month-olds also imitate the goal-relevant aspects of adults’ actions rather than the motions themselves, suggesting that infants understand the intentions of the adult (e.g., Carpenter et al., 2005; Schwier, Van Maanen, Carpenter, & Tomasello, 2006).

Intentionality understanding: Summary and future directions. Although studies indicate that young infants understand some actions as intentional, most of the research is on specific, goal-directed outcomes. Understanding of more complicated intentions underlying other people’s behavior may not be understood until later in development. During the last half of the first year and continuing in development, children become better able to represent the intentions of others. Infants’ imitation of intentional as opposed to accidental actions requires additional capacities beyond intentionality understanding alone, but even these have shown that 12-month-olds are capable of understanding adults’ intentions. The studies by Behne et al. (2005) are more applicable

to the IWM concept than are studies showing imitation of adults' actions. Extrapolating from their findings, it seems possible that infants would understand their caregivers' unwillingness to respond to certain infant emotional states or attachment needs. Furthermore, when parents are temporarily inaccessible or unable to respond sensitively, infants may understand that these responses are not intentional, and thus, they do not integrate them into their IWM in the same way. Woodward (2009) concluded her review of intentionality understanding in infants by highlighting three aspects of intentionality understanding that have not yet been fully explored, and each of these aspects is particularly relevant to forming an IWM of an attachment figure: infants' understanding of (a) others' social intentions, (b) how others' emotions relate to their actions and intentions, and (c) others' intentions and actions over time. Given the connection of these social-cognitive abilities to attachment theory, future research in these areas will not only provide more information on infants' social-cognitive abilities, but will also shed light onto the cognitive processes supporting the formation an IWM in infancy.

Memory for Past Experiences. Thus far, I have reviewed research indicating that infants have the capacities to know who their attachment figures are, where they may be found, and have some understanding about their attachment figures' emotional signals and intentional behaviors relevant to building an IWM. Given infants' knowledge of social interactions, the question is: Do infants have the capacity to remember aspects of their attachment-related interactions?

According to attachment theory, IWMs are based on the infants' experiences with their caregivers. As Bowlby (1973) stated, "the varied expectations of the accessibility and responsiveness of attachment figures that different individuals develop during the

years of immaturity are tolerably accurate reflections of the experiences those individuals have actually had (p. 202).” As such, infants must possess some capacity for remembering experiences with each of their caregivers if they are to develop IWMs of their caregivers. In this section, I describe how the memory system is commonly conceptually divided, describe the conceptual relation between the explicit memory system and the IWM, review research on explicit memory in infancy, describe the conceptual relation between the implicit memory system and the IWM, review research on implicit memory in infancy, and describe the few studies that have tested infants’ memory for their own social-emotional interactions.

Dichotomous memory systems. The memory system is commonly divided into two types of memory: implicit (or procedural) and explicit (or declarative) memory (Schacter & Tulving, 1994). Implicit memory refers to memory processes that are largely inaccessible to consciousness. These memories include the motor and behavioral skills learned from repeated practice of a task or activity that no longer require active thought to produce (e.g., riding a bicycle, tying shoes, typing, driving), classical and operant conditioning, and memories induced by priming. Implicit memory is slow, reliable, inflexible, and requires the specific context from which the memory was formed (Bauer, 2006). Explicit memory is traditionally defined by its accessibility to consciousness, that is, its ability to be recalled into current thought processes. These memories include remembered facts and general knowledge (semantic memory) and autobiographical memories for experienced events (episodic/event memory; Bauer, 2006). Both recall and recognition (briefly reviewed in the section on face recognition) are supported by explicit memory and contain information concerning the particulars of an experience: who, what,

where, when, why, and how (Bauer, 2004). In contrast to implicit memory, explicit memory is fast, fallible, and flexible, with flexibility being a key feature of explicit memory (Bauer, 2006; Eichenbaum, 1997). *Representational flexibility* is “the ability to retrieve memories with cues and in contexts that are not identical to those originally encoded” (Jones & Herbert, 2006, p. 200). This ability “permits inferential use of memories in novel situations” (Eichenbaum, 1997, p. 554). Human case studies of brain damage (e.g., H. M.; Scoville & Milner, 1957) and animal work of selected brain lesioning indicate that associative pathways and subcortical regions mediate implicit memory, whereas the medial temporal lobe mediates explicit memory (see Nelson, 1995, for a review).

When conceptualizing memory into these dichotomous systems, it is important to note that there is debate about whether multiple memory systems are necessary to account for infant memory capacities and whether the distinction between implicit and explicit memory is relevant in infancy (see Rovee-Collier, 2007; Rovee-Collier & Cuevas, 2009). Furthermore, implicit and explicit memories develop concurrently during experiences (Bauer, 2006). For instance, once learned, tying shoes is a routine motor skill that requires little conscious thought. If asked, however, most adults can explain how to tie shoes. Thus, elements of this skill are stored in both implicit and explicit memory. Further discussion of this debate is beyond the scope of this paper; I describe the relevance of explicit and implicit memory in forming internal working models of attachment figures.

Although many memory tasks can be accomplished by using either implicit or explicit memory system or both, several tasks that are appropriate for infants have been

identified for which performance depends on one system or the other. In order to determine whether a task requires explicit memory, several criteria have been proposed. First, the task must pass the amnesia test. Amnesic patients suffer deficits in explicit memory, but not implicit memory. As such, if a task requires implicit memory, patients with amnesia should perform well, whereas they should fail if the task requires explicit memory (McKee & Squire, 1993). Amnesic patients perform well on motor learning tasks (such as the mobile conjugate reinforcement paradigm, Oscar-Berman, 1980), but show deficits in recognition tasks using the visual-paired comparison (VPC) test (Diamond, 1990; Oscar-Berman & Pulaski, 1997) and deferred imitation (see Bauer, 2006). Second, the task should recruit brain regions identified as critical to explicit memory, namely, the medial temporal lobe, hippocampus, and amygdala. Deferred imitation and VPC tasks recruit the medial temporal lobe (for reviews, see Nelson, 1995; Rovee-Collier, Hayne, & Colombo, 2001) and monkeys with medial temporal lobe lesions show deficits in VPC (Bachevalier, Brickson, & Hagger, 1993; Pascalis & Bachevalier, 1999). Additionally, research has shown that once children acquire language, they will discuss deferred imitation events that occurred to them pre-verbally, suggesting that the memory was encoded explicitly (Bauer, Wenner, & Kroupina, 2002).

The role of explicit memory in forming an IWM. In formulating attachment theory, Bowlby (1969/1982) cited semantic and episodic memory in his discussions of IWMs, suggesting that explicit memory is particularly relevant to forming an IWM. Relatedly, Bretherton and Munholland (2008) drew connections between the IWM and Nelson and Gruendel's (1981) conceptualization of event representations and generalized event representations. Infants need to combine memories of unique experiences in order to

remember who their attachment figures are, how each of their attachment figures behaved in specific contexts, and how the attachment figures typically behave.. The memories need to be recalled in later interactions to facilitate adaptive responding in new situations and to form expectations about how their caregivers will respond in new situations. These features are all characteristic of representational flexibility, which suggests that explicit memory is a relevant capacity to building an IWM.

Explicit memory in infancy. Although it was once believed that infants could not develop or possess explicit memories because they did not possess the necessary representational capacity (Piaget, 1952), researchers now recognize that infants are able to remember events and complete tasks believed to tap explicit memory capacities. According to Nelson (1995), early in the first few months, infants evidence a form of “pre-explicit” memory that supports recognition memory, but that explicit memory develops between 8 and 12 months.

In deferred imitation tasks, an experimenter models an action (e.g., opening a box in a specific way), or series of actions (e.g., taking off a puppet glove, shaking it, and putting it back on), to the infant. After a delay, infants are allowed to manipulate the objects themselves. Studies compare these experienced infants who have seen the action to naive infants who have not see the action performed. If the infants form memories of these events, then experienced infants are expected to imitate aspects of the event, whereas naive infants should not. In visual recognition tasks, infants are exposed to a visual stimulus (e.g., pattern, picture, person, emotional expression). After a delay, infants are presented with the familiar stimulus and a novel stimulus. These paradigms

rely on infants' propensity for novelty. Memory is inferred when infants look longer at the novel object suggesting that they recognize the familiar object.

Using the deferred imitation task, several studies have shown that infants between 6 and 9 months show memory for events after delays as long as 24 hours (e.g., Barr, Dowden, & Hayne, 1996; Collie & Hayne, 1999; Meltzoff, 1988). With development, infants between 9 and 11 months become able to remember more about events, for longer periods of time, and with less exposure to the events (Bauer, 2006). Further improvements in explicit memory occur after the first year, but are not discussed here (see Bauer, 2004, 2006).

The role of implicit memory in forming an IWM. Although Bowlby (1969/1982) focused on the role of explicit memory in attachment representations, it is likely that aspects of the attachment relationship are remembered through implicit memory processes and that these implicit memories contribute to the infants' IWM. In particular, attachment theorists have emphasized the role of procedural representations, which are "rule-based representations of how to proceed, of how to do things" (Lyons-Ruth et al., 1998, p. 284; see Beebe & Lachmann, 1994; Main et al., 1985; Waters & Waters, 2006). After repeated interactions with their attachment figures, infants develop an implicit knowledge of the cause-effect contingency between their attachment behavior and their caregivers' subsequent sensitivity or insensitivity (Beebe & Lachmann, 1994). These procedural representations, which have been referred to as "implicit relational knowing" (Lyons-Ruth et al., 1998), require the infant to be in the original social context (i.e., interacting with their caregiver; Fogel, 2004) and they follow a script such as, "When I approach my attachment figure, he or she responds sensitively (or insensitively)."

Implicit memory in infancy. Despite the theoretical debate regarding the development of explicit memory in infancy, researchers have long acknowledged an operational implicit memory system in infancy (see Fogel, 2004). During the mobile conjugate reinforcement task, researchers tie a string to the infant's ankle which is then connected to a mobile, such that when the infant kicks his or her legs, the mobile moves. Infants quickly learn the contingency between their motor movements and the mobile's motion as evidenced by their increased kicking behavior. Researchers then remove the string and measure the infant's kicking behavior as an index of memory. If infants remember that their motor movements cause the mobile to move, then their kicking behavior should be higher than infants who never learned the contingency. Infants as young as 8 weeks old pass the mobile conjugate reinforcement task after delays ranging from 24-hours to 2 weeks depending on the amount of training (Rovee-Collier, 1999). These findings show that from early in life, infants represent the relations between their behaviors and the environmental consequences. These implicit memory processes relate to a key feature of an infants' IWM of their attachment figure: how their attachment figure is likely to respond to their varied attachment behaviors.

Memory for social-emotional interactions. Of particular relevance to the formation of the internal working model is memory for social-emotional interactions. Most work on infants' memory for events provides infants with non-valenced experiences to remember. It is possible, however, that memory for social-emotional events operates differently from memory for non-valenced experiences. Only a few studies have investigated infants' memory for such experiences. Each of these studies utilized visual-paired comparison (VPC) methods to tap infants' recognition memory,

two using puppets as the stimuli and two using adult experimenters. Although infant memory is typically inferred based on infants' longer looking toward novelty, factors such as age, exposure duration, length of delay, and stimulus complexity affect whether infants will express the typical novelty preference or whether infants will express a preference toward familiarity or even no preference following familiarization (Rose et al., 2004). As such, *any* systematic looking time differences observed between looking toward familiar or novel stimuli are taken as evidence of infant memory.

In one of the first studies assessing infant memory for emotional events, Nachman, Stern, and Best (1986) randomly assigned 7-month-old infants to either a “rousing,” positively valenced interaction with a puppet or a neutral, non-emotionally valenced interaction with a puppet. Infants were later tested with a VPC task with the familiar puppet and a novel puppet following a 2-minute and 1-week delay. If infants simply recognize familiar objects, then infants in both conditions should look longer at a novel puppet. If, however, infants remember the emotional nature of the interaction, then infants should differentially respond to the emotionally valenced puppet compared to the neutral puppet. The latter pattern emerged at the 1-week post-test. Infants in the neutral condition looked longer at the novel puppet and displayed no positive affect, whereas infants in the positive condition actually looked longer at the familiar puppet and smiled toward the puppet. These findings suggest that infants have the capacity to remember positive aspects of their interactions with others.

A similar investigation was conducted by Brown, Robinson, Herbert, and Pascalis (2006) using five different infant age groups (6-, 9-, 12-, 18-, and 24-month-olds). In this study, all infants were familiarized to a similarly “rousing,” positive puppet. Immediately

following the interaction, infants' recognition memory was tested in a VPC with the familiar puppet and a novel puppet. Infants aged 6, 9, and 12 months displayed no preference for either puppet, whereas older infants looked significantly longer at the familiar puppet. Again, these findings suggest that infants remember the positive aspects of their interactions with others. At first glance these findings appear to contradict the age at which Nachman et al. (1985) discovered this ability and to contradict the proposition of attachment theory that infants remember emotional experiences during the first year; however, several differences in the design of these studies should be noted. First, Brown et al. (2006) assessed infants immediately following presentation and found that infants under 12 months of age showed no evidence of memory. Similarly, Nachman et al. found no visual preference in 7-month-olds two minutes after presentation. These short delays may provide insufficient time for the infant to represent and consolidate the information from the events. Older infants, on the other hand, may be able to represent and consolidate the information in these shorter time frames. Second, in Brown et al.'s study, the experimenters were present and visible to the infants during the puppet interaction. The presence of the experimenter may have distracted younger infants from focusing on the puppet. Third, Brown et al. presented photographs of the puppets during post-test, rather than the actual puppets. This change from 3-D to 2-D may have been difficult for younger infants to represent as the same puppet.

Infants have also demonstrated the capacity to remember social-emotional interactions with human interaction partners. Bigelow and Birch (1999) conducted a study investigating infant preference for contingent social interaction and memory for such interaction a week later. Four to five month old infants were presented

simultaneously with two adult strangers on video screens. One of the strangers was receiving live video feedback of the participating infant and interacted contingently with the infant. The other screen displayed a recording of a stranger who had been previously videotaped while interacting with another infant (i.e., this interaction with the participating infant was non-contingent). During familiarization, infants looked significantly longer at the contingent stranger (i.e., infants preferred to look at the contingent stranger). Infants also displayed more positive affect toward the contingent stranger than the non-contingent stranger. Six days later, infants returned to the laboratory and were tested with a similar display of the same two strangers; this time, however, both strangers acted contingently. Infants preferred to look at the adult who had acted contingently in the first session. In addition, infants displayed more positive affect toward the previously contingent adult than the previously non-contingent adult as the test session progressed. Again, this study indicates that infants remember positive aspects of their interactions. If the infants only remembered the experimenter without the valence attached, a novelty preference would be expected. Because infants were familiarized and tested with both the contingent and non-contingent adults, it is unclear from these findings whether the infants prefer the previously contingent adult or avoid the previously non-contingent adult, or both.

Similarly, Bornstein, Arterberry, & Mash (2004) tested infants' long-term memory for an emotional interpersonal interaction by varying the adult's contingent behavior. At 5 months of age, infants participated in the "still-face" procedure (Tronick, 1989) with an unfamiliar female adult. The still-face paradigm involves interrupting a contingent face-to-face interaction with a facial display of flat affect; infants typically

respond robustly to the still-face with negative affect and motor reactivity (Mesman et al., 2009). Thus, the familiarization event included both positive (contingent interaction) and negative (still-face) interaction experiences. Fifteen months later, infants returned to the laboratory and their looking time was measured while viewing recorded videos of three women (one of which they had seen in the 5-month still-face). These “experience condition” infants were compared to another group of 20-month-olds who had not participated at 5 months (“no experience condition”). Overall, children in the experience condition looked less at the women than children in the no experience condition, suggesting that these children were familiar with the presentation. Moreover, children in the experience condition looked significantly less at the familiar woman compared to the two new women. Based on the differential looking pattern, the authors conclude that young infants retain memory for single, unique emotional interactions over long delays. These findings, however, can be interpreted in a more parsimonious way. As the authors noted, it is possible that the novelty preference exhibited by children in the experience condition reflects simply the visual recognition of a familiar person, with no memory for the emotional, interactive components of the first encounter. This alternate explanation cannot be disentangled without a comparison group of infants who, at 5-months, could have been familiarized with the stranger in non-valenced interaction (e.g., presentation of the person’s face) or in an only positively valenced interaction (e.g., an interaction without the still-face). Looking times from these infants could then be compared to determine whether the emotional aspect, or sheer familiarity, of the initial interaction guided the novelty preference. These additional conditions would also allow researchers

to disentangle the effects of positive and negative interactions in memory for social interactions.

Memory for social-emotional interactions: Summary and future directions. Taken together, the studies of infant memory for social-emotional interactions suggest that infants within the first year do indeed possess the capacity to remember emotional aspects of their interactions. The looking time patterns and affective responses exhibited by infants after receiving a single social-emotional experience indicate that infants remember key aspects of these interactions related to building an IWM: the who (specifically the findings of Bigelow & Birch, 1999) and what (positive, contingent, non-contingent) of experiences. The existing studies support the capacity of infants to remember positive aspects of their interactions. Yet to be studied is infants' memory for solely negative interactions with others. Although the studies by Bigelow and Birch (1999) and Bornstein et al. (2004) used non-contingent interactions in their designs (which infants typically experience as negative), elements of each study's design prevent full interpretation of whether infants remembered the negative components of the interactions (especially given that the still-face includes both positive and negative components). Positive and negative interactions with others are relevant inputs into an infant's IWM. Future research should include careful experimental tests of positive and negative emotion memory. Furthermore, future research should investigate how repeated and/or varied types of emotional interactions are represented for a single person. Studies assessing memory for single events certainly support the claim that infants remember past interactions, but full understanding of memory related to IWMs will require examining multiple interactions. For instance, if the interaction partner is always contingent,

sometimes contingent, or never contingent, will infants represent these differently and will the generalized event representations be observable in infant behavior during memory tasks?

Expectations for Others' Behavior. According to attachment theory, infants use their memory of past interactions with their attachment figures as the basis for their expectations about the likely behavior of their caregivers in new interactions (Bowlby, 1973; Bretherton & Munholland, 2008; Main et al., 1985). For the purposes of this paper, I follow Thompson's (2008) portrayal of IWMs, which states that these expectations for the caregivers' availability and responsiveness constitute the IWM. According to this definition, expectations are included within the IWM, and thus, forming expectations for another person's behavior based on that person's past behavior is an important capacity to building an IWM. Others have viewed expectations as a function or outcome of the IWM, where the IWM is an experience-based set of representations of the caregivers' past behavior (e.g., Crittenden, 1995). In this view, the capacity to form expectations about another person's behavior would not be directly related to forming an IWM, but would be related to using the IWM. Given my position that IWMs include expectations, the capacity for infants to create expectations is relevant to forming an IWM.

Attachment researchers suggest that infants' differential behavioral patterns in the Strange Situation are the result of differential expectations about their caregivers' behavior (Ainsworth et al., 1978; Main et al., 1985; Waters & Deane, 1985). It is possible, however, that infants behave in these ways, not because they have expectations about their caregivers' future behavior, but because they have developed experience-based feelings about their caregivers. For example, securely attached infants have

caregivers who respond sensitively, therefore, these infants may simply like to be with their attachment figure; whereas insecure-avoidant infants have been rejected, and therefore, may not like being with their attachment figure, and insecure-ambivalent infants have mixed feelings about their caregivers. As such, these naturalistic observations cannot be used to support the existence of experience-based expectations. I have reviewed literature suggesting that infants have the capacity to remember events they have experienced, including social-emotional events. I now turn to research showing that infants use information from past experiences to guide their expectations of others in new situations.

Infants' expectations in novel events have been studied using controlled procedures and methodologies to assess infants' cognitions non-verbally. Among these looking time methods are habituation-dishabituation, visual expectation paradigm, and violation-of-expectation (a modification of habituation procedures). In all of these paradigms, infants are familiarized with aspects of a display. The characteristics of the displays are then changed in a meaningful way. Infants' longer looking times during novel, inconsistent, improbable, or impossible events are interpreted as infant surprise, suggesting that infants formed a different idea of how the event should have occurred (violation of expectation). Studies employing eye tracking (see Gredebäck, Johnson, & von Hofsten, 2010, for a review) and brain imaging (e.g., EEG to assess the sensorimotor alpha rhythm, Southgate, Johnson, El Karoui, & Csibra, 2010; and ERP, Senju, Johnson, & Csibra, 2006) have supported the assumption that infants' looking times reflect generation of on-line predictions for future events, rather than post-hoc attempts to make sense of events after they occur.

Non-social expectations. Considerable work has demonstrated that infants – in some cases as young as 2 months of age – form expectations for non-social events, including reasoning about physical objects (e.g., Adler & Haith, 2003; Téglás, Giroto, Gonzalez, & Bonatti, 2007; for reviews see Baillargeon, Li, Ng, & Yuan, 2009; and, Spelke, Breinlinger, Macomber, & Jacobson, 1992) and action-effect contingencies where infants simply observe the relations (e.g., Hauf & Aschersleben, 2008) or are active participants in learning the relations between their actions and environmental effects (see Rovee-Collier, 1997, for a review of studies using the mobile conjugate reinforcement paradigm). The ability to predict event outcomes in non-social domains may support the prediction of future events in the social domain. Research indicates, however, that infants reason about the behavior of humans and animate objects quite differently from that of inanimate objects (Rakison & Poulin-Dubois, 2001), suggesting that different capacities may exist for predicting social events.

Social expectations. Research on infants' social expectations has been divided into two main areas. First, considerable research has examined infants' social expectations during their face-to-face interactions with others. Second, research on infant social cognition has examined infants' expectations for other peoples' behavior after observing their previous behavior. Both bodies of research provide data supporting the notion that infants are capable of forming expectations about the likely behavior of others based on previous experience.

Face-to-face interactions. From early in life, infants adjust their behavior to elicit responses from their caregivers and demonstrate positive affect when their efforts are reinforced (e.g., Markova & Legerstee, 2006; Murray & Trevarthen, 1985; Nadel,

Carchon, Kervella, Marcelli, & Reserbat-Plantey, 1999). Research using the “still-face” paradigm (Tronick, 1989) and the double-video feedback paradigm (Murray & Trevarthen, 1985) indicates that young infants (2-3 months old), and even newborns (e.g., Nagy, 2008), can detect the difference between contingent and non-contingent interactions, prefer to interact with contingent partners, and react negatively to the loss of contingent interactions (e.g., Bigelow & Birch, 1999; Tronick, 1989; see Mesman et al., 2009, for a review and meta-analysis of the still-face effect). If infants expect social interactions to be contingent, then loss of such contingency would violate the infants' expectations. The negative behavioral responses following the still-face are interpreted as a violation of the infants' expectations. These robust effects are evident very early in life, suggesting that infants expect social interactions to be contingent. These general expectations appear to be applied to all social partners (i.e., familiar and unfamiliar adults) and they appear early in infancy (e.g., Gekoski, Rovee-Collier, & Carulli-Rabinowitz, 1983; Lamb & Malkin, 1986); therefore, they do not reflect the relationship-specific, experience-based expectations relevant to building an IWM of another person. Infants may simply enjoy contingent interactions and dislike noncontingent interactions, therefore, when the adult interaction partner assumes the still-face, infants respond with negative affect to show their dislike of the condition, rather than as a violation of their expectation that interactions should be contingent.

The expectations relevant to the IWM are those that develop based on past interactions with a specific person. Starting at approximately 3 months of age, infants respond differently in face-to-face interactions with their mothers, fathers, and strangers (e.g., Kisilevsky et al., 1998). Starting around 4-5 months of age, infants respond more

negatively when their mother, compared to when a stranger, failed to pick them up during distress-relief sequences (e.g., Gekoski et al., 1983; Lamb & Malkin, 1986). According to Mesman, van IJzendoorn, and Bakermans-Kranenburg's (2009) recent review and meta-analysis of the still-face effect, infants responded more negatively when their mothers stop interacting and assume a "still-face" than when strangers do so. In addition, naturally occurring differences in maternal sensitivity and positivity during the baseline face-to-face interaction were positively correlated with infants' negative responses. Taken together, these results suggest that infants have different expectations for the behavior of different adults that appear based on their past experiences (or at least familiarity) with that person. Although these results can be interpreted as supporting the capacity for infants to develop relationship-specific expectations, they do not speak to infants' capacity to form flexible, novel expectations of their caregivers' likely behavior in new situations. The expectations for these face-to-face interactions may simply be built from past experiences in the same type of interaction. In order to support the IWM concept, research must test whether infants are capable of forming *novel* expectations of others' behavior based on past experience.

Social cognition. The past decade has seen remarkable advances in the methodologies and research designed to assess pre-verbal infants' understanding of other people. Much of this research has asked whether infants have the ability to predict the likely behavior of others based on those peoples' past behavior, which is a key component of the IWM that infants builds of their attachment figures. In fact, Rochat and Striano (1999) defined social cognition as "the process by which individuals develop the ability to monitor, control, and *predict* the behavior of others (p. 4; italics added)."

Attention to this body of research, therefore, should provide information relevant to infant capacities relevant to building an IWM. The social-cognitive research, just like the cognitive research on infant expectations in non-social domains, indicates that infants use a variety of information about people in past events to predict the likely behavior of those people in future events, including the observed person's past dispositions toward specific objects, agents, and actions.

Research on infants' understanding of intentionality and goal-directed action suggests that infants expect adults to behave in accord with their previously executed goals. For example, Woodward (1998) repeatedly presented infants with a display of an adult reaching for a target object while ignoring a distracter object until infants were habituated. Then, in the test trials, the location of the objects was changed and the adult either reached for a new object on the old path (new object choice, familiar action) or the old object on a new path (familiar object choice, new action). Under these conditions, infants as young as 6 months looked significantly longer at the displays when the adult reached for the new object. These results are interpreted as the infants understanding that the adult had a goal of obtaining a specific object. Further studies confirm that if the environmental constraints surrounding the goal object change (i.e., the objects are in new locations, or obstacles are removed from obstructing the goal), infants look longer when adults persist in an old action pattern compared to when they simply reach directly for the goal-object (Csibra, 2008; Gergely et al., 1995; Kamewari, Kato, Kanda, Ishiguro, & Hiraki, 2005; Southgate, Johnson, & Csibra, 2008).

Furthermore, infants as young as 5 months of age appear to understand these object-directed actions are not only intentional, but represent the person's preferences

(e.g., Luo & Baillargeon, 2005, 2007). Luo & Baillargeon (2007) used a variety of displays to assess infants' understanding of another person's object-directed actions. Infants (12.5 months old) were habituated to an actor reaching toward an object rather than a distracter object in one of three variations to Woodward's (1998) procedure in which the distracter object was either (a) visible to the actor and infant, (b) not visible to the actor, but was visible to the infant, or (c) not visible to the actor because the actor placed it behind a screen, but was visible to the infant. Each group of infants was then shown test events with the two objects present and visible to the actor. The actor either reached for the target object or the distracter object. If infants simply expect people to persist toward their previous goal, then infants in all conditions should look longer when the person switches to the distracter object. If, however, infants base their predictions on the understanding of the actor's preference between these objects (and understand the relation between adults' looking and knowing), then they should look longer when the actor reaches for the distracter object in conditions (a) and (c) because the actor consistently chose the target object over the distracter object in the past, but have no looking preference in condition (b) because the infants have no information about the actor's attitude toward the distracter object, as the distracter object was consistently hidden from the actor's view. Infants' looking time patterns were consistent with this latter hypothesis indicating that infants attribute preferences to people while observing their goal-directed actions and generate predictions about their behavior in new situations.

In addition to using adults' goal-directed actions as the basis for predicting behavior, infants use their understanding of adults' emotional signals (see earlier section

on emotion understanding) and attentional cues (see Caron, 2009) to make predictions about people's likely behavior (Vaish & Woodward, 2010). Across two studies (Barna & Legerstee, 2005; Phillips, Wellman, & Spelke, 2002), infants aged 9-, 12-, and 14-months witnessed an adult look toward and positively comment on a target object. In test trials, the adult was shown either holding the target object (consistent with their emotional and attentional cues) or holding a new object (inconsistent event). In each study, infants looked longer at the inconsistent event, suggesting that infants expect people's actions to coordinate with their previous emotional and attentional signals.

To clarify the results of these studies, which confounded emotional and attentional cues, Vaish and Woodward (2010) investigated 14-month-olds' (but not younger infants') ability to predict actions from emotional cues. Adults looked into a cup while ignoring a distracter cup and provided either a happy or disgust reaction. The authors hypothesized that if infants use emotional cues, they should expect the adult to reach into the cup in the happy condition, but not in the disgust condition. Regardless of the expressed emotion, infants looked longer when adults later reached into the distracter cup than into the target cup. The authors suggest that infants use attentional cues, not emotional cues, to predict the likely behavior of others. These results, however, do not preclude the possibility that infants may use other emotional cues to make predictions in other situations about a person's behavior. There are several possibilities for why an adult would reach into a disgusting place and infants may have even witnessed adults act in this seemingly inconsistent way (e.g., when changing their diapers or cleaning the house).

Not all actions are performed toward objects as goals. Sometimes a person's goal is simply to perform the action because the action itself is enjoyable. Song and

Baillargeon (2007) investigated infants' (aged 9.5 months) ability to predict another person's behavior after witnessing that person engage repeatedly in an action (sliding toys) on multiple toys. During test events, infants watched the adult choose between two identical novel toys that were constrained by a wood frame that either allowed for sliding (long frame) or did not (short frame). Infants looked longer during the short frame events, suggesting that they expected the adult to select the "slidable" object and were surprised when they chose the "non-slidable" object.

Especially relevant to the claims of attachment theory, Buresh and Woodward (2007) have shown that 9- and 12-month-olds are capable of tracking specific people's goals. What could be a page directly out of Bowlby's writings on IWM of attachment figures, these authors explain that tracking people's actions, goals, and intentions allows humans "to predict and interpret actions on-line by relating a person's prior and current behaviors, and distinguishing them from the behaviors of other persons" (p. 287). Certainly, these capacities would support the ability to develop person-specific IWMs, which attachment theory suggests infants are forming of each of their attachment figures. In a series of studies, Buresh and Woodward habituated infants to reaching events where the actor was fully visible (slight modification to Woodward, 1998). During test events, infants were shown same-actor or switch-actor conditions with old/new path, old/new object combinations. The results confirmed their hypotheses indicating that infants attributed specific goals to specific actors. Consistent with previous same-actor research (e.g., Woodward, 1998), infants in this condition looked longer during new goal test events. In the switch-actor condition, however, infants' looking times did not differ between the reaching events of the two objects. This pattern of results suggests that

infants understand that different people have different goals, and infants use their knowledge of those specific people's past behavior to anticipate the people's likely behavior. As such, infants may be able to attribute preferences such as, "Mom comforts me when I'm upset, but Dad doesn't" and use that information to expect how each parent will respond when the child shows attachment behavior in the future.

Lastly, infants make predictions about the likely behavior of actors based on the way those actors have interacted with others. Although the studies reviewed here did not use human actors, previous research indicates that infants attribute human characteristics to human-like objects that are self-propelled and appear to have free choice (e.g., Gergely, Nádasdy, Csibra, & Bíró, 1995; Luo & Baillargeon, 2005). These studies are particularly relevant to the IWM of an attachment figure because they include relational and valenced information about others. In a pioneering study, Premack and Premack (1997) familiarized 12-month-old infants to a computer-animated display where an agent (a self-propelled circle) either helped or hindered another agent pass through a hole. During the test event, all infants were shown a display where the helping or hindering agent hit the other character. Infants who had been habituated to the helping event looked longer during the test than infants who had been habituated to the hindering event. These findings suggest that the helping agent's later anti-social behavior violated the infants' expectations, whereas the hindering agent's later anti-social behavior did not violate the infants' expectations. Consistent with these findings, Kuhlmeier, Wynn, and Bloom (2003) and Hamiln, Wynn, and Bloom (2007) familiarized infants to a display where an agent (circle) was either helped or hindered in its goal to climb a hill. In later test events, 10- and 12-month-old, but not 6-month-old, infants were surprised when the circle

approached the hinderer, but not when it approached the helper. Six-month-olds understood the helping and hindering acts as evidenced by their robust preference to choose the helper over the hinderer and neutral agents, as well as a neutral agent over the hinderer, but did not form an expectation about the circle's likely behavior.

Expectations: Summary and future directions. Infants are remarkably capable of forecasting the likelihood of future events in non-social and social domains. In doing so, infants evidence the capacity to generate novel expectations based on previously presented information. For example, 12-month-olds expected a blue ball to roll out of a lottery machine (even though they were never shown this type of outcome) when the blue ball was shown to be more common than a red ball (Téglás et al., 2007). Although forecasting the likely behavior of people may be more difficult, the research reviewed here suggests that infants begin using some information about the past behavior of others between 2 and 6 months, and that by 9 months of age infants are capable of using diverse information about the past behavior of others to anticipate those people's behavior. These results are consistent with the theorized timetable of infants' IWM formation.

The research using face-to-face interactions demonstrates that the familiarity of infants' relationship partners (i.e., past experience) predicts infants' social expectations for their face-to-face interactions, but the research lacks the flexible extension of generating predictions in novel situations. On the other hand, the research stemming from social cognition indicates infants' abilities to form novel predictions, but largely ignores the infants' role in interacting with others and the social-emotional aspects of interactions with others. The information that infants gain from their interactions with others is particularly relevant to the attachment IWM that they develop of those particular people.

Infants' IWMs are based on their attachment-related experiences in the relationship with the attachment figure, not on observing the attachment figure. Moreover, at least one study has shown that actually interacting with another person facilitates understanding and prediction of their likely behavior compared to simply observing the person (i.e., both 14- and 18-month-olds were capable of predicting the other person's behavior toward a toy when they had interacted with the person, but only 18-month-olds were capable based on observation alone; Moll & Tomasello, 2007). To my knowledge, no study has investigated infants' ability to generate novel expectations about another person's social behavior after interacting socially with that person. Although the findings from the existing studies lend support to the claims of the attachment IWM, no study has shown that infants can expect the future social behavior of another person based on their past interactions with that person. Future research that combines elements from both of these research traditions will be most fruitful in examining infants' abilities to generate novel predictions for the likely behavior of others based on their past social-emotional interactions with those people.

Conclusion and Future Directions

In conclusion, attachment theory suggests that infants develop experience-based mental representations called internal working models (IWMs) of their attachment figures to predict their attachment figures' likely behavior in future interactions. This review has shown that infants possess the cognitive capacities relevant to forming internal working models of their attachment figures, but considerable research is necessary to test these capacities under conditions that parallel the attachment relationship. First, research designs should include the infant as an interactive partner. The majority of studies

examining infant social cognition involve the infant observing another person rather than participating in the interaction. Second, emotional components should be present in the design, not just social components. IWMs of attachment figures develop from attachment-related experiences, which are highly emotional for the infant. As such, examination of infant memory and expectations for other people's behavior should both include emotional elements. Lastly, research designs should incorporate multiple experiences with others to determine how repeated and varied experiences are remembered, represented, and used to generate expectations about others' likely behavior. For example, what expectations would infants have about another person's likely behavior if that person was responsive twice and unresponsive twice in past interactions. Both attachment researchers and social cognitive researchers can learn from each others' theoretical models and methodologies to understand child development at the intersection of social, emotional, and cognitive development in infancy.

The emerging research designs that integrate social, emotional, and cognitive development will be most fruitful in assessing the specific capacities tied to the internal working model concept (see Pessoa, 2008, for discussion of the intertwining of emotion and cognition processes in the brain). For instance, there is much to be learned about infant understanding of social intentions as they relate to attachment formation. Future work will help elucidate which of these capacities are necessary, sufficient, and supportive of the formation of the model. It may be that understanding of intentions is not necessary for developing an IWM of an attachment figure, but having that understanding allows the infant to make more accurate expectations about their caregiver's likely behavior. Moreover, more capacities are certain to be identified. In addition to identifying

additional capacities for the IWM of an attachment figure, researchers should work to understand whether the model of the self develops from the same cognitive capacities, or if additional capacities, such as self-recognition, are related or necessary for the model of self in the attachment relationship. This list is not meant to be exhaustive, but is meant rather to begin a dialog between attachment researchers and cognitive developmentalists to achieve a comprehensive understanding on infant development. I join others in calling for research bridging cognitive and social-emotional development (Calkins & Bell, 2010; Olson & Dweck, 2008). Specifically, it is my hope that attachment researchers will re-focus their attention on the cognitive aspects of the formation of the IWM. By using the methodologies in infant social cognitive research, attachment researchers no longer need to overlook the IWM concept, especially not in infancy.

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Appendix B:**IRB approval letter**

May 25, 2011

To: Investigator: Jude Anne Cassidy
Co-Investigator(s): Not Applicable
Student Investigator: Laura Jernigan Sherman
Department: BSOS - Psychology

From: Joseph M. Smith, MA, CIM
Manager
University of Maryland, College Park

Re: IRB Application Number: 10-0311 (PAS# 3098.4)
Project Title: "Social-emotional interactions in infancy"

Approval Date: 05-19-2011

Expiration Date: 05-30-2012

Type of Application: Addendum

Type of Research: Non-Exempt

Type of Review: Expedited

The University of Maryland, College Park Institutional Review Board (IRB) approved your IRB application. The research was approved in accordance with the University's IRB policies and procedures and 45 CFR 46, the Federal Policy for the Protection of Human Subjects. Please reference the above-cited IRB application number in any future communications with our office regarding this research.

Recruitment/Consent: For research requiring written informed consent, the IRB-approved and stamped informed consent document is enclosed. The IRB approval expiration date has been stamped on the informed consent document. Please keep copies of the consent forms used for this research for three years after the completion of the research.

Continuing Review: If you want to continue to collect data from human subjects or analyze data from human subjects after the expiration date for this approval, you must submit a renewal application to the IRB Office at least 30 days before the approval expiration date.

Modifications: Any changes to the approved protocol must be approved by the IRB before the change is implemented except when a change is necessary to eliminate apparent immediate hazards to the subjects. If you want to modify the approved protocol, please submit an IRB addendum application to the IRB Office.

Unanticipated Problems Involving Risks: You must promptly report any unanticipated problems involving risks to subjects or others to the IRB Manager at 301-405-0678 or jsmith@umresearch.umd.edu.

Student Researchers: Unless otherwise requested, this IRB approval document was sent to the Principal Investigator (PI). The PI should pass on the approval document or a copy to the student researchers. This IRB approval document may be a requirement for student researchers applying for graduation. The IRB may not be able to provide copies of the approval documents if several years have passed since the date of the original approval.

Additional Information: Please contact the IRB Office at 301-405-4212 if you have any IRB-related questions or concerns.

Appendix C:
Demographic questionnaire

ID # _____

Date _____

Demographics

<p>About your baby:</p> <p>Sex:</p> <p><input type="checkbox"/> Male</p> <p><input type="checkbox"/> Female</p> <p>Date of birth (mm/dd/yyyy): _____</p> <p>Weight at birth: _____</p> <p>Race/Ethnicity (check all that apply):</p> <p><input type="checkbox"/> White/Caucasian</p> <p><input type="checkbox"/> Black/African-American</p> <p><input type="checkbox"/> Hispanic/Latino</p> <p><input type="checkbox"/> Asian/Pacific Islander</p> <p><input type="checkbox"/> Other: _____</p>	
<p>Your relationship to the baby (for example: mother, father, etc.):</p> <p>_____</p>	
<p>Who lives with your baby and what is their relationship to your baby? (for example: mother, father, stepfather, baby's uncle, grandmother, 2-year-old sister, etc.):</p> <p>_____</p>	
<p>About the baby's MOTHER:</p> <p>Age: _____</p> <p>Relationship status:</p> <p><input type="checkbox"/> Married</p> <p><input type="checkbox"/> Engaged</p> <p><input type="checkbox"/> Steady dating relationship</p> <p><input type="checkbox"/> Divorced</p> <p><input type="checkbox"/> Single, never married</p> <p>Highest level of education:</p> <p><input type="checkbox"/> Some high school</p> <p><input type="checkbox"/> High school</p> <p><input type="checkbox"/> Some college/Associate's degree/ Vocational training</p> <p><input type="checkbox"/> Bachelor's degree</p> <p><input type="checkbox"/> Graduate degree</p>	<p>About the baby's FATHER:</p> <p>Age: _____</p> <p>Relationship status:</p> <p><input type="checkbox"/> Married</p> <p><input type="checkbox"/> Engaged</p> <p><input type="checkbox"/> Steady dating relationship</p> <p><input type="checkbox"/> Divorced</p> <p><input type="checkbox"/> Single, never married</p> <p>Highest level of education:</p> <p><input type="checkbox"/> Some high school</p> <p><input type="checkbox"/> High school</p> <p><input type="checkbox"/> Some college/Associate's degree/ Vocational training</p> <p><input type="checkbox"/> Bachelor's degree</p> <p><input type="checkbox"/> Graduate degree</p>

Appendix D:**Detailed procedure for the practice game and choice test****Practice Game Procedure**

Infant sits on parent's lap facing 90 degrees from the puppet stage.

Experimenter B kneels in front of infant.

Set 1:**A. Present first puppet (gray mouse)**

1. Start with puppets behind back. Place gray mouse on Right hand.
2. While looking at infant, "Hi."
3. Bring Right hand puppet around, display puppet 6-8 inches from face, gently shake, "Look."
4. After infant looks at puppet, say, "Here you go," and move the puppet within infant's reach.
5. Look down slightly at the infant's torso – wait for the infant to touch the puppet.
 - If the infant is looking at the puppet, keep waiting for the infant to touch the puppet.
 - If the infant is looking only at the experimenter and this continues for more than 10 seconds, look up at the infant, gently shake the puppet and say, "Here you go, you can play with the puppet," then look down and wait for the infant to touch the puppet.
 - o If the infant still continues to look at the experimenter and does not touch the puppet after 10 more seconds, gently shake the puppet and say, "Here you go."

- If the infant still continues to look at the experimenter and does not touch the puppet after another 10 seconds, remove the puppet from sight and place behind your back. Say to the mother, "I'm going to show him/her the puppet again. After I move the puppet closer to him/her, could you please say, "It's okay, you can play with the puppet." Then, repeat the presentation.
 - If the infant looks away from the experimenter and puppet more than 2 seconds, gently shake the puppet again and say, "Here you go, you can play with the puppet" – wait for the infant to touch the puppet.
 - If the infant still looks away from more than 2 seconds, gently shake the puppet and say, "Here you go."
 - If the infant looks away again for more than 2 seconds, remove the puppet from sight and place behind your back. Say to the mother, "I'm going to show him/her the puppet again. After I move the puppet closer to him/her, could you please say, "It's okay, you can play with the puppet." Then, repeat the presentation.
6. After the infant touches the puppet, smile and say, "Good job."
 7. Allow the infant 15 seconds to touch/play with the puppet while puppet remains on hand. Do not let the infant put the puppet in his or her mouth.
 8. Then, gently remove the puppet from view and keep behind back on hand.

B. Present second puppet (brown monkey)

1. Repeat procedure A above, but with the brown monkey on Left hand.

C. Present both puppets (gray mouse & brown monkey)

1. While looking at infant, say, "Hi"
2. Bring Both Right and Left hand puppet around, display each puppet 6-8 inches from face, gently shake saying, "Look"
3. After the infant looks at each puppet, say, "Which one do you want?"
 - *Be sure that the infant looks at you while saying "Which one do you want?"
 - If the infant does not look at you say, "OK, Which one?"
4. After the infant looks back at you, move the puppets within the infant's reach.
5. Look down slightly at the infant's torso – wait for the infant to touch a puppet.
6. Once the infant touches a puppet, remove the other puppet from view and keep behind your back. Allow the infant 15 seconds to play with the puppet (keep the puppet on your hand). After 15 seconds gently remove the puppet and keep behind your back.
 - If the infant is looking at the puppets, keep waiting for the infant to touch a puppet.
 - If the infant is looking only at the experimenter and this continues for more than 10 seconds, look up at the infant, gently shake the puppets and say, "Which one do you want," then look down and wait for the infant to touch a puppet.
 - o If the infant still continues to look at the experimenter and does not touch a puppet after 10 more seconds, gently shake the puppets and say, "Which one?"

- If the infant still continues to look at the experimenter and does not touch a puppet after another 10 seconds, remove the puppets from sight and place behind your back. Say to the mother, "I'm going to show him/her the puppets again. After I move the puppet closer to him/her, could you please say, "It's okay, you can pick one." Then, repeat the presentation.
- If the infant looks away from the experimenter and puppet more than 2 seconds, gently shake the puppets again and say, "Which one do you want?" – wait for the infant to touch a puppet.
 - If the infant still looks away from more than 2 seconds, gently shake the puppets and say, "Which one?"
 - If the infant looks away again for more than 2 seconds, remove the puppets from sight and place behind your back. Say to the mother, "I'm going to show him/her the puppets again. After I move the puppets closer to him/her, could you please say, "It's okay, you can pick one." Then, repeat the presentation.

Set 2:**Repeat these general steps using Puppets 3 and 4 (gray bunny, brown fox)**

For Set 2, however, the first puppet will be presented on the experimenter's Left hand and the second puppet will be presented on the experimenter's Right hand.

Set 3:

Then, repeat these general steps using Puppets 1 and 4 (gray mouse, brown fox)

Immediate and Delayed Choice Test Procedure

The immediate and delayed choice test procedures follow the same choice procedure as Set C in the practice choice game.

1. While looking at infant, say, "Hi"
2. Bring Both Right and Left hand puppets around, display each puppet 6-8 inches from face, gently shake saying, "Look"
3. After the infant looks at each puppet, say, "Which one do you want?"
 - *Be sure that the infant looks at you while saying "Which one do you want?"
 - If the infant does not look at you say, "OK, Which one?"
4. After the infant looks back at you, move the puppets within the infant's reach.
5. Look down slightly at the infant's torso – wait for the infant to touch a puppet.
6. Once the infant touches a puppet, remove the other puppet from view and keep behind your back. Allow the infant 15 seconds to play with the puppet (keep the puppet on your hand). After 15 seconds gently remove the puppet and keep behind your back.
 - If the infant is looking at the puppets, keep waiting for the infant to touch a puppet.
 - If the infant is looking only at the experimenter and this continues for more than 10 seconds, look up at the infant, gently shake the puppets and say, "Which one do you want," then look down and wait for the infant to touch a puppet.
 - o If the infant still continues to look at the experimenter and does not touch a puppet after 10 more seconds, gently shake the puppets and say, "Which one?"

- If the infant still continues to look at the experimenter and does not touch a puppet after another 10 seconds, remove the puppets from sight and place behind your back. Say to the mother, "I'm going to show him/her the puppets again. After I move the puppet closer to him/her, could you please say, "It's okay, you can pick one." Then, repeat the presentation.
- If the infant looks away from the experimenter and puppet more than 2 seconds, gently shake the puppets again and say, "Which one do you want?" – wait for the infant to touch a puppet.
 - If the infant still looks away from more than 2 seconds, gently shake the puppets and say, "Which one?"
 - If the infant looks away again for more than 2 seconds, remove the puppets from sight and place behind your back. Say to the mother, "I'm going to show him/her the puppets again. After I move the puppets closer to him/her, could you please say, "It's okay, you can pick one." Then, repeat the presentation.

Appendix E:

Baseline Preferential Looking (Visual Paired Comparison)

First, Experimenter B shows her hand on the Right side, then Left side, and then at the Middle of the curtain to have the infant look at the places where the puppets will be presented and note the location for later coding of infant attention:

“Here we go....” Show hand on right side, “Look over here.” Wait for infant to look. “Good job.”

Show hand on left side, “And here.” Wait for infant to look.
“Good job.”

Show hand in middle, “And right in the middle.” Wait for infant to look.
“Good job.”

Second, Experimenter B presents the two puppets for 15 seconds at the right/left positions which are 25 inches apart (starting right/left positions will be counterbalanced across infants):

“Here we go....”
(bounce for 5 seconds, tilt side to side for 5 seconds, and remain still for 5 seconds)

Third, Experimenter B presents the two puppets for 15 seconds in the opposite locations (left/right):

“Here we go...”
(bounce for 5 seconds, tilt side to side for 5 seconds, and remain still for 5 seconds)

Immediate and Delayed Test Preferential Looking (Visual Paired Comparison)

Experimenter B presents the two puppets for 15 seconds at the right/left positions which are 25 inches apart (right/left positions will be counterbalanced across infants):

“Here we go....”
(puppets remain still for the 15 second test)

(For each infant, the right/left positions of the VPC will be the same for their immediate and delayed choice tests)

Appendix F:

Detailed procedure for the social-emotional interactions

Experimenter B opens puppet stage curtain to give the infant the toy.

“Hi there, look at this toy...would you like to play with the toy?”

Experimenter B closes the curtains.

Give the infant 30 seconds to play with the toy before the first puppet emerges.

Positive and negative puppet interactions alternate for at least 3, 40-second trials of each puppet (order will be counterbalanced across infants):

Studies 1

a) Positive (40 seconds), Break (10 seconds), Negative (40 seconds), Break (10 seconds), Positive (40 seconds), Break (10 seconds), Negative (40 seconds), Break (10 seconds), Positive (40 seconds), Break (10 seconds), Negative (40 seconds), Break (10 seconds).

b) Negative (40 seconds), Break (10 seconds), Positive (40 seconds), Break (10 seconds), Negative (40 seconds), Break (10 seconds), Positive (40 seconds), Break (10 seconds), Negative (40 seconds), Break (10 seconds), Positive (40 seconds), Break (10 seconds).

Study 2

Positive condition

a) Positive (40 seconds), Break (10 seconds), Neutral (40 seconds), Break (10 seconds), Parent moves toy away from infant, Positive (40 seconds), Break (10 seconds), Neutral (40 seconds), Break (10 seconds), Parent moves toy away from infant, Positive (40 seconds), Break (10 seconds), Neutral (40 seconds), Break (10 seconds), Parent moves toy away from infant.

b) Neutral (40 seconds), Break (10 seconds), Parent moves toy away from infant, Positive (40 seconds), Break (10 seconds), Neutral (40 seconds), Break (10 seconds), Parent moves toy away from infant, Positive (40 seconds), Break (10 seconds), Neutral (40 seconds), Break (10 seconds), Parent moves toy away from infant, Positive (40 seconds), Parent moves toy away from infant.

Negative condition

a) Negative (40 seconds), Break (10 seconds), Parent gives toy to infant, Neutral (40 seconds), Break (10 seconds), Parent gives toy to infant, Negative (40 seconds), Break (10 seconds), Parent gives toy to infant, Neutral (40 seconds), Break (10 seconds),

Negative (40 seconds), Break (10 seconds), Parent gives toy to infant, Neutral (40 seconds), Break (10 seconds).

b) Neutral (40 seconds), Break (10 seconds), Parent gives toy to infant, Negative (40 seconds), Break (10 seconds), Parent gives toy to infant, Neutral (40 seconds), Break (10 seconds), Negative (40 seconds), Break (10 seconds), Parent gives toy to infant, Neutral (40 seconds), Break (10 seconds), Negative (40 seconds).

Positive interactions:

Puppet emerges from behind curtain in the middle of the stage.

Positive puppet interacts contingently with infant for 40 seconds. Positive puppet should match the infant's level of engagement, pace, and movements. For example, if the infant shakes the toy up and down, the puppet will bounce up and down saying, "Yay!" If the infant drops the toy, the puppet will say, "Uh-oh," pick up the toy and hand it to the infant saying, "Here you go."

When the positive puppet is first, the puppet simply interacts contingently and positively with the infant. On subsequent positive trials, the positive puppet will look at the toy, then back at the infant, then back at the toy, pick up the toy, and give it to the infant.

<i>Sample Script when Positive puppet is First</i>	<i>Sample Script for Subsequent Trials</i>
"Hi, [baby's name], hi!"	"Hi there, [baby's name]."
"Ooo, that's a fun toy."	"Oh, look at the fun toy."
"Yeah."	"Here, would you like to play with me?"
"Yes."	"Yes."
"I like playing with you."	"I like playing with you."
"Isn't that fun?"	"Isn't that fun?"
"Yay"	"Yay"
"Wow, that's a neat toy."	"Yeah."
"Ok, bye-bye. Bye-bye."	"Ok, bye-bye. Bye-bye."

Negative Interactions:

Puppet emerges from behind curtain in the middle of the stage.

Negative puppet takes the toy away from the infant and holds it for 40 seconds. The negative puppet may bring the toy closer to the infant and then pull the toy away when the infant reaches for it, saying, "No!" When the negative puppet leaves, he places the toy on the edge of the puppet stage so that the toy is in the infant's sight, but out of reach.

Negative interactions are also tailored to each infant to maintain the infant's level of negativity. If an infant becomes too upset, they will be unable to participate.

<i>Sample Script for Negative Puppet</i>
<p>“No, [baby’s name], no!”</p> <p>“That’s my toy.” [take toy]</p> <p>“I want the toy.”</p> <p>“No.”</p> <p>“It’s <i>not</i> for you.”</p> <p>“It’s <i>mine</i>. My toy.”</p> <p>“Don’t”</p> <p>“Mine.”</p> <p>“I don’t want you to play.”</p>

Neutral Interactions:

Puppet emerges from behind curtain in the middle of the stage.

Neutral puppet does not engage with the toy. The neutral puppet simply moves left to right and up and down and speaks in a neutral, monotonous tone. The neutral puppet interacts when the infant has the toy, but does not act contingently upon the infant's behavior and does not comment on the toy.

For the positive condition: After the break following the neutral interactions, parents will take the toy from the infant and set it out of the infant's reach (prior to the interactions, experimenter B will explain this procedure to the parent and signal the parent during the study). Then, the positive puppet will be able to give the infant the toy.

For the negative condition: After the break following the negative interactions, parents will take the toy and give it to the infant (prior to the interactions, experimenter B will explain this procedure to the parent and signal the parent during the study). Then, the negative puppet will be able to remove the toy from the infant.

<i>Sample Script for Neutral Puppet</i>

“Hello.”

“Hi there.”

“I see your toy.”

“OK.”

“Good bye.”

Appendix G:

Laboratory-Temperament Assessment Battery

EC 2,3. TOY RETRACTION

Rationale

This episode provides an opportunity for the expression of anger by interrupting the exploration of a toy. The context is interpersonal, and the situation can be viewed as a violation of social norms.

Physical setting



A medium-sized table (80 cm x 140 cm) is placed with the long end perpendicular to a one-way mirror. The child (C) is secured in a high chair and seated at the end of the table, facing the mirror. The mother (M) is seated on C's left, approximately 1 m away, around the corner of the table. The familiar experimenter (E) is

seated approximately 1 m from C on C's right, across the table from M. Two attractive stimuli rattles are hidden underneath the table out of C's view until the beginning of the episode.

Procedure

E brings two attractive stimuli rattles into C's view, demonstrates how they work, and allows C to choose a rattle. When the choice is made, the episode begins. After C has played with the chosen toy for 15 s, E cues M (nods her head or clears her throat) to gently slide the toy from C and place the toy just out of C's reach and leave the toy there for 15 s. E then gives the toy back and the procedure is repeated 2 more times. The toy is returned to C after the third trial to reduce any distress experienced during the session.

Camera instructions

The camera shot should include a frontal, close-up view of C's face and upper torso.

Coding

This episode consists of three, twenty-second trials--each presentation of the toy is one trial. For coding purposes, each trial begins when M starts to take the toy from C, and ends when the toy is returned to C. Each trial is divided into four, 5-second epochs.

Variables to be coded:

- a) Latency to first anger response.
- b) Intensity of struggle.
- c) Intensity of facial anger.
- d) Intensity of distress vocalizations.
- e) Parent effectiveness.
- f) Baseline state.

Definition of variables:

- a) Latency to first anger response: Time, in seconds, starting when M removes toy from C to the first sign of anger (facial, vocalic, postural, or instrumental).
- b) Intensity of struggle: Peak intensity of struggling in each epoch is rated on the following scale:
 - 0 = No struggling to hold on to the toy at all. No resistant movement.
 - 1 = Low intensity struggle.
 - 2 = Medium intensity struggle. Sporadically pulls toy away from parent using arms and/or body. Movements could include medium intensity pulling of toy, leaning forward, arching back or kicking. Generally lasts 2 - 3 s.
 - 3 = Moderately high intensity struggle. Near continuous moderate intensity pulling of toy. Can include the same movements as number 2 with higher intensity. Generally lasts 3 - 4 s.
 - 4 = High intensity struggle. Continuous movement of moderately high intensity with intervals of high intensity movements to get toy. Generally lasts 5 or more s.

- c) Intensity of facial anger: Presence of anger or anger blends is noted in each epoch using AFFEX (See Appendix A for definitions) and rated on the following scale:
- 0 = No facial region shows codable anger movement.
 - 1 = Only one facial region shows codable movement, identifying a low intensity anger, or expression is ambiguous.
 - 2 = Only 2 facial regions show codable movement, or expression in one region (e.g., brows) is definite.
 - 3 = An appearance change occurs in all 3 facial regions, or coder otherwise has impression of strong anger.
- d) Intensity of distress vocalizations*: Peak intensity of distress vocalizations is noted in each epoch and rated on the following scale:
- 0 = No distress.
 - 1 = Mild protest verbalization that may be difficult to identify as hedonically negative.
 - 2 = Definite protest, limited to a short (1-2 second) duration.
 - 3 = Longer protest, fussing or mild, low-intensity cry (cry has extended or rhythmic quality).
 - 4 = Definite non-muted crying.
 - 5 = Full intensity cry/scream (child is losing control).
- *Note: some vocalizations in this episode will not be anger-related and should not be coded.
- e) Effectiveness of parent: the parent's effectiveness as a participant in the episode is coded. The parent receives one overall code for the entire episode.
- 0= Not effective: Parent does not move toy out of C's reach or returns it prematurely in two out of the three trials.
 - 1= Mildly effective: Parent does not move toy out of C's reach or returns it prematurely in one of the trials.
 - 2= Effective: Parent follows the instructions that E has given in all three of the trials.
- f) Baseline state: The child's state prior to the beginning of an episode:
- 1= tired/drowsy.
 - 2= alert/calm.
 - 3= alert/active.
 - 4= fussy.
 - 5= crying.

Appendix H:
Emotion Coding Documents

Draft date: 3/8/13

Negative Emotion Coding for Puppet Study Interactions

Laura J. Sherman, Jackie Gross, and Jude Cassidy
University of Maryland

Unpublished coding manual

OVERALL GOAL STATEMENT:

Babies by 9 or 10 months old are already very social and interactive with others in their environment. Some are more emotional than others when interacting socially. Our goal in coding these interactions is to capture the infant's emotional experience with each puppet. As such, we are only interested in their relational emotion, that is, their emotion in connection to the puppet and not to outside factors like dropping a toy or hearing a loud noise. Therefore, if a reaction is *clearly* attributable to an outside factor, it is not codeable. We use clues from infants' facial expressions, vocalizations, and physical movements, to infer certain things about their emotional states during these social interactions.

General information about this process:

Video Session to Code

Study 1) Sessions to code:

- Alternating Puppet Interactions:
Positive/Negative (starting order counterbalanced with at least three ~40 sec interactions each – look to see if there were additional sessions or sessions presented out of order).
- Let Jackie or Laura know if you notice anything different about the order or structure of the interactions.

Study 3) Sessions to code:

- Alternating Puppet Interactions, either:
 - a) Positive/Neutral (starting order counterbalanced with at least three ~40 sec interactions each – look to see if there were additional sessions or sessions presented out of order), or
 - b) Negative/Neutral (starting order counterbalanced with at least three ~40 sec interactions each – look to see if there were additional sessions or sessions presented out of order)
- Let Jackie or Laura know if you notice anything different about the order or structure of the interactions.

Creating the Coding Template – instructions:

- 1) Open INTERACT file and corresponding video.
- 2) Delete existing codes by xxx, but keep the start and stop times of the Interactions (positive and negative) and wait sessions.
- 3) Use existing start times for the emotion coding interactions.
- 4) Change or confirm the End times for each interaction session – for the emotion coding, the session will end when the puppet says bye, good-bye, or other ending phrase (e.g., see you later). If the puppet does not say an ending phrase, end the session when the puppet starts to leave, specifically when the puppet is first tilted down and no longer completely upright to the infant (in this case, the existing end time will remain).
- 5) Divide each interaction session into 5-second segments. To do this: click on the line for the first set, then go to Data > Split Dataset > and enter “ 05: ” into the field). Copy the 05: value. Then, click on the line for next set, go to Data > Split Dataset > and paste the value of 05: into the field. Click enter. Repeat for each of the Positive, Negative, and Neutral interactions.
- 6) Save the template as the IDnumber_template

The Basic Emotions



Joy / Happiness

Your forehead is relaxed – most likely it remains neutral. It could show light wrinkles if eyebrows are lightly raised.

The corners of the mouth are curling up, sometimes showing the teeth. If someone's laughing out loud, the mouth is open. The cheekbones are lifted.

The eyes crinkle, crows feet may extend from outer corners. Eyes may appear squinted. Cheeks raise/bulge.



Anger (Frustration)

Your forehead is pushed together in a frown, pushing down the eyebrows. Furrowed brows: Bulging or vertical furrows between the eyes may be visible.

Sometimes mouth is open, with snarling lips and depressed corners of the mouth – squarish mouth (double Elvis lip) – or lips are closed, pressed or pursed together.

The eyes are bulging out, putting tension on the eyelids. May look tense or squinted. Your nostrils are standing out and the nose is wrinkled.



Sadness (Disappointment)

Inner corners of eyebrows move upward and together resulting in bulging/furrows in middle of forehead. The eyebrows are squashed together, and the forehead is frowning.

The corners of your mouth are depressed, often with a shaking lower lip.

The skin around your eyes is pulled in, and the eyes are tearing up (or even crying). Wrinkles are forming from the nostrils to the corners of your mouth.



Scared (Fear/Wariness) | Surprise which could

contain some fear

Eyebrows go up and then down again. Entire brow should be raised/neutral and drawn together. Brows may also look straighter across than usual. Faint horizontal furrows may be present in forehead.

Upper eyelid raises making the eyes appear wider. Eyes have tense appearance.

Your lips are stretched outwards, and your lower lip is pulled down. Lip corners are drawn straight back. Mouth is usually less than wide open.

Surprise: When you're surprised, your eye brows are pulled up high, making your eyes wide open, and your forehead wrinkled. Your mouth opens as your jaw muscles relax and your lower jaw drops.

Notes across all modalities:

Each 5-second segment will be coded for peak intensity (0 – 3) across three modalities (negative facial expressions, negative physicality, and negative vocalizations)

Each Segment Stands Alone

- Code each 5-second segment as a stand-alone segment. Meaning, for example, if a vocalization, reach, or facial expression begins in the first segment and continues into the second segment while maintaining low intensity, both segments would receive a code of 1 for that modality. If the intensity gets higher in the second segment, then code the first as a 1, and the second as high as observed. In another example, if an infant initiates a reach out toward the toy in segment 2 and then freezes with their arm still extended toward the toy, but isn't actively engaged in a forward reach, they are simply continuing in the reach, then code this based on its observed intensity. If at any point of the segment, the infant's arm is extended at the elbow toward the puppet/toy, then code some amount of physicality, even if the reach is ending and was only brief in the segment, as we are coding for the segment's peak intensity (see note immediately below).
- Remember to code carry-over from the previous segment if it applies! Even if the face, voc, or movement lasts for just a fraction of a second into the next segment, it would be coded in that new segment too.

Consider Intensity First, then Duration

- For each segment, always code for the peak intensity. Codes are a balance of severity and duration. For instance, a long medium (2 facial regions) expression that spans most of the segment is coded as a 3 in the same way that a single severe expression (all 3 facial regions) is coded as a 3. The peak intensity is considered first, that is, if an infant displays what is considered "medium" facial affect by showing negativity simultaneously in 2 regions, first think code a 2, but then, if the facial affect lasts for most of the segment, this will increase the code to a 3. So, duration can only bump up an existing peak intensity code.

*Code what you see, and use **clear** indicators to help: Sometimes you'll have missing data*

- Sometimes the infant's face will be obscured (for example, infant goes behind the picture-in-picture screen, turns away from the camera, camera falls, puppet is blocking the face, etc.). As long as you have seen the face at all (no matter how briefly) during the 5-second segment, you can code the peak intensity that you observed. (good examples: 10025 seg 4,1 and 10017). There may be other clear indicators for you to code the face (for example, infant engages 2 facial regions at the beginning of the segment and is vocalizing negatively and reaching, thus being a medium for the face, but then goes behind the picture-in-picture window for the rest of the segment). As such, it is not possible to see the face in order to decide if the infant should be coded as high for the face...but, if the infant continues to vocalize and reach negatively while covered by the picture-in-picture, you can code as high

facial affect. Thus, you've identified the peak based on your brief observation, and you've used other clear indicators to decipher the duration of the facial expression.

- If the puppet does not touch/try to remove the toy from the infant in the first (or second, etc) segment of the negative interaction, this will be missing data on negative physicality, unless there is clear negative banging. Thus, leave your code for physicality blank until the puppet makes its move to remove the toy. If the puppet tries to remove the toy, but the infant is simply too far away, this will be blank, missing data, *unless* the infant is retracting the toy, moving away from the puppet, or other physical movement to escape the puppet's attempt to get the toy.

*You will be coding negative emotion present during both the positive **and** negative interactions*

- Babies commonly express negative emotion during interactions with the nice puppet. Be aware that we want to capture all negative relational emotional expressions, regardless of when they happen.

Code only relational negativity, not negativity due to things other than the puppet

- Use context clues to determine if negativity is due to the interaction with the puppet. One common clue is that infant is looking at the toy with furrowed brows. This usually means the infant is curious about the toy itself, not that he/she is upset about the puppet. However, looking down or looking away doesn't necessarily mean that the negativity isn't relational. This is just one clue of many to use when trying to decide if it is relational.

In addition to the peak intensity codes in the three modalities, 2 additional categories will be marked in each 5-second segment ONLY if the behavior is observed. These codes are marked if the following types of behavior are present in the segment:

4th Category: Facial Irregularities: Present: mark the occurrence of any facial irregularities noted (i.e., irregularity was present, but not distinction of intensity). Note any departure from the infant's "normal"/neutral behavior that is not clearly identifiable as negative OR positive. For example, a twitch, tic, or long blink will be coded as facial irregularities.

5th Category: Infant Escape: Present: mark the occurrence of infant escape behavior, if noted (i.e., just that it was present, not level of intensity). This includes arching, full body turn away, trying to climb down. Attempting to get away from the puppet, the interaction, or the situation overall.

Negative Emotion Coding Checklist- Coding passes checklist

Code for each child in the order presented here. Finish all codes before moving on to coding the next child.

Negative Facial Affect – WATCH AND CODE ON MUTE. FOR EACH 5 S. SEGMENT:

1. Watch the 5-second segment to get overall impression of infant's expression AND notice any facial irregularities.
2. Watch the segment paying attention to the infant's **brow/forehead region**, and get an idea of any codeable expression.
3. Watch again, paying attention to the infant's **eyes/nose/cheeks region**, and get an idea of any codeable expression.
4. Watch again, paying attention to the infant's **mouth/chin region**, and get an idea of any codeable expression.
5. Watch again, paying attention to all regions – are they occurring simultaneously or individually? Watch as many times as necessary, and determine your code. Be observant!
6. Rewatch once more to confirm your code for that segment.
7. Finally, if you saw any facial irregularities, mark as present.

Complete Steps 1 – 7 for EACH 5-second segment across the entire puppet interaction procedure. That is, complete all of the Negative Facial Affect Modality.

Then, move on to coding Negative Physicality.

Negative Physicality – WATCH AND CODE ON MUTE, FOR EACH 5 S. SEGMENT:

1. Watch segment to get overall impression of infant's negative physicality AND notice any infant escape behavior.
2. Watch segment again paying attention to the infant's reaching behavior and determine how you would code the reaching behavior of that segment.
3. Watch segment again paying attention to the infant's banging. Is the banging present simultaneously with a negative facial expression or vocalization? Determine how you would code the infant's banging.
4. Combine your idea for the code of reaching *and* banging to determine what your code would be for the 5-second segment. Re-watch the segment to confirm your overall

code.

- 5. Finally, if you saw any escape behavior, mark as present.

Complete Steps 1 – 5 for EACH 5-second segment across the entire puppet interaction procedure. That is, complete all of the Negative Physicality Modality.

Then, move on to coding Negative Vocalization.

Negative Vocalization – LISTEN AND CODE WITHOUT VIDEO IMAGE, FOR EACH 5 S. SEGMENT:

- 1. Listen to the segment to get overall impression of infant’s vocalizations.
- 2. If a vocalization is present, listen to the segment again, paying special attention to the vocalizations. If they are definitively negative, determine your code. If there are neutral vocalizations, then view the video to see if they occurred in the presence of other negative cues, and determine your code.
- 3. Watch and LISTEN again, to confirm your code.

Negative Facial Affect

Includes general negativity, anger, frustration, sadness, disappointment, fear, distress, etc. (see The Basic Emotions table and the AFFEX table in the Appendix). We are not interested in the specific emotion being expressed, but in the sum total of all negative relational emotions expressed.

Coded across 3 facial regions:

- a) Brows/Forehead
- b) Eyes/Nose/Cheeks
- c) Mouth/Chin

EXPRESSION	EXPRESSION CUES (motion in the segment is not required to code these expressions. For each description below, if a region is engaged, the expression will be coded)
Anger	brows lowered, furrowed eyes tense, squinted, or bulging lips pressed firmly or squarish mouth
Fear	brows raised eyes open mouth opens slightly
Disgust	upper lip is raised nose bridge is wrinkled, cheeks raised
Sadness	raise inner portion of brows lowering of mouth corners chin quivers

Intensity of Negative Facial Affect:

*Coding tip: Because each baby differs in how expressive they are, use their neutral face as a baseline to judge their negative facial affect. Once you've identified a Neutral face for a particular baby, use that as a reference point if you are unsure of subtle facial expressions.

Note: This is an ordinal scale. The distance between a 0 and a 1 is different than the distance between a 2 and a 3. This is how the scale should be conceptualized for the boundaries of the codes if there was an underlying continuous amount of negativity, the boundaries for coding would be:

None	Low Ranging from: subtle tension to 1 clear, brief engagement	Medium	High
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None/Neutral – INTERACT key: a (“affect”)

No facial region shows codable negative expression. Face may be positive, or show non-negative movements or expressions. Such as, mouth open/opening, but not in negative manner, brows engaged in interest. Must be definitively negative or occur frequently enough to be coded as low (see #1). Also, code 0 if the observed negative facial expression is clearly in reaction to an outside (non-puppet interaction) factor, such as a loud noise (banging the toy on the table) or occurs just before the puppet is present (see #10013, set 5) as these reactions would not be “relational” emotion, and thus, are outside of our interest in coding the negativity of the interaction.

Low – INTERACT key: 1

Global descriptor: MILDLY NEGATIVE

Only one facial region shows codable negativity. Infant’s face may shift briefly and return to neutral. Also, if 2 very subtle negative things occur (such as ½ expression in 1 region), which wouldn’t normally be coded if observed by itself, code for low intensity facial affect. Note that brow expressions could be due to interest, not fear, and therefore, may not be definitively negative. Also, code visible low level tension in the face, particularly in the brow region. The tension may occur over multiple segments so keep your eye trained on muscle engagement, not necessarily muscle movement, in each segment. See #10013. Tension tends to "carry over" into other segments.

Medium – INTERACT key: 2

Global descriptor: MODERATELY NEGATIVE (“EVERYTHING-IN-BETWEEN” 1 AND 3)

Only 2 facial regions show simultaneous codable negativity,

OR Expression in one region (e.g., brows) is pronounced and lasts for most of the segment.

OR single regions are engaged independently of one another, but they total up to include most of the segment. Such as, for example, brows clearly engage (then disengage) and then the mouth clearly engages.

High – INTERACT key: 3

Global descriptor: COMPLETELY NEGATIVE

Negative expression occurs simultaneously in all 3 facial regions, OR expression in 2 simultaneous regions is pronounced and lasts for most of the segment.

Negative Physicality:

Any movement that indicates the infant is having a negative experience with the puppet. This includes: having the toy taken away when the infant wants to keep it, attempting to get the toy but not getting it, bump/movement of body in protest, and negative banging of hands or toy on the table.

Negative banging is defined as banging of hands or toy on the table OR a bump/movement of body in protest. These must be accompanied by simultaneous negative facial affect or negative vocalization to be considered negative. Otherwise, they could be considered banging due to excitement, boredom, happiness, etc.

*note: squirming, leaning back on the caregiver, turning away from the presentation, and other physical markers/ movements will not be coded here. These are not definitively negative.

There are different sets of coding criteria during each interaction. First, observe how the infant reacts during the beginning of the interaction when the puppet removes the toy. These criteria are labeled as “*Initial removal.*” Then, during the remainder of the interaction use the criteria labeled “*Later segments.*”

Coding negative physicality during positive puppet interactions:

You may find it difficult to follow the guidelines for coding negative physicality during the positive puppet interaction. This is because the puppet never takes the toy away, and the child will rarely, if ever, reach for the toy and NOT get it from the puppet. This interaction can be coded for the presence of other negative physicality, however, such as negative banging.

How to decide if the reach is negative:

Does the child have access to the toy?

Yes. Then he/she is probably just reaching to touch the puppet. If it doesn't seem like the child is upset because he/she isn't able to reach the puppet, or you're not sure, but don't see anything negative happening in the face or vocalizations, then don't code the reach as negative. If, however, it seems like the child is upset that he/she can't reach the puppet and the puppet isn't coming closer, then check to make sure there is something negative in the face or vocalizations happening at the same time. If there is, then code the reach as negative.

No. If the child doesn't have access during the reach and the puppet doesn't give her/him access, this is considered a negative interaction (reaching and not getting). Code as a negative reach regardless of other indicators of negativity.

Intensity of Negative Physicality:

None (Neutral) – INTERACT key: d (“doing”)

No Struggle

Initial removal:

No struggling to hold on to the toy, either because infant is not holding the toy or relinquishes the toy without any resistance or difficulty for the puppet. If, however, the infant is not initially holding the toy, but subsequently reaches as it's pulled away or reaches during the first segment, code the intensity of that reach in the segment.

Later segments:

Infant does not reach for the toy or struggle to get the toy/puppet.

and

No negative banging of the toy or hands on the table or of the body.

Low – INTERACT key: 7

Global descriptor: LOW COMMITMENT, HALF-HEARTED ATTEMPTS

Initial removal:

Infant shows some amount of resistance when the toy is taken. This may be brief, almost as if there's something sticky on the infant's hand that keeps it attached to the toy momentarily OR more holding, you may see the arm move with the toy, but not actively pulling it, and then they relinquish the toy. These periods generally last less than 1.5 seconds and then the puppet obtains the toy, but duration is not a sole factor for coding this category. This timing factor is just what is typical of this code, but not a requirement. Always consider peak intensity first, then the duration of that can move the code up if it occurs for most of the segment.

Later segments:

Infant reaches or is reaching for the toy with low intensity only and does not get it (i.e., no engagement of the trunk/body toward toy). This may be observed as a simple outstretched arm/hand toward the puppet. Arm has to be toward the puppet/toy, it cannot simply be lifted up. Observable extension of the elbow. Shoulder may come forward slightly because it's connected to their arm, but infant does not twist the upper body. Torso may raise slightly without a bend or twist at the waist, or only one shoulder moves such that it's not a full twist of the body. Infant is either sitting back or sitting up straight at a 90 degree angle.

OR

Presence of negative banging (toy or hands or body) without any struggle over the toy present in the segment.

Medium – INTERACT key: 8

Global descriptor: CLEARLY COMMITTED (“Everything-in-between”)

Initial removal:

Medium intensity struggle (lasting about 1.5-4 seconds). May pull toy using arms. Infant maintains a stronger grasp on the toy, holding it back from the puppet.

Later segments:

Infant reaches or is reaching for the puppet/toy and doesn't get it with medium intensity (i.e., the infant engages their trunk/upper body during the reaching – torso must be actively twisted or leaning/bending forward). If the torso simply moves up or if only one shoulder moves, such that it's not a full twist, but the shoulder moves because it is connected to the arm, then this code is not appropriate. If the infant's waist is already bent more than 90 degrees at the waist toward the puppet/toy while reaching, this is a medium reach too.

OR

A low intensity struggle (identified in #1) with negative banging (toy, hands, or body) on the table in the segment.

High – INTERACT key: 9

Global descriptor: FULLY COMMITTED TO GETTING THE TOY

Initial removal:

High intensity struggle. Continuous holding of the toy (4-5 seconds of the segment) with intervals of high intensity effort to get/keep toy. Actively pulling/tugging the toy when the puppet tries to take it. Arm may be straight, but infant is actively struggling. Puppet has considerable difficulty getting the toy.

Later segments:

Infant reaches or is reaching with high intensity, however brief (i.e., engagement of the lower body, as in any movement of lower body to propel infant closer to toy, lunge with or without forward reaching of hand, attempt to crawl across table). Infant's butt comes off the caregiver's lap to reach for/get closer to the toy/puppet. Obviously, you won't be able to see the infant's butt because they are behind the table, but there are several markers that indicate that the lower body is engaged: shoulders up, caregiver's hands/arms move to restrain the infant. See 10025 as an example of subtle lower body engagement.

OR

A medium intensity struggle (identified in #2) with negative banging (toy, hands, or body) in the segment.

Negative Vocalizations (distress, protest)

Terms for types of vocalizations:

Protest voc – The vocal cords are used, as though the infant were speaking a syllable.

Fussing – On the path toward crying, but not quite crying. It is different from spoken vocs, because it is more dysregulated and rhythmic.

Crying – Extended and rhythmic.

Continued negative whining – continuous (rhythmic and extended).

MILD Voc – no pitch change, not a screech, low intensity, lightly expressing displeasure

MODERATE Voc – a change in pitch such that the voc's pitch goes up during the second portion of it. A moderate voc may have more than one syllable to it, may be slightly rhythmic without being crying, may be a screech without being a scream, or may just be "everything in between" lightly expressing displeasure and fully expressing displeasure.

Intensity of Negative Vocalizations:

None (Neutral) – INTERACT key: s ("saying")

No distress. Infant either does not vocalize, vocalizes positively, or vocalization is neutral and cannot be identified as negative (such as an effortful grunt).

NOTE: If you cannot decide whether a vocalization is or is not neutral, watch the segment for facial affect clues. For example, if the infant shows codeable negativity of facial affect, it will be coded as a negative (not neutral) vocalization. Only consider facial affect during undecided/neutral vocalizations, do not consider physicality. Also, the negative facial expression must occur AT THE SAME TIME as the voc in question, not simply within the same 5 second segment.

Low – INTERACT key: 4

Global descriptor: LIGHTLY EXPRESSING DISPLEASURE

One mild protest vocalization/distress verbalization that lasts for less than half the segment. Think about if the infant could talk, they would briefly say "No" or "Stop"

Medium – INTERACT key: 5

Global descriptor: "Everything-in-between"

One mild protest vocalization that lasts for more than half the segment. If the infant could talk, they would say, “Nooooooo” or “Stoooooooooop”

OR Two or more mild protest vocs. If they could talk, “No, Stop, I don’t like it”

OR One more intense (moderate) protest vocalization that is limited to a short (1-2 second) duration. If they could talk, “No!!” or “STOP!”

High – INTERACT key: 6

Global descriptor: FULLY EXPRESSING DISPLEASURE, VERY EXPRESSIVE VOCALLY

Here, we are thinking about more dysregulated vocalizations. The infant is yelling, fussing, whining, crying, or is more upset so they aren’t using “words.”

One moderate protest voc(s) for most of the segment

OR fussing/crying/continued negative whining for majority of the segment (cry has extended or rhythmic quality).

OR Full intensity cry/scream (child losing control).

Global Negativity

<p>After coding each 5-second segment of the 40-second interaction, watch the 40-second interaction in full, and code the global, overall negativity of the interaction:</p>					
	Not at all	Somewhat negative	Moderately negative	“Everything-in-between”	Very negative
Interact key:	Q	W	E	R	T
			<i>Also code here these special situations that you may</i>	<i>Also code here these special situations that you may observe:</i>	

			<p><i>observe:</i></p> <p>Interaction alternates between some medium negativity and neutral.</p> <p>It started negative but ended neutral and was neutral for most of the interaction at the end.</p>	<p>Interaction ends negative, but did not begin as such and may have been mostly neutral.</p> <p>Interaction had medium negativity that lasted the majority of the time.</p>	
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APPENDIX A: AFFEX FACIAL EXPRESSION DEFINITIONS

Emotion	Movements In Forehead/Brows Regions	Movements In Eyes/Nose/Cheeks Regions	Movement In Mouth/Lips/Chin Regions	Notes
Anger	<ul style="list-style-type: none"> ✓ Inner corners are lowered and drawn together. ✓ Bulging or vertical furrows between the eyes may be visible due to this movement. 	<ul style="list-style-type: none"> ✓ Eyes may look tense or squinted. ✓ Cheeks may be raised. ✓ Fold under eye may deepen. 	<ul style="list-style-type: none"> ✓ Mouth looks tense, wide open and squarish. ✓ Alternatively, mouth appears closed with lips pressed together. 	<ul style="list-style-type: none"> ✓ Don't confuse brow movements with those in interest. ✓ See illusion of sadness note.
Fear	<ul style="list-style-type: none"> ✓ Entire brow should be raised/neutral and drawn together. ✓ Brows may also look straighter across than usual. ✓ Faint horizontal furrows may be present in forehead. 	<ul style="list-style-type: none"> ✓ Upper eyelid raises making the eyes appear wider. ✓ Eyes have tense appearance. 	<ul style="list-style-type: none"> ✓ Lip corners are drawn straight back. ✓ Mouth is usually less than wide open. 	<ul style="list-style-type: none"> ✓ Don't confuse interest brows for fear. ✓ See illusion of sadness note.
Sadness	<ul style="list-style-type: none"> ✓ Inner corners move upward and together resulting in bulging/furrows in middle of forehead. 	<ul style="list-style-type: none"> ✓ Cheeks may look lower than usual or have a droopy appearance. ✓ Alternatively, cheeks may be raised and eyes squinted. 	<ul style="list-style-type: none"> ✓ Lip corners should be drawn down. ✓ Bottom lip may be pushed up and out by the chin which may be tense or wrinkled. 	
Joy	<ul style="list-style-type: none"> ✓ Most likely remain neutral. 	<ul style="list-style-type: none"> ✓ Cheeks raise ✓ Furrow below the eyes deepens. ✓ "Crows feet" will extend from the outer corners of the eye. ✓ Eyes may appear squinted. 	<ul style="list-style-type: none"> ✓ Lip corners are raised. ✓ Nasolabial fold deepens. 	
Interest	<ul style="list-style-type: none"> ✓ Entire brow is raised. ✓ Alternatively, brows are drawn together and slightly lowered. 	<ul style="list-style-type: none"> ✓ Eyes look wider than usual due to raised brows. ✓ Alternatively, eyes may be squinted and cheeks raised. 	<ul style="list-style-type: none"> ✓ Mouth may open. 	<ul style="list-style-type: none"> ✓ When coding infants, do not code "mouth opens" as interest unless it is in response to a stimulus

note on the potential for an "illusion of sadness"

There are several occasions when an illusion of sadness may appear. Sadness should not be coded in these situations:
 The first situation is when brows are drawn tightly down and together. In this case, it is common for the inner most corners of the brows to bulge up in the middle falsely giving the appearance of sadness. This is most likely due to the large amount of fat in the infant face.
 The second situation is when the outer corners of the brows are lowered falsely giving the appearance that the inner corners have raised. In this case, be sure to observe the actual movement of the brows. In sadness, the inner corners need to be raised and drawn together. Simply observing a still frame of this expression is not sufficient to distinguish between true sadness and the illusion of sadness.
 Finally, an illusion of sadness may occur when children inhale deeply during a bout of crying. In this situation, the lip corners will be drawn down by the inhaling action giving the impression of sadness.

These descriptions were adapted from C.E. Izard's *The Maximally Discriminative Facial Movement Coding System*.

NEGATIVE FACIAL EXPRESSIONS

Every 5-second segment code the intensity:				
Modality:	None (Neutral)	Low	Medium	High
Interact key:	a “affect”	1	2	3
<p>Negative Facial Expressions</p> <p>(negativity, anger, sadness, fear, distress)</p> <p>Facial regions:</p> <ul style="list-style-type: none"> - Brows/forehead - Eyes/Nose/Cheeks - Mouth/Chin 	<p>No facial region shows codable negative expression.</p> <p>OR</p> <p>There is a negative expression but it’s not due to the interaction with the puppet.</p>	<p>Mildly negative</p> <p>Only one facial region shows codable negativity. Infant’s face may shift briefly and return to neutral OR visible low level tension, typically in the brows.</p> <p>OR 2 very subtle 1/2 expressions</p>	<p>“Everything in between”</p> <p>Only 2 facial regions show codable negativity simultaneously OR expression in one region is pronounced and lasts for most of the segment. OR single regions are engaged independently of one another, but for most of the segment.</p>	<p>Completely negative</p> <p>Negative expression occurs in all 3 facial regions simultaneously OR expression in 2 regions is pronounced and lasts for most of the segment.</p>

CODE ON MUTE

NEGATIVE PHYSICALITY

Every 5-second segment code the intensity:				
Modality:	None (Neutral)	Low	Medium	High
Interact key:	d “doing”	7	8	9
<p>Negative Physicality</p> <ul style="list-style-type: none"> - attempting to get the toy but not getting it - negative banging: <ul style="list-style-type: none"> - bump/bang of the body in protest - banging toy on the table - banging hands on the table <p>** In order to code negative banging, the banging action must be accompanied by a simultaneous negative face or vocalization.</p>	<p><i>Initial removal:</i> No struggling to hold on to the toy, either not holding or no resistance.</p> <p><i>Later segments:</i> Infant does not reach for the toy or struggle to get the toy/puppet. and No negative banging.</p>	<p>Low commitment, half-hearted</p> <p><i>Initial removal:</i> Infant shows some amount of resistance. As little as “sticky fingers” to holding as it’s taken, but not pulling.</p> <p><i>Later segments:</i> Infant reaches or is reaching for the toy with low intensity only (i.e., no movement of bending at the waist while reaching). <u>OR</u> Presence of negative banging without any struggle over the toy present in the segment.</p>	<p>“Everything-in-between”</p> <p><i>Initial removal:</i> Infant maintains a stronger grasp on the toy, holding it back from the puppet.</p> <p><i>Later segments:</i> Infant reaches or is reaching for the puppet/toy and doesn’t get it with medium intensity (i.e., forward movement at the waist toward the toy, or infant is already bent forward more than 90 degrees at the waist while reaching). Twisting or bending at the waist.</p> <p><u>OR</u> A low intensity struggle (identified in #1) with negative banging in the segment.</p>	<p>Fully committed</p> <p><i>Initial removal:</i> Continuous holding and pulling toy OR holding with intervals of high intensity effort to get/keep toy. Actively pulling, tugging the toy. Puppet is struggling.</p> <p><i>Later segments:</i> Infant reaches or is reaching with high intensity, however brief (i.e., lower body engaged, body propelling infant closer to toy, lunge, crawl across table). Infant’s butt comes off the caregiver’s lap.</p> <p><u>OR</u> A medium intensity struggle (identified in #2) with negative banging in the segment.</p>

CODE ON MUTE

NEGATIVE VOCALIZATIONS

Every 5-second segment code the intensity:				
Modality:	None (Neutral)	Low	Medium	High
Interact key:	s “saying”	4	5	6
Negative Vocalizations (distress, protest vocalization, whining, fussing, crying)	No distress. Infant either does not vocalize, vocalizes positively, or vocalization is neutral.	Lightly expressing displeasure Only 1 mild protest voc/distress verbalization which lasts for less than half the segment. "no" or "stop"	“Everything-in-between” 1 mild protest voc which lasts for more than half the segment "noooooooooo" OR two or more mild protest vocs "No, stop, I don't like it" OR 1 moderate protest voc, limited to a short (1-2 second) duration. "NO!!!"	Fully expressing displeasure, very expressive vocally Moderate protest voc(s) for most of the segment "NOOOOOOO!!!" OR any fussing/crying/continued negative whining OR full intensity cry/scream.

CODE WITH AUDIO ONLY, WITHOUT VIEWING VIDEO

	Not Present	Present
4th Category: Facial Irregularities Note any departure from the infant’s “normal”/neutral behavior that is not clearly identifiable as negative. For example, a twitch, tic, or long blink will be coded as facial irregularities.	Do not need to mark if not present	Interact key: /
5th Category: Infant Escape Arching, full body turn away, trying to climb down. Attempting to get away from the puppet, the interaction, or the situation overall.	Do not need to mark if not present	Interact key: *

Positive Emotion Coding for Puppet Study Interactions

Laura J. Sherman, Jackie Gross, and Jude Cassidy
University of Maryland

Unpublished coding manual

OVERALL GOAL STATEMENT:

Babies by 9 or 10 months old are already very social and interactive with others in their environment. Some are more emotional than others when interacting socially. Our goal in coding these interactions is to capture the infant's emotional experience with each puppet. As such, we are only interested in their relational emotion, that is, their emotion in connection to the puppet and not to outside factors like mom giving the baby a hug. Therefore, if a reaction is *clearly* attributable to an outside factor, it is not codeable. We use clues from infants' facial expressions, vocalizations, and physical movements, to infer certain things about their emotional states during these social interactions.

General information about this process:

Video Session to Code

Study 1) Sessions to code:

- Alternating Puppet Interactions:
Positive/Negative (starting order counterbalanced with at least three ~40 sec interactions each – look to see if there were additional sessions or sessions presented out of order)
- Inform your supervisor by e-mail if you notice anything different about the order or structure of the interactions.

Study 3) Sessions to code:

- Alternating Puppet Interactions, either:
 - a) Positive/Neutral (starting order counterbalanced with at least three ~40 sec interactions each – look to see if there were additional sessions or sessions presented out of order), or
 - b) Negative/Neutral (starting order counterbalanced with at least three ~40 sec interactions each – look to see if there were additional sessions or sessions presented out of order)
- Inform your supervisor by e-mail if you notice anything different about the order or structure of the interactions.

The Basic Emotions



Joy / Happiness

Your forehead is relaxed – most likely it remains neutral. It could show light wrinkles if eyebrows are lightly raised.

The corners of the mouth are curling up, sometimes showing the teeth. If someone's laughing out loud, the mouth is open. The cheekbones are lifted.

The eyes crinkle, crows feet may extend from outer corners. Eyes may appear squinted. Cheeks raise/bulge.



Anger (Frustration)

Your forehead is pushed together in a frown, pushing down the eyebrows. Furrowed brows: Bulging or vertical furrows between the eyes may be visible.

Sometimes mouth is open, with snarling lips and depressed corners of the mouth – squarish mouth (double Elvis lip) – or lips are closed, pressed or pursed together.

The eyes are bulging out, putting tension on the eyelids. May look tense or squinted. Your nostrils are standing out and the nose is wrinkled.



Sadness (Disappointment)

Inner corners of eyebrows move upward and together resulting in bulging/furrows in middle of forehead. The eyebrows are squashed together, and the forehead is frowning.

The corners of your mouth are depressed, often with a shaking lower lip.

The skin around your eyes is pulled in, and the eyes are tearing up (or even crying). Wrinkles are forming from the nostrils to the corners of your mouth.



Scared (Fear/Wariness) | Surprise which could

contain some fear

Eyebrows go up and then down again. Entire brow should be raised/neutral and drawn together. Brows may also look straighter across than usual. Faint horizontal furrows may be present in forehead.

Upper eyelid raises making the eyes appear wider. Eyes have tense appearance.

Your lips are stretched outwards, and your lower lip is pulled down. Lip corners are drawn straight back. Mouth is usually less than wide open.

Surprise: When you're surprised, your eye brows are pulled up high, making your eyes wide open, and your forehead wrinkled. Your mouth opens as your jaw muscles relax and your lower jaw drops.

Notes across all modalities:

Each 5-second segment will be coded for peak intensity (0 – 3) across three modalities (positive facial expressions, positive physicality, and positive vocalizations)

Each Segment Stands Alone

- Code each 5-second segment as a stand-alone segment. Meaning, for example, if a vocalization, reach, or facial expression begins in the first segment and continues into the second segment while maintaining low intensity, both segments would receive a code of 1 for that modality. If the intensity gets higher in the second segment, then code the first as a 1, and the second as high as observed. In another example, if an infant initiates a reach out toward the toy in segment 2 and then freezes with their arm still extended toward the toy, but isn't actively engaged in a forward reach, they are simply continuing in the reach, then code this based on its observed intensity. If at any point of the segment, the infant's arm is extended at the elbow toward the puppet/toy, then code some amount of physicality, even if the reach is ending and was only brief in the segment, as we are coding for the segment's peak intensity (see note immediately below).

Consider Intensity First, then Duration

- For each segment, always code for the peak intensity. Codes are a balance of severity and duration. For instance, a long medium (2 facial regions) expression that spans most of the segment is coded as a 3 in the same way that a single severe expression (all 3 facial regions) is coded as a 3. The peak intensity is considered first, that is, if an infant displays what is considered "medium" facial affect by showing emotion simultaneously in 2 regions, first think code a 2, but then, if the facial affect lasts for most of the segment, this will increase the code to a 3. So, duration can only bump up an existing peak intensity code.

*Code what you see, and use **clear** indicators to help: Sometimes you'll have missing data*

- Sometimes the infant's face will be obscured (for example, infant goes behind the picture-in-picture screen, turns away from the camera, camera falls, puppet is blocking the face, etc.). As long as you have seen the face at all (no matter how briefly) during the 5-second segment, you can code the peak intensity that you observed. (good examples: 10025 seg 4,1 and 10017). There may be other clear indicators for you to code the face (for example, infant engages 2 facial regions at the beginning of the segment and is vocalizing positively and reaching, thus being a medium for the face, but then goes behind the picture-in-picture window for the rest of the segment). As such, it is not possible to see the face in order to decide if the infant should be coded as high for the face...but, if the infant continues to vocalize and reach positively while covered by the picture-in-picture, you can code as high facial affect. Thus, you've identified the peak based on your brief observation, and you've used other clear indicators to decipher the duration of the facial expression.

*You will be coding positive emotion present during both the positive **and** negative interactions*

Babies commonly express positive emotion during interactions with both puppets. Be aware that we want to capture all positive relational emotional expressions, regardless of when they happen.

In addition to the peak intensity codes in the three modalities, 1 additional category will be marked in each 5-second segment ONLY if the behavior is observed. These codes are marked if the following types of behavior are present in the segment:

4th Category: Physical Matching/Mirroring: Present/Not Present: Indicate whether the infant and puppet have any physical matching or mirroring in each segment. For example: if the infant shakes the toy and then the puppet shakes in tandem, if the infant bangs the toy and then the puppet bounces up and down. Only mark that this occurred, not the quality of the interaction. You don't need to mark anything if this doesn't occur.

Positive Emotion Coding Checklist – Coding passes checklist

Code for each child in the order presented here. Finish all codes before moving on to coding the next child.

Positive Facial Expression – WATCH AND CODE ON MUTE. FOR EACH 5 S. SEGMENT:

1. Watch the 5-second segment to get overall impression of infant's expression
2. Watch the segment paying attention to the infant's **mouth/chin region**, and get an idea of any codeable expression. Ask, how big/open is the smile?
3. Watch again, paying attention to the infant's **eyes/nose/cheeks region**, and get an idea of any codeable expression. Are the eyes engaged? Crinkled? Cheeks bulging?
4. Watch again, paying attention to all regions – Watch as many times as necessary, and determine your code. Be observant!
6. Rewatch once more to confirm your code for that segment.

Complete Steps 1 – 6 for EACH 5-second segment across the entire puppet interaction procedure. That is, complete all of the Positive Facial Affect Modality.

Then, move on to coding Positive Physicality.

Positive Physicality – WATCH AND CODE ON MUTE, FOR EACH 5 S. SEGMENT:

1. Watch segment to get overall impression of infant's positive physicality AND whether you think physical matching/mirroring occurred.
2. Watch segment again paying attention to the infant's reaching behavior and determine how you would code the reaching behavior of that segment. Is the reaching positive or negative?
3. Watch segment again paying attention to the infant's banging (toy, body, and hands). Is the banging present simultaneously with a positive facial expression or vocalization? Determine how you would code the infant's banging.
4. Watch segment again paying attention to other positive physical movements: clapping, waving, sharing, etc. Where do those behaviors fall in the definitions?
5. Combine your idea for the code of reaching *and* banging to determine what your code would be for the 5-second segment. Re-watch the segment to confirm your overall code.
6. Finally, was physical matching/mirroring present in this segment? Code if

present.

Complete Steps 1 – 6 for EACH 5-second segment across the entire puppet interaction procedure. That is, complete all of the Positive Physicality Modality. Then, move on to coding Positive Vocalizations.

Positive Vocalizations – LISTEN AND CODE WITHOUT VIDEO IMAGE, FOR EACH 5 S. SEGMENT:

1. Listen to the segment to get overall impression of infant's vocalizations.
2. If a vocalization is present, listen to the segment again, paying special attention to the vocalizations. If they are definitively positive, determine your code. If there are neutral vocalizations, then view the video to see if they occurred in the presence of other positive cues, and determine your code.
3. Watch and LISTEN again, to confirm your code.

Positive Facial Expression:

*Coding tip: Because each baby differs in how expressive they are, use their neutral face as a baseline to judge their positive facial affect. Once you've identified a Neutral face for a particular baby, use that as a reference point if you are unsure of subtle facial expressions.

When it comes to coding positive facial affect, you are mostly focusing on the intensity of the infant's smile. In more intense smiles, the infants whole face will light up (crow's feet with extend out from the corners of the eyes, cheeks will bulge, and open smile will be observed).

Note: This is an ordinal scale. The distance between a 0 and a 1 is different than the distance between a 2 and a 3. This is how the scale should be conceptualized for the boundaries of the codes if there was an underlying continuous amount of positivity, the boundaries for coding would be:

None	Low	Medium	High
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Some definitions to help you code:

Brief smile = lasts less than half the segment (<2.5 seconds)

Mild smile = corners of mouth are only slightly upturned, mouth could be open or closed, and cheek/eye region is not significantly engaged

Whole face smile = corners of mouth are upturned, eyes become more narrow, crows' feet appear in the corners of the eyes, the upper part of the cheeks bulge and are lifted upward

Moderate smile = any smile which doesn't qualify for either mild or whole face. It's somewhere in between.

Intensity Codes for Positive Facial Expression:**None/Neutral – INTERACT key: f (“face”)**

No facial region shows codable positive expressions.

Face may be negative or show non-positive expressions or movements, such as the mouth opening and closing, the baby chewing, but lips are not upturned in any smile.

Low – INTERACT key: n**MILDLY POSITIVE**

To get a low score, all positive facial affect must be both brief and mild. The sum total of all seconds during which a smile occurred must be less than 2.5 seconds AND all smiles must qualify as "mild" (see definitions above). Most often, a mild smile will be closed mouthed, but it could be open. \

No engagement (i.e., crow’s feet crinkle) of the eye region. Infant’s face may shift briefly then return to neutral.

In the segment, the infant shows brief amusement/enjoyment.

Medium – INTERACT key: m**Global descriptor: MODERATELY POSITIVE (“EVERYTHING-IN-BETWEEN”)**

The medium score is used as a "catch all" for any score which does not qualify as being mild, but also does not yet meet criteria for a high score. This may include but is not limited to:

- a) moderate smile(s) which do not last for majority of the segment
- b) mild smile(s) which occur for at least half the segment.

High – INTERACT key: +**Global descriptor: COMPLETELY POSITIVE**

To get a high score, the 5 second segment must contain either: a) a "whole face smile" of any duration, b) a sum total of more than 2.5 seconds of moderate smiling (i.e., add up all the seconds during which a moderate smile occurred). See the definitions above for what is a moderate and/or whole face smile.

Positive Physicality:

Physical enjoyment of the interaction. Signs begin with general positive physicality which are coded in lower levels of the scale (e.g., expelling positive energy by bouncing, rubbing table, or banging hands/toy on table) and range up to positive physicality that are clearly routed in the puppet relationship and interacting (e.g., sharing the toy, waving, saying hi or bye).

Codeable behaviors to look for:

- attempting to reach the puppet (may include touching if puppet is close enough during the reach)
- pointing at the puppet
- handing the toy back to the puppet [sharing]
- waving “hi” or “bye”
- clapping
- arms waving excitedly/flapping

Lower level codeable behaviors (i.e., expelling of positive energy): The following behaviors will also be considered positive, but are lower level behaviors (because they’re not as social). They must be accompanied by simultaneous positive facial expression or vocalization to be considered positive, otherwise it could be boredom or frustration. If no other positive physical movement occurs in the segment beyond one of these, the highest rating the segment can get is a low. If some other positive physicality occurs in the segment, the presence of one (or more) of these behaviors would bump up the score one level. For example, if the infant reached for the puppet with medium-level intensity, and then bounced up and down in her seat while simultaneously smiling, then the segment would be coded as a high.

- positive banging
- bouncing in seat
- rubbing hands on the table

There are different sets of coding criteria during each interaction. First, observe how the infant reacts during the beginning of the interaction when the puppet removes the toy. These criteria are labeled as “*Initial removal.*” Then, during the remainder of the interaction use the criteria labeled “*Later segments.*”

Coding positive physicality during negative puppet interactions:

You may find it difficult to follow the guidelines for coding positive physicality during the negative puppet interaction. This is because it can be difficult to tell whether the child is reaching toward the puppet because she/he wants to interact with the puppet or because the child wants the toy but the puppet won’t share it. Use this guideline to tell whether the reach counts as “positive physicality”: If the child already has access to the toy and reaches toward the puppet, we can infer that she/he is reaching to interact with the puppet, which would be considered positive physicality. If the child reaches toward the puppet while the puppet is holding the toy and the child is simultaneously smiling or vocalizing positively, this would also be a positive

physical movement. If, however, the child reaches toward the puppet while not having access to the toy, does not get the toy, and is not smiling or vocalizing positively, this is considered a negative physical movement (and as such, would not be coded in this system).

Intensity Codes for Positive Physicality:

None (Neutral) – INTERACT key: g (“gross motor”)

Initial toy offer:

Infant does not make any movement toward the toy- does not accept the toy from the puppet. The puppet leaves it on the table. Sometimes the infant will then take the toy after the puppet has left the toy on the table and this would be considered under None/Neutral because there was no relational connection in giving and taking the toy.

Later segments:

No distinctly positive movements.

Low – INTERACT key: j

Global descriptor: Somewhat hesitant/mildly interested in playing with puppet

Initial toy offer:

Once the infant begins to accept the toy, he/she does so very slowly or reluctantly. Or may not actually reach for it, just accepts it. Imagine as if the infant is saying, “um.....ok” when the puppet tries to give the toy. This includes a hesitant/mild reach for the toy, even if infant doesn’t actually take it.

Sometimes the infant only takes the toy after the puppet has left the toy on the table and this would be considered under None/Neutral because there was no relational connection in giving and taking the toy.

Later segments:

A brief (less than half segment) low level reach to interact with puppet, or offers puppet the toy but puppet doesn’t take it. The infant will only reach with hand/arm (no upper body movement, aside from the shoulder which is connected to the arm). Imagine as if the infant is saying, “I’d like to touch you, oh, no, okay, that’s fine.”

OR

Expelling of positive physical energy, with no other signs of positive physicality.

Medium – INTERACT key: k

Global descriptor: “Everything-in-between”

Initial toy offer:

Infant reaches for and quickly takes the toy, but isn't obsessed with getting it. This includes a medium-level reach for the toy, even if infant doesn't actually take it.

Later segments:

Multiple or continued reaching for the puppet without body move OR a medium-level reach for any part of the segment. A medium-level reach involves a slight bend at the waist to get closer to the puppet during a reach. There is engagement of the upper torso during the reach. OR Arms waving/flapping (must be accompanied by positive voc or facial, otherwise, could be frustration). OR Pointing at the puppet. A medium code shows very positive physicality but it is not necessarily social in nature.

OR

Low physicality with expelling of positive physical energy also in the segment.

High – INTERACT key: 1**Global descriptor: Clearly excited to get the toy/play with puppet***Initial toy offer:*

Infant actively reaches for and accepts the toy. Clear physical excitement to receive the toy, such as flapping, bouncing, lunging. Imagine the infant saying, "yes! Give it! Give it! Give it!" This includes a clearly excited reach for the toy, even if the infant doesn't actually take it.

Later segments: An enthusiastic reach toward the puppet, which involves the infant's butt lifting off the caregivers lap to propel infant closer to puppet, almost a lunge toward puppet. OR any of the following: sharing the toy, clapping, waving to puppet.

OR

Medium physicality with expelling of positive physical energy also in the segment

Positive Vocalizations:

Positive vocalizations (vocs) are typically higher pitched than neutral vocalizations.

May have a lilt.

(Note: not a sigh). These include but are not limited to:

- cooing
- babbling
- squealing
- giggling
- laughing
- A positive vocalization will ALSO be defined as a neutral-sounding voc that is accompanied by simultaneous positive facial affect or positive physicality. If, while listening to the interaction without watching the screen, you hear a voc that sounds neutral, you must rewatch the segment to see whether positive facial affect or physicality occurred at the same time as the voc. If it did, the voc can now be considered officially "positive". Make sure, however, that the positive face/physicality occurred AT THE SAME TIME as the voc in question, and not simply within the same 5 second segment. Also make sure that the voc does not sound negative at all. It happens sometimes, although rarely, that a negative sounding voc will occur at the same time as a smile or some other positive indicator. This would not count as a positive voc.

Intensity Codes for Positive Vocalizations:

None (Neutral) – INTERACT key: h (“hi”)

No positive vocalization. Infant either does not vocalize, vocalizes negatively, or vocalizes neutrally (without being accompanied by a positive facial expression or positive physicality).

Low – INTERACT key: i

Global descriptor: Mildly positive

One brief mildly positive vocalization. Should be brief, a coo or gurgle. (although, a single very positive vocalization would be coded as a 3). Keep in mind that a neutral sounding voc will be considered positive if accompanied by simultaneous positive face or physicality.

Medium – INTERACT key: o

Global descriptor: “Everything-in-between”

More than 1 mild positive vocalization, OR a single mild positive vocalization that occurs for most of the segment OR a moderately positive vocalization. Babbling.
Keep in mind that a neutral sounding voc will be considered positive if accompanied by simultaneous positive face or physicality.

High – INTERACT key: p

Global descriptor: Completely positive and Very expressive

Very positive vocalizations, including squealing, any giggling or laughter.

POSITIVE FACIAL EXPRESSIONS

Every 5-second segment code the intensity:				
Modality:	None (Neutral)	Low	Medium	High
Interact key:	f "face"	n	m	+
<p>Positive Facial Expressions</p> <p><i>Important definitions:</i> <u>Brief</u> = < 2.5 sec <u>Mild</u> = corners of mouth only slightly upturned, mouth could be open or closed, and cheek/eye region is not engaged <u>Whole face smile</u> = corners of mouth upturned, eyes become more narrow, crows' feet in the corners of the eyes, the upper part of the cheeks bulge & are lifted upward <u>Moderate smile</u> = any smile which is somewhere in between mild and whole face.</p>	<p>No facial region shows codable positive expression.</p>	<p>Mildly positive</p> <p>All positive facial affect is both brief & mild. The sum total of all seconds during which a smile occurred is less than 2.5 sec AND all smiles qualify as "mild".</p> <p>No engagement (i.e., crow's feet crinkle) of the eye region. Infant's face may shift briefly then return to neutral.</p>	<p>"Everything-in-between"</p> <p>Code here if the intensity or length of the smile(s) do not fit criteria for either low or high scores. May include but is not limited to: a) moderate smile(s) which do not last for majority of the segment b) mild smile(s) which occur for at least half the segment.</p>	<p>Completely positive</p> <p>Either: a) a "whole face smile" of any duration, b) a sum total of more than 2.5 seconds of moderate smiling (i.e., add up all the seconds during which a moderate smile occurred).</p>

CODE ON MUTE

POSITIVE PHYSICALITY

Every 5-second segment code the intensity:				
Modality:	None (Neutral)	Low	Medium	High
Interact key:	g “gross motor”	j	k	l
<p>Positive Physicality</p> <p><i>Behaviors:</i> <i>Social Physicality:</i> - attempting to reach the puppet - handing the toy back to the puppet [sharing] - clapping, - pointing at the puppet - waving “hi” or “bye”</p> <p><i>Non-social expelling of positive energy:</i> - positive, excited banging - bouncing - waving arms excitedly - flapping</p> <p>* The non-social positive physicality can only be deemed <i>positive</i> if it occurs <u>simultaneously</u> with a positive facial expression or vocalization, otherwise it could be boredom or frustration.</p>	<p><i>Initial toy offer:</i> Infant does not make any movement toward the toy- does not accept the toy from the puppet. The puppet leaves it on the table.</p> <p><i>Later segments:</i> No distinctly positive movements.</p>	<p>Somewhat hesitant/ mildly interested in playing with puppet</p> <p><i>Initial toy offer:</i> Infant accepts the toy but slowly or reluctantly. Imagine “um...ok”</p> <p><i>Later segments:</i> A brief (less than half segment) low level reach to interact with puppet, OR offers puppet the toy but puppet doesn’t take it. Arm reach only. No upper body move.</p> <p>OR</p> <p>Expelling positive energy only in the segment, no social positive physicality.</p>	<p>“Everything-in-between”</p> <p><i>Initial toy offer:</i> Infant reaches for and quickly takes the toy, but isn’t obsessed with getting it.</p> <p><i>Later segments:</i> Multiple or continued reaching for the puppet with upper body movement (torso bend or twist) OR Arms waving/flapping (must be accompanied by positive voc or facial, otherwise, could be frustration). Pointing at the puppet.</p> <p>OR</p> <p>Low social positive physicality with expelling positive energy also in the segment.</p>	<p>Cleary excited to get the toy/play with puppet</p> <p><i>Initial toy offer:</i> Infant actively reaches for and accepts the toy. Clear physical excitement to receive the toy, such as flapping, bouncing, lunging. Imagine “yes! Give it! Give it! Give it!”</p> <p><i>Later segments:</i> Continued reach (majority of the segment) to interact with puppet or uses lower body to interact, OR any of the following: sharing the toy, clapping, waving to puppet.</p> <p>OR</p> <p>Medium social positive physicality with non-social expelling of positive energy also in the segment.</p>

CODE ON MUTE

POSITIVE VOCALIZATIONS

Every 5-second segment code the intensity:				
Modality:	None (Neutral)	Low	Medium	High
Interact key:	h “hi”	i	o	p
<p>Positive Vocalizations Positive vocalizations are typically higher pitched than neutral vocalizations. May have a lilt. (Note: not a sigh)</p> <ul style="list-style-type: none"> - cooing - babbling - squealing - giggling - laughing - neutral-sounding voc that happens at the same time as positive face or positive physicality will be considered positive. 	<p>No positive vocalization. Infant does not vocalize, vocalizes negatively, or vocalizes neutrally without accompanying positive face or physicality.</p>	<p>Mildly positive</p> <p>One brief mildly positive vocalization. Should be brief, a coo or gurgle. (although, a single <u>very</u> positive vocalization would be coded as a 3).</p>	<p>“Everything-in-between”</p> <p>More than 1 mild positive vocalization, OR a single mild positive vocalization that occurs for most of the segment OR a moderately positive vocalization (such as a single giggle sound). Babbling.</p>	<p>Completely positive and Very expressive</p> <p>Very positive vocalizations, including squealing, any giggling or laughter (2 or more syllables).</p>

CODE WITHOUT VIDEO UNLESS YOU NEED TO CHECK A NEUTRAL-SOUNDING VOC

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