



# At the Intersection of Social and Cognitive Development: Internal Working Models of Attachment in Infancy

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## Abstract

Three visual habituation studies using abstract animations tested the claim that infants' attachment behavior in the Strange Situation procedure corresponds to their expectations about caregiver–infant interactions. Three unique patterns of expectations were revealed. Securely attached infants expected infants to seek comfort from caregivers and expected caregivers to provide comfort. Insecure-resistant infants not only expected infants to seek comfort from caregivers but also expected caregivers to withhold comfort. Insecure-avoidant infants expected infants to avoid seeking comfort from caregivers and expected caregivers to withhold comfort. These data support Bowlby's (1958) original claims—that infants form internal working models of attachment that are expressed in infants' own behavior.

*Keywords:* Internal working models; Attachment; Infant cognition; Individual differences

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## 1. Introduction

Some infants readily seek and accept comfort from their caregivers. Others do not. Where one infant might rush to greet her returning mother, another infant might just as easily turn away. Where one infant might seek reassurance when upset, another might refuse to be comforted. More than 30 years ago, developmentalist Mary Ainsworth designed a semi-naturalistic laboratory procedure to capture these individual differences (Ainsworth, Blehar, Waters, & Wall, 1978). This procedure has come to be known as the Strange Situation and remains the gold standard in the field today.

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Ainsworth's work was grounded in the theories of John Bowlby (1958, 1982), who, guided by ethological theory (Harlow, 1958; Hinde, Thorpe, & Vince, 1956; Lorenz, 1950), proposed a behavioral system that harnessed infants' feelings of safety or threat to regulate their proximity to their caregivers and thereby promote infant survival. Inspired as well by early cognitive theory (Craik, 1943; Piaget, 1954), Bowlby (1982) proposed that this behavioral system was accompanied by internal working 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 all the others.

These internal working models were thought to influence the child's subsequent processing of social experiences and allow the child to anticipate, plan for, and adapt to his or her social world. It was these internal working models that Ainsworth's Strange Situation was intended to capture.

Hundreds of studies now testify to the robustness of the classifications described in Ainsworth's original descriptions and indeed to the distinct parenting behaviors that accompany each (Cassidy & Shaver, 2008; De Wolff & van Ijzendoorn, 1997). According to those original descriptions (Ainsworth et al., 1978), infants who most easily seek and accept comfort from their parents are considered *secure* in their attachments and are more likely to have received sensitive and responsive caregiving than other infants. Infants who are reluctant to seek comfort are considered *insecure-avoidant* and are more likely to have experienced consistent rejection from their parents. Finally, infants who seek comfort from their caregivers but struggle to accept the comfort that is offered are considered *insecure-resistant* and are more likely to have received inconsistent parenting: sometimes responsive and sometimes unresponsive.

Despite researchers' success in showing the association between parenting behaviors and infants' behavior in the Strange Situation, this research area has not been without controversy, including controversy over whether internal working models actually exist in infancy. Researchers working with older populations, such as preschoolers, school-age children and adults, have developed assessment tools for internal working models with relative representational face-validity—that is, language-based tasks in older children and adults or symbolic play in preschoolers (Bretherton, Ridgeway, & Cassidy, 1990; Main, Kaplan, & Cassidy, 1985; see also Bretherton, 2005, for a recent review of the representational view of attachment). The assessment tools in infancy, however, have remained steadfastly in the realm of naturalistic behavior, with their relationship to representational models taken somewhat on faith (Ainsworth et al., 1978; Waters & Deane, 1985). This has led to assessment behaviors that are uncomfortably entwined with the very behaviors they are intended to explain. In addition, these very behaviors, for instance, proximity-seeking, reactivity, and ease of soothability, can and have been invoked in other theoretical taxonomies, particularly those concerning temperament (Kagan, 1984; Rothbart, 1981; Thomas & Chess, 1977). Kagan (1984) offered one of the most skeptical critiques of attachment theory. The three classes of organized attachment behavior described by Ainsworth, Kagan argued, are the inevitable outcome of placing children of varying degrees of reactivity and inhibition in a novel

and frightening situation, and thus have more to do with temperament than any presumed internal working models of caregiver–infant relations.

The reliance on ambiguous behavioral methods in infancy, though problematic, is perhaps understandable. 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. The visual habituation technique in particular, adapted from developmental vision science, has been used with great effect to demonstrate the robustness of infants' representations of the worlds.

The visual habituation paradigm exploits the fact that infants tend to look longer at novel (or unexpected) events than at familiar (or expected) events (Spelke, 1985). Generally speaking, if infants are shown a display repeatedly, their looking times will decline, presumably as a result of increasing familiarity with the display. Infants' visual attention to a new display will recover to the degree that they find it novel or different from the original. This fact can be used to tease apart the possible interpretations that infants assign to the events depicted in the displays.

Using this and similar methods, we now know that well before the emergence of language or symbolic play, infants represent fundamental, core aspects of the world (Carey, 2008). Infants represent the spatiotemporal continuity of physical objects and actions (Baillargeon, 2004; Spelke, 1991). They represent the relative sizes of sets and can perform simple computations across them (Carey, 2008; Wynn, 1995; Xu, Spelke, & Goddard, 2005). They represent the goals of humans (Woodward, 1998) and nonhumans (Johnson, 2003) and they can evaluate the rational means for achieving simple goals (Gergely, Na'dasdy, Csibra, & Bíró', 1995). Infants have even been shown to evaluate whether the interactions between two generic agents are positive or negative and prefer to interact with the positive agent (Hamlin, Wynn, & Bloom, 2007; Kuhlmeier, Wynn, & Bloom, 2003). The world, as represented by infants, may be simpler than the world of adults, but it is representationally rich and coherent.

Although this method has been used largely to explore universal developmental differences, there are no logical reasons to prevent its use in the service of individual differences. Recently, we reported the first successful use of this method to address individual differences in the domain of attachment relationships (Johnson, Dweck, & Chen, 2007). In this study, a small exploratory number of infants were habituated to an animated display of an abstract infant figure (depicted by a small oval) becoming distressed when left behind by a caregiver (depicted by a large oval). Once habituated, the infants were shown two outcomes of the infant's distress: one in which the caregiver returned to the crying infant and another in which the caregiver ignored the crying infant by moving farther away. Our securely attached infants, as assessed in the traditional Strange Situation, looked relatively longer at the test event that was most unfamiliar or unexpected to them—the one in which the caregiver ignored the crying infant—compared with the insecurely attached infants. The expectations of insecurely avoidant and insecurely resistant infants did not differ from each other in this initial test, nor did they seem to distinguish between the two events. However, because of the small number of infants tested, it was difficult in this initial sample to draw firm conclusions about the exact expectations of the insecurely attached infants.

In the studies described here, we again used animated displays of generic infants and caregivers to explore infant participants' expectations of caregiver–infant interactions. In the first study, we report a recap and extension of the data in Johnson et al. (2007). Additional infants were added to the original data set and further statistical analyses were performed in order to clarify the insecurely attached infants' expectations of a caregiver's responsiveness to the distress of an infant. In the second study, we tested infants' expectations of the responsiveness of a distressed infant to a returning caregiver. In the third study, we tested infants' expectations for whom a distressed infant will approach given the choice between responsive and unresponsive caregivers. In all three studies, infant participants' expectations of the animated characters were compared with the infants' own behavior and classifications in the Strange Situation.

## 2. Study 1: Recap and extension of Johnson et al. (2007)

Attachment theorists argue that individual differences in infants' behavior in the Strange Situation are associated with different expectations of how caregivers behave (Ainsworth et al., 1978). Johnson et al. (2007) reported exploratory findings in a visual habituation study in support of this claim. Study 1 includes and extends the data reported in Johnson et al. (2007) by increasing the original sample size and thus the power needed to test specifically whether (a) secure infants expect caregivers to be responsive to their signals of distress and (b) insecure infants expect caregivers to be unresponsive.

### 2.1. Participants

Thirty-three infants (13 males) participated ( $M = 407$  days,  $SD = 40$  days). Twenty-three additional infants were tested in the visual habituation procedure but were excluded for failing to complete the procedure (7), experimental error (3), or failure to habituate (13). Families were recruited from a commercial mailing list of new parents in the San Francisco Bay area. All parents gave their written, informed consent. A subset of these data were reported in Johnson et al. (2007).

### 2.2. Methods

Infants participated in two procedures: a visual habituation test of social expectations and the Strange Situation (Ainsworth et al., 1978). The visual habituation test was always conducted first.

#### 2.2.1. Social expectations visual habituation procedure

The infant was seated on her caregiver's lap in a small darkened room 54 inches in front of a floor-to-ceiling room divider made of black curtain. Embedded at eye level in the room divider was a  $28 \times 19$ -inch rear projection video screen. Caregivers were instructed to close their eyes.

We used the Xhab software (Pinto, 1996) to record infants' looking time in an infant-controlled visual habituation procedure. Coders began recording infants' looking time in both the habituation and test phases after the action in the display was completed as signaled by a bell. A trial record was initiated only when the infant looked at the still display continuously for more than 0.5 s and ended when the infant looked away for 2 continuous seconds or 120 s had elapsed. Infants were considered habituated when the total looking time of three consecutive trials declined to half of the looking time of the first three consecutive trials whose sum exceeded 12 s. Test trials began immediately after habituation was reached. Infants who failed to habituate within 14 trials (the standard limit) were excluded.

Fig. 1 shows schematics of the abstract separation and reunion events in the habituation and test trials. Each trial opened with a blank blue screen. After 4 s, a bell rang to get the infant's attention and the video appeared. In the habituation event, two animated circles enacted a separation event. The large "mother" and small "infant" appeared together at the bottom of a steep incline. The mother traveled halfway up the incline to a small plateau, leaving the infant behind. As the mother came to rest, the infant below began to cry, an event depicted by a slight pulsation and bouncing and an actual human infant cry. The animation then paused and a bell signaled the coders to beginning recording. The entire animation spanned 5 s.

When an infant reached habituation, two test events were shown twice each in counter-balanced order. Each test event opened with the mother still positioned halfway up the incline, as the infant continued to cry. In the responsive outcome, the mother returned to the infant. In the unresponsive outcome, the mother ignored the infant's cries and continued up the slope. The two events were equivalently paced and spanned 5 s. The same soundtrack of a crying infant was added to each.

Twenty-six of the infants (79%) were double-coded for looking time by trained coders who were blind to the events observed by the infants. The coders achieved a Cohen's kappa of .75. The coders were also blind to the attachment status of the infants.

### Habituation Event: Separation



### Test Events:

#### Responsive Caregiver



#### Unresponsive Caregiver



Fig. 1. Schematics of the displays in Study 1.

### 2.2.2. *Strange Situation procedure*

The procedure described by Ainsworth et al. (1978) was used to classify infants by attachment status. This involved eight standardized episodes of 3 min or less in which the infant was introduced to a novel room with toys and a stranger. The caregiver then left the infant alone, either with the stranger or by herself depending on the episode. The infant's behavior upon each of two reunions with the caregiver was coded for proximity-seeking, contact maintenance, avoidance, and resistance. These behaviors were used to classify infants as secure, insecure-avoidant, or insecure-resistant. A primary coder, trained and certified by the University of Minnesota's Institute for Child Development Attachment Workshop, and blind to infants' looking time performances, classified the attachment status of all the infants from videotapes. A second coder coded 20 of the tapes (61%) and achieved a Cohen's kappa of .69. Disagreements were resolved through discussion. Eighteen of the infants were classified as secure (B), eight as insecure-avoidant (A), and seven as insecure-resistant (C).

## 2.3. *Results*

### 2.3.1. *Habituation trials*

On average, infants habituated to the separation display in 9.4 trials ( $SD = 2.9$ ). This number did not vary by attachment status (secure infants = 8.9 trials [ $SD = 3.3$ ], insecure-avoidant infants = 9.9 trials [ $SD = 2.3$ ], and insecure-resistant infants = 9.9 trials [ $SD = 2.4$ ],  $F < 1$ ). Infants completed the habituation process with average looking times of 5.6 s ( $SD = 4.2$ ) over the last three trials. This number also failed to differ by attachment status (secure infants = 6.2 s [ $SD = 5.2$ ], insecure-avoidant infants = 4.7 s [ $SD = 3.2$ ], and insecure-resistant infants = 5.0 s [ $SD = 2.1$ ],  $F < 1$ ).

### 2.3.2. *Test trials*

The same strategy was used in all three studies to examine infants' reactions to the test trials, so we explain this in detail here. Analyses were performed in three phases. First, we compared the two insecure groups with each other to determine whether their responses to the different test outcomes were the same or different. Second, we compared the resulting group(s) from the first analysis to the secure infants. In both of these phases, we used repeated-measure analyses of variance (ANOVAs) to compare responses to the two types of test outcomes across the attachment groups, with particular attention paid to potential interactions. We also used chi-square analyses to test whether the number of infants who looked longer at one outcome than the other differed across groups. Finally, intragroup analyses were used to explore the pattern of results within each group. For these we used paired  $t$  tests.

Mean looking times to each test outcome were calculated for each infant. Overall, infants looked at the responsive test outcomes for 7.6 s ( $SD = 5.6$ ) and the unresponsive test outcomes for 7.6 s ( $SD = 5.7$ ). When grouped by attachment status, however, the securely attached infants looked for 6.7 s ( $SD = 5.6$ ) at the responsive test outcome and 8.9 s ( $SD = 6.9$ ) at the unresponsive one; insecure-avoidant infants looked 9.0 s ( $SD = 7.0$ ) and

5.0 s ( $SD = 2.2$ ), respectively, and insecure-resistant infants looked 8.0 s ( $SD = 3.6$ ) and 7.0 s ( $SD = 4.3$ ).

Preliminary analyses found no influence of test order or infants' gender on looking times, so these variables were removed from further analyses.

*2.3.2.1. Initial comparison of insecure subtypes—Avoidant versus resistant:* By hypothesis, resistant and avoidant infants share the expectation that their own caregiver will be unresponsive to their needs. To test whether they also shared the same expectations of our animated caregiver, a repeated-measure ANOVA with test outcome and attachment status was performed. As predicted, no difference in how the two groups treated the test outcomes was found,  $F < 1$ . The two insecure groups were therefore collapsed into a single group with looking times of 8.6 s ( $SD = 5.5$ ) to the responsive outcomes and 5.9 s ( $SD = 3.4$ ) to the unresponsive outcomes. These aggregated results were then compared with those of secure infants.

*2.3.2.2. Main comparison of all infants—Secure versus insecure:* Also by hypothesis, secure and insecure infants have different expectations about the responsivity of their own caregiver. Unlike insecure infants, secure infants are thought to expect their caregivers to be responsive. A repeated-measure ANOVA was used to test whether this difference would hold with our animated caregivers. As predicted, securely attached infants looked relatively longer at outcomes in which the caregiver ignored the infant's cries, while insecurely attached infants looked relatively longer at outcomes in which the caregiver responded,  $F(1,31) = 9.78$ ,  $p = .004$ , partial  $\eta^2 = .24$ . No main effects of either variable were found (see Fig. 2).

To test whether these results were representative of the entire group of infants, we performed a nonparametric analysis. Thirteen of the 18 securely attached infants looked longer

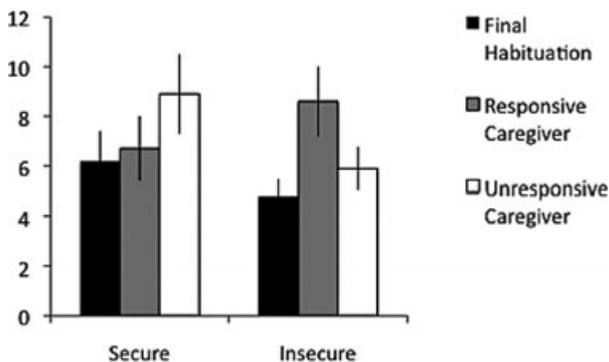


Fig. 2. Results from Study 1. The black bars show the average looking time to the last three habituation trials. The gray bars show the average looking time to the two responsive test trials. The white bars show the average looking time to the two unresponsive test trials. Looking times are in seconds. Error bars show the standard errors.

when the caregiver was unresponsive, while 11 of the 15 insecurely attached infants (6 of 8 avoidant and 5 of 7 resistant) looked longer when the caregiver was responsive,  $\chi^2(n = 33) = 6.80, p = .009$ .

*2.3.2.3. Within-group comparisons:* Preplanned, paired *t* tests were used to gauge the strength of each group's responses in its own right, as opposed to relative to each other. Indeed, securely attached infants found the caregiver's unresponsive behavior more unexpected than the responsive behavior and looked significantly longer at it,  $t(17) = 2.37, p = .03$ . They also tended to dishabituate to the caregiver's unresponsive behavior,  $t(17) = 1.91, p = .07$ , but not responsive behavior,  $t(17) = .41, p = .68$ , where dishabituate is defined as a significant recovery of attention to a test event compared with habituation. Conversely, insecurely attached infants showed the opposite pattern of results. These infants found the caregiver's responsive behavior unexpected, as evidenced by their dishabituation to those test trials,  $t(14) = 2.89, p = .01$ , though not the unresponsive test trials,  $t(14) = 1.42, p = .18$ . They also found the responsive behavior somewhat more unexpected than the unresponsive behavior,  $t(14) = 2.06, p = .06$ .

#### 2.4. Summary of Study 1

The results of the current analyses reinforced and clarified the findings from Johnson et al. (2007) that infants' expectations of a caregiver's responsiveness differ depending on their own attachment status. The extra infants tested also provided enough power to detect significant patterns within each group. Securely attached infants expected the caregiver to respond to an infant's cries and were surprised when it instead ignored the infant. Insecurely attached infants showed the opposite pattern of results. Once again, however, despite the increased power, we found no significant differences between the insecurely avoidant and insecurely resistant infants, reconfirming that the two groups share an expectation of unresponsive caregivers.

### 3. Study 2

In the recap and extension of Johnson et al. (2007) presented in Study 1, we showed that infants' expectations of a generic caregiver match their own presumed expectations in the Strange Situation. The goal of Study 2 was to test whether their expectations of a generic infant would match their own behavior in the Strange Situation. Both secure and insecure-resistant infants are eager to approach caregivers during reunion, while insecure-avoidant infants are reluctant. Thus, we predicted that, unlike Study 1, the two insecure groups would differ from each. Instead, insecure-resistant infants should share the expectations of secure infants, with both groups expecting the infant to approach the caregiver and both finding withdrawal by the infant to be unexpected. Insecure-avoidant infants should show the opposite expectations, looking longer at outcomes in which the infant approaches the caregiver and less when the infant withdraws.

### 3.1. Participants

Thirty infants (15 males) participated ( $M = 381$  days,  $SD = 12$  days). Twenty-nine additional infants were tested in the visual habituation procedure but were excluded for failing to complete the procedure (10), experimental error (4), or failure to habituate (15). Families were recruited from a commercial mailing list of new parents in the San Francisco Bay area. All parents gave their written, informed consent.

### 3.2. Methods

Infants participated in two procedures: a visual habituation test of social expectations and the Strange Situation. The visual habituation test was always conducted first.

#### 3.2.1. Social expectations visual habituation procedure

The visual habituation procedure was the same as that described in Study 1. The animated events are depicted in Fig. 3. Infants were again habituated to a separation event involving a caregiver and infant. In this version, when the infant cried, the caregiver responded by returning; however, the event paused before the caregiver reached the infant. The entire event lasted 9 s. The two test events varied the infant's reaction to the caregiver's return. As a reminder of the initial separation, the test events both opened with the infant crying out to the caregiver at the top of the hill, who immediately returned to the bottom of the hill. In the Responsive outcomes, the infant figure approached the caregiver. In the Unresponsive outcomes, the infant figure withdrew. As before, the timing of the two events was identical and both began with the same cry of a human infant. They lasted 7 s.

Trained coders who were blind to the computer events and the infants' attachment status double-coded the looking times of 16 of the infants (53%) for a Cohen's kappa of .72.

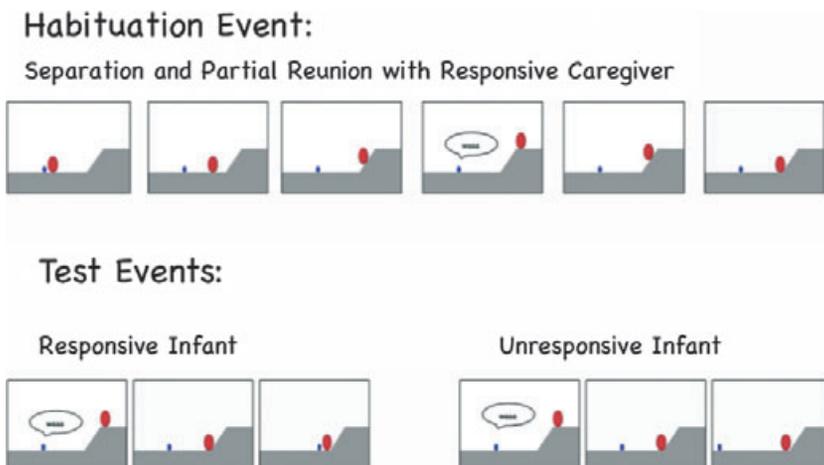


Fig. 3. Schematics of the displays in Study 2.

### 3.2.2. *Strange Situation procedure*

The Strange Situation was again used to assess attachment status. The primary coder, blind to looking time performances, classified the attachment status of all the infants. A secondary coder coded a subset of 20 tapes (54%). Eighty-eight percent agreement was achieved, Cohen's kappa = .79. Fourteen were classified as secure (B), seven as insecure-avoidant (A), and nine as insecure-resistant (C).

## 3.3. *Results*

### 3.3.1. *Habituation trials*

On average, infants habituated to the partial reunion display in 8.4 trials ( $SD = 2.3$ ). This number did not vary by attachment status (secure infants = 7.6 trials [ $SD = 2.1$ ], insecure-avoidant infants = 9.0 trials [ $SD = 1.1$ ] trials, and insecure-resistant infants = 9.2 trials [ $SD = 1.6$ ]),  $F = 1.7$ , *ns*. Infants completed the habituation process with average looking times of 5.0 s ( $SD = 2.5$ ) over the last three trials. This number also failed to differ by attachment status (secure infants = 5.4 s [ $SD = 3.0$ ], insecure-avoidant infants = 4.7 s [ $SD = 1.6$ ], and insecure-resistant infants = 4.7 s [ $SD = 2.5$ ]),  $F < 1$ .

### 3.3.2. *Test trials*

Mean looking times to each test outcome were calculated for each infant. Overall, infants looked at the Responsive Infant test outcomes for 4.4 s ( $SD = 2.2$ ) and the Unresponsive Infant test outcomes for 4.8 s ( $SD = 2.4$ ). When grouped by attachment status, the securely attached infants looked for 3.5 s ( $SD = 2.0$ ) and 4.7 s ( $SD = 2.4$ ), respectively; insecure-avoidant infants looked 6.7 s ( $SD = 1.7$ ) and 4.4 s ( $SD = 2.1$ ), respectively; and insecure-resistant infants looked 3.9 s ( $SD = 1.5$ ) and 5.3 s ( $SD = 2.9$ ).

The same three-phase analysis strategy was used as in Study 1. Preliminary analyses found no influence of test order or infants' gender on looking times, so these variables were removed from further analyses.

*3.3.2.1. Initial comparison of insecure subtypes—Avoidant versus resistant:* Based on infants' own behavior in the Strange Situation, we predicted that resistant and avoidant infants would respond differently to these displays. As predicted, the resistant group looked relatively longer at test outcomes in which the animated infant withdrew from the caregiver, while the avoidant infants looked relatively longer when the animated infant approached the caregiver,  $F(1, 14) = 6.07$ ,  $p = .027$ , partial  $\eta^2 = .30$ . Therefore, the two insecure subtypes were kept separated in further analyses. No other effects were found (see Fig. 4).

*3.3.2.2. Main comparison of all infants—Secure versus insecure:* Because secure infants also actively seek to engage their caregivers at reunion, we predicted that their responses would resemble those of the resistant infants, but not those of the avoidant infants. These predictions were confirmed. Together, the secure and resistant infants looked longer at the unresponsive infant who withdrew from the caregiver than the responsive infant who approached the caregiver,  $F(1,21) = 5.93$ ,  $p = .024$ , partial  $\eta^2 = .22$ , and

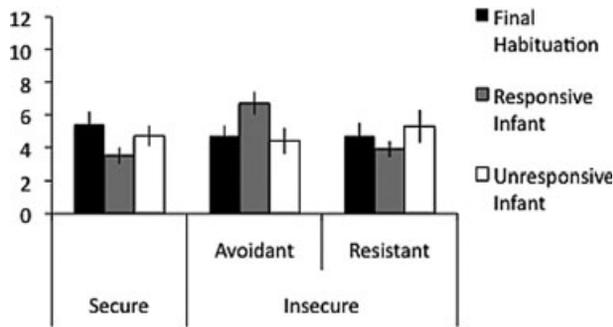


Fig. 4. Results from Study 2. The black bars show the average looking time to the last three habituation trials. The gray bars show the average looking time to the two responsive test trials. The white bars show the average looking time to the two unresponsive test trials. Looking times are in seconds. Error bars show the standard errors.

they did so to the same extent. However, compared with secure infants, the avoidant infants looked relatively longer at the responsive than unresponsive infant,  $F(1,19) = 10.35$ ,  $p = .005$ , partial  $\eta^2 = .35$ . There were no group effects on the duration of looking in general.

Nonparametric chi-square analyses revealed the same pattern of results. Twelve of the 14 securely attached and 6 of the 9 resistantly attached infants looked longer when the infant withdrew from the caregiver,  $\chi^2(n = 23) = 1.17$ , *ns*. However, 5 of the 7 avoidantly attached infants looked longer when the infant approached the caregiver, which was significantly different than the distribution seen in the secure infants,  $\chi^2(n = 21) = 6.86$ ,  $p = .009$ .

**3.3.2.3. Within-group comparisons:** As in Study 1, paired *t* tests were used to examine the responses of each group separately, though given the results reported earlier, we collapsed the secure and resistant infants into a single group.

Together, secure and resistant infants looked significantly longer when the animated infant withdrew at the caregiver's return than when it approached,  $t(22) = 2.50$ ,  $p = .021$ . These infants also showed a significant decrease in looking to the responsive test outcomes compared with the last three Habituation trials,  $t(22) = 2.28$ ,  $p = .033$ . However, they showed no change in looking to the unresponsive, withdrawal outcomes,  $t(22) = .27$ ,  $p = .79$ .

Interpretation of the avoidant infants' looking behavior is more tenuous given the small sample size of only seven infants. Nonetheless, the results were in the predicted direction. This group showed a marginal tendency to look longer during trials when the animated infant approached the caregiver than when it withdrew,  $t(6) = 2.16$ ,  $p = .074$ . When the comparison was limited to just the first two test trials, the *p* value fell slightly to .06. When only the last habituation and first pair of test trials were included, avoidant infants dishabituated to the test events in which the animated infant approached the caregiver,  $t(6) = 3.48$ ,  $p = .013$ , but not when the infant withdrew,  $t(6) = .51$ ,  $p = .63$ .

### 3.4. Summary of Study 2

Again, infants' expectations varied with their attachment status. However, unlike Study 1 the two insecure groups did not share the same expectations. When reasoning about the infant's behavior rather than the caregiver's, resistant infants resembled the secure infants. Both found the infant's withdrawal from a returning caregiver unexpected. Avoidant infants found the infant's withdrawal unremarkable but found the infant's approach to the caregiver relatively unexpected. In all three groups, infants' expectations mirrored their behavior in the Strange Situation.

## 4. Study 3

Studies 1 and 2 found attachment-related differences in infants' expectations of caregiver behavior and infants' expectations of infant behavior. The goal of Study 3 was to test the robustness of these expectations as they apply to slightly different caregiver–infant scenarios. Specifically, we tested whether infants would again discriminate between responsive and unresponsive caregivers and now form expectations about which one the infant character would choose to approach when both are present.

### 4.1. Participants

Thirty-five infants (20 males) participated ( $M = 376$  days,  $SD = 10$  days) in this study. Thirty-four additional infants were tested in the visual habituation procedure but were excluded for failing to complete the procedure (15), experimental error (5), or failure to habituate (14). Families were recruited from a commercial mailing list of new parents in the San Francisco Bay Area. All parents gave their written, informed consent.

### 4.2. Methods

Infants again participated in a visual habituation test of social expectations and the Strange Situation. The visual habituation test was always conducted first.

#### 4.2.1. Social expectations visual habituation procedure

Infants were habituated to an alternating sequence of two events in this study. The events copied the responsive and unresponsive caregiver test trials in Study 1, with one main exception. In this case, the two caregivers were given distinct colors and shapes (a red triangle for the responsive caregiver and a green rectangle for the unresponsive caregiver) so that infants could track which one was which across trials and test events. We counterbalanced which caregiver was presented first across infants. Each event lasted 6 s.

After infants habituated they were presented with two test events, twice each in counterbalanced order. Both events opened with the two caregivers positioned at the top left and top right of the screen with the infant positioned halfway between them at the bottom. When

the trial began, the infant cried and approached one or the other of the two caregivers. In both cases, the caregivers were still and silent throughout. The events lasted 5 s each (see Fig. 5).

Fifteen of the infants (43%) were double-coded by trained coders who were blind to the computer events and infants' attachment status. Coders achieved 88% agreement with a Cohen's kappa of .72.

4.2.2. Strange Situation procedure

The Strange Situation was used to assess attachment status. The primary coder, blind to looking performances, coded the videotapes of all infants. A secondary coder coded a subset of 18 tapes (51%). Eighty-one percent agreement was achieved, Cohen's kappa = .69. Twenty were classified as secure (B), eight as insecure-avoidant (A), and seven as insecure-resistant (C).

4.3. Results

On average, infants habituated to the alternating caregiver displays in 9.4 trials ( $SD = 2.5$ ). This number did not vary by attachment status (secure infants = 9.2 trials [ $SD = 2.4$ ], insecure-avoidant infants = 9.2 trials [ $SD = 2.5$ ], and insecure-resistant infants = 10.1 trials [ $SD = 3.1$ ],  $F < 1$ ). Infants completed the habituation process with average looking times of 5.2 s ( $SD = 2.5$ ) over the last three trials. This number also failed to differ by attachment status (secure infants = 5.7 s [ $SD = 2.8$ ], insecure-avoidant infants = 5.2 s [ $SD = 1.9$ ], and insecure-resistant infants = 4.0 s [ $SD = 1.6$ ],  $F = 1.2, ns$ ).

Habituation Event:

Alternating Responsive Caregiver and Unresponsive Caregiver



Test Events:



Fig. 5. Schematics of the displays in Study 3.

Mean looking times to each test outcome were calculated for each infant. Overall, infants looked at the Responsive test outcomes for 6.5 s ( $SD = 3.9$ ) and the Unresponsive test outcomes for 6.9 s ( $SD = 4.4$ ). When grouped by attachment status, the securely attached infants looked for 5.6 s ( $SD = 3.1$ ) and 7.8 s ( $SD = 4.9$ ), respectively; insecure-avoidant infants looked 9.0 s ( $SD = 5.5$ ) and 7.2 s ( $SD = 3.3$ ), respectively; and insecure-resistant infants looked 6.4 s ( $SD = 3.1$ ) and 3.7 s ( $SD = 2.5$ ). Preliminary analyses found no influence of infants' gender, order of habituation events, or order of test events on looking times, so these variables were removed from further analyses.

#### 4.3.1. Initial comparison of insecure subtypes: Avoidant versus resistant

As in the first two studies, we first compared the two insecure groups with each other with a repeated-measure ANOVA. The results of Study 1 suggested that both groups of insecure infants distinguished between the responsive and unresponsive caregiver and found the unresponsive caregiver the more familiar one. Thus, both groups should find interactions with the responsive caregiver more unexpected than interactions with the unresponsive caregiver. In addition, however, the results of Study 2 suggested that the avoidant infants also found infant approach behavior unexpected, even to the somewhat responsive caregiver in that study. Thus, we might expect the avoidant infants to find *both* of these test events unexpected and worthy of increased attention.

The results suggest both possibilities are true. In general, both groups attended more when the infant approached the responsive caregiver than the unresponsive caregiver, though only marginally. Importantly, both groups did so to the same degree, that is, there was no group by outcome interaction,  $F < 1$ . However, consistent with their response to the animated infant's approach behavior in Study 2, avoidant infants looked longer at the test events overall than did the resistant infants (8.1 s [ $SD = 3.1$ ] vs. 5.1 s [ $SD = 2.2$ ], respectively),  $F(1, 13) = 4.67$ ,  $p = .05$ , partial  $\eta^2 = .26$ .

Nonetheless, because the two subgroups of insecure infants responded in the same relative manner to the two test outcomes, we collapsed them for the purpose of the comparison to secure infants. As a group, insecure infants looked at the responsive outcomes for 7.8 s ( $SD = 4.6$ ) and the unresponsive outcomes for 5.6 s ( $SD = 3.4$ ) (see Fig. 6).

#### 4.3.2. Main comparison of all infants: Secure versus insecure

As in Study 1, we predicted that secure and insecure infants would have opposite reactions to the test outcomes. Specifically, we predicted that secure infants would find approaches to the unresponsive caregiver relatively more unexpected and look longer at those while insecure infants would do the reverse. As in Study 1, this prediction was confirmed,  $F(1, 33) = 7.02$ ,  $p = .012$ , partial  $\eta^2 = .18$ . No main effect of either attachment status or test outcome was found.

A nonparametric chi-square analysis revealed a pattern in the predicted direction, though it did not reach significance. Thirteen of the 20 securely attached infants looked longer when the infant approached the unresponsive caregiver, whereas 9 of the 15 insecurely attached infants (4 of 8 avoidant and 5 of 7 resistant) looked longer when the infant approached the responsive caregiver,  $\chi^2(n = 35) = 2.16$ ,  $p = .14$ .

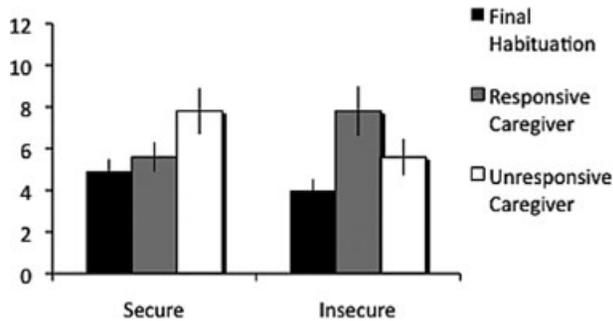


Fig. 6. Results from Study 3. The black bars show the average looking time to the last three habituation trials. The gray bars show the average looking time to the two responsive test trials. The white bars show the average looking time to the two unresponsive test trials. Looking times are in seconds. Error bars show the standard errors.

#### 4.3.3. Within-group comparisons

As in Study 1, paired  $t$  tests were used to examine the responses of the secure and insecure groups separately.

As predicted, securely attached infants looked significantly longer at the approaches to an unresponsive than responsive caregiver,  $t(19) = 2.21$ ,  $p = .04$ . These infants also showed a significant dishabituation to the unresponsive test trials,  $t(19) = 2.93$ ,  $p = .009$ , but not the responsive ones,  $t(19) = .70$ ,  $p = .49$ .

Conversely, insecure infants showed an opposite, though somewhat mixed pattern of results. As predicted, these infants dishabituated when the infant approached the responsive caregiver,  $t(14) = 3.25$ ,  $p = .006$ . However, they also marginally dishabituated to the unresponsive caregiver,  $t(14) = 1.88$ ,  $p = .081$ . Interestingly, this effect was driven entirely by the avoidant infants, rather than the resistant infants;  $t_{\text{avoidant}}(7) = 3.28$ ,  $p = .013$ ;  $t_{\text{resistant}}(6) = 0.19$ ,  $p = .86$ . Furthermore, as already mentioned, although insecure infants looked nominally longer at the responsive than unresponsive outcomes, this difference did not reach significance.

#### 4.4. Summary of Study 3

As seen in the previous two studies, Study 3 suggests that infants' expectations of caregiver–infant interactions are associated with the quality of their own caregiver relationships. Secure infants looked longer at interactions involving unresponsive caregivers than those involving responsive caregivers. Relatively speaking, insecure infants showed a reversed pattern of looking behavior.

## 5. Discussion

Three studies tested and extended the claim that infants' behavior in the Strange Situation procedure corresponds to their expectations about caregiver–infant interactions. Three

unique patterns of expectations were revealed. Securely attached infants expected infants to seek comfort from caregivers and expected caregivers to provide comfort. Insecure-resistant infants expected infants to seek comfort from caregivers but also expected caregivers to withhold comfort. Insecure-avoidant infants expected infants to avoid seeking comfort from caregivers and expected caregivers to withhold comfort. These data extend the exploratory results published in Johnson et al. (2007) and support Bowlby's original claims—infants form internal working models of attachment-relevant behavior, and these models are associated with infants' own behavior.

Secure infants are infants who readily seek and accept comfort from their own caregivers. They are thought to have experienced consistently available and responsive caregivers. When shown our animated displays of generic caregivers and infants, secure infants expected caregivers to be responsive (Study 1) and infants (Study 2) to be receptive to their partners. They also expected infants to seek out responsive rather than unresponsive caregivers (Study 3).

Resistant infants are those who readily seek comfort from their caregivers but are then reluctant to accept it. These infants are thought to have experienced inconsistent caregiving—parents who are unpredictably available and responsive. When shown our animated displays, these infants were surprised by responsive caregiver behavior (Study 1) and seemed to think it more likely that an infant would approach a previously unresponsive caregiver than a previously responsive one (Study 3). In line with their own behavior, they were nonetheless surprised to see an infant ignore or withdraw from a returning caregiver (Study 2). Like the secure infants, they seemed to expect infant interaction.

Avoidant infants showed yet a third pattern. These infants are characterized by their reluctance to either seek *or* accept support from a caregiver when stressed. They are thought to have experienced consistent, repeated rejection of their bids by their caregivers. Like resistant infants they seemed to find the responsive caregiver behavior unexpected (Study 1). Unlike either the resistant or the secure infants, however, avoidant infants found the animated infant's withdrawal from its caregiver completely unremarkable (Study 2) and instead tended to find approaches to caregivers *of any sort* relatively unexpected (Studies 2 and 3).

Taken together, these three studies yielded three distinct patterns of infant responses. Overall, these patterns showed striking correspondences to the attachment styles of the group that produced them. The looking patterns of the secure and resistant groups in particular rule out alternative explanations based on more generic approach-withdrawal tendencies, independent of interaction histories. In Study 3, *both* test outcomes displayed approach events, yet secure and resistant infants each selectively attended to the outcome that more strongly contradicted their own attachment style.

Independent evidence for infants' internal working models also militates against the reduction of Strange Situation behavior to more general individual differences such as temperament (e.g., Kagan, 1984). Although avoidant infants may appear less distressed or in need of comfort in the Strange Situation than do resistant infants, they were just as likely to find the responsive caregiver behavior surprising. Similarly, although resistant infants may

appear more distressed by separation than secure infants, they nonetheless find infant approaches to the responsive caregiver—the one most likely to provide comfort—unexpected. These patterns of results, although meaningless from a purely temperamental perspective, are predicted by attachment theory.

Although these results argue against the reduction of attachment styles to temperamental differences, they do not argue against all influences of temperament. There are at least two ways temperamental influences could exert themselves. As debated in the literature, temperament could influence the sort of caregiving infants elicit and thus their attachment styles (Ge et al., 1996; van den Boom, 1994; for review see Vaughn & Bost, 1999.) Alternatively, and relevant in light of a representational component of attachment, temperament might influence how infants perceive and represent their experiences. That is, two temperamentally different infants receiving the same objective caregiving might nonetheless perceive, encode, and interpret that caregiving differently.

The earlier issues were addressed by the current results, but other questions are now raised. How generalizable are the representations tapped by our animated displays? Who do infants think the characters represent? Do they represent the infants' own mothers, fathers, or caregivers; primary caregivers, secondary caregivers, or any caregiver? This method may provide a way to probe these questions, as well as quantify contributions of different caregivers to infants' attachment styles (Fox, Kimmerly, & Schafer, 1991).

Are there also individual differences in infants' representations of social events beyond the separation–reunion events addressed here? We predict similar results with other attachment-related scenarios such as accidents or illness (events that involve a child in distress), but what about nonattachment-based social interactions? Kuhlmeier et al. (2003) showed a strong, universal tendency among infants to expect that individuals will approach others who help rather than hinder them. Why did not Kuhlmeier's infants show individual differences in their responses? One possibility is because their characters, although also generically nonhuman, were the same size as each other and thus, may have been more easily construed as “peers” than caregiver–infant. This again raises the question of who infants think the characters are and, in this case, what information in our displays they are using. Does relative size license specific, privileged inferences? Is the caregiver–infant relationship a conceptual primitive?

The development of additional, converging tools for studying and assessing conceptions of social relationships in infants is long overdue. The objective quantifiability provided by this method, combined with its relative simplicity should make it appealing to a broad range of infant researchers interested in the development of social behavior and cognition. More work remains, however. For one, it cannot automatically be assumed that any and all mental representations will parallel behavior. The correspondence in this case is striking, but it need not have been. Second, even in this successful case, close to half of the infants recruited failed to successfully habituate to the displays. This is a serious handicap for researchers interested in developing alternative tools for assessing individual differences in social development. Nonetheless, these findings are an encouraging first step.

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