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Attention and Memory for Faces and Actions in Infancy: The Salience of Actions over Faces in Dynamic Events

Lorraine E. Bahrick, Lakshmi J. Gogate, and Ivonne Ruiz

Discrimination and memory for video films of women performing different activities was investigated in 5.5 month-old infants. In Experiment 1, infants ($N = 24$) were familiarized to the faces of one of three women performing one of three repetitive activities (blowing bubbles, brushing hair, and brushing teeth). Overall, results indicated discrimination and memory for the actions but not the faces after both a 1-min and a 7-week delay. Memory was demonstrated by a visual preference for the novel actions after the 1-min delay and for the familiar actions after the 7-week delay, replicating prior findings that preferences shift as a function of retention time. Experiment 2 ($N = 12$) demonstrated discrimination and memory for the faces when infants were presented in static poses at the 1-min delay, but not the 7-week delay. In Experiment 3 ($N = 18$), discrimination of the actions was replicated, but no discrimination among the objects embedded in the actions (hairbrush, bubble wand, toothbrush) was found. These findings demonstrate the attentional salience of actions over faces in dynamic events to 5.5 month-olds. They highlight the disparity between results generated from moving versus static displays in infancy research and emphasize the importance of using dynamic events as a basis for generalizing about perception and memory for events in the real world.

INTRODUCTION

The natural environment presents a dynamic flow of objects, actions, and events to the young infant. The social environment is primarily characterized by moving, speaking people, performing different activities and often interacting with the infant in close-up, face-to-face encounters. What does the infant abstract from this diverse array of changing stimulation? What is salient to the infant, visually attended to, and remembered, and what is less salient? A great deal of research has focused on infant perception of faces, suggesting that young infants are excellent perceivers of faces (see Walker-Andrews, 1997, for a review), whereas little research has focused on perception of human activities. Face perception has even been described as "special" in the sense that faces are thought to be unusually salient and easily discriminated at an early age relative to other stimuli (e.g., Fagan, 1972, 1979; Kleiner, 1987; Kleiner & Banks, 1987; Maurer & Young, 1983). Some investigators have even argued that faces are innately preferred (e.g., Goren, Sarty, & Wu, 1975; Johnson & Morton, 1991; Morton & Johnson, 1991). Most studies of face perception, however, have primarily assessed perception of static photos, or live faces in still poses. Consequently, little is known about the perception and discrimination of faces in the context of natural motions or dynamic events. Another body of research has also explored infant perception of action and motion information and has found young infants to have excellent perception and memory for motion, and to be skilled at abstracting information about form through motion (see Kellman & Arterberry, 1998, for a review). In fact, it is thought that movement is one of the earliest and most powerful garners of infant attention (e.g., Fantz & Nevis, 1967; Haith, 1980). How then, do infants attend to and process dynamic person events? What is the relative salience for activities versus the faces of individuals performing those activities? To date, little if any research has assessed the perception of faces in the context of actions, or pitted the salience of faces against the salience of actions. How do the findings of face perception generalize to faces of moving, acting individuals? This article addresses these issues.

Infants are quite good at discriminating among static representations of faces at an early age. They can tell the difference between static images of the face of their mother and a stranger (Barrera & Maurer, 1981; Bernard & Ramey, 1977; Bushnell, 1982; Caron, Caron, Caldwell, & Weiss, 1973; Walton, Bower, & Bower, 1992) and between two strangers (Cohen & Strauss, 1979; Cornell, 1974; Fagan, 1972, 1976) in the first months of life. Research has also demonstrated that infants are skilled at discriminating among live faces and videos of faces, including the mother versus a stranger or the mother versus the father (Carpenter, Teece, Stechler, & Friedman, 1970; Field, Cohen, Garcia, & Greenberg, 1984; Sai & Bushnell, 1988; Spelke & Owsley, 1979; Tincoff & Jusczyk, 1998). Infants have

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also been shown to generalize from live faces of strangers to static images of the same faces (Dirks & Gibson, 1977). By the age of 3 months, infants are even able to discriminate between a close-up image of their own face and that of another infant of the same age in both static and moving video displays (Bahrick, Moss, & Fadil, 1996). Thus, infants show face perception and discrimination of individual faces across a variety of domains in the first months of life. All of the studies described above, however, are similar in that they have presented close-ups of faces with minimal motion. Live faces have typically been presented still, in a neutral or smiling expression (Field et al., 1984; Sai & Bushnell, 1988), speaking (Spelke & Owsley, 1979), or in one study, nodding slowly on some trials (Carpenter et al., 1970). Studies presenting video displays of dynamic faces have typically portrayed the faces with little movement (e.g., as the actor viewed an interesting visual display, or watched a news show; see Bahrick et al., 1996; Tincoff & Jusczyk, 1998, respectively). These findings of perception and discrimination among relatively still faces, therefore, may not necessarily generalize to the perception of the dynamic faces of individuals performing activities in everyday life.

E. J. Gibson (1969) has argued that motion carries information about the appearance of objects and that through motion infants are able to abstract invariant patterns of stimulation specifying enduring properties of objects. In fact, for adults, motion has been found to facilitate perception of facial identity (Lander, Christie, & Bruce, 1999; Schiff, Banka, & Bordes Galdi, 1986). Indeed, infants have been found to be excellent perceivers of motion information and through motion, infants can abstract information about meaningful properties of objects. Thus, studies suggest that infants can perceive figural coherence in dynamic point light displays specifying a human walking (Bertenthal, Proffitt, & Cutting, 1984; Fox & McDaniel, 1982). Infants can detect the actual shape of an object better when the object is moving rather than still (Kellman & Spelke, 1983; Kellman, Spelke, & Short, 1986; Owsley, 1983;) and they can abstract the common shape of an object undergoing various types of motions (E. J. Gibson, Owsley, Walker, & Megaw-Nyce, 1979), as well as discriminating different classes of motion (E. J. Gibson, Owsley, & Johnston, 1978; Walker, Owsley, Megaw-Nyce, Gibson, & Bahrick, 1980). Infants also abstract information about object substance and composition (Bahrick, 1983, 1987, 1988, 1992), object permanence (Baillargeon, 1987; Baillargeon, Spelke, & Wasserman, 1985), causality (Cohen & Oakes, 1993; Leslie & Keeble, 1987), changing distance (Pickens, 1994; Walker-Andrews & Lennon, 1985), human affect (Walker, 1982; Walker-Andrews, 1988), and the self (Bahrick & Watson, 1985; Rochat, 1995; Rochat & Morgan, 1995) in moving, dynamic events. In fact, infants attend to and discriminate dynamic changes in affect and social contingency in face-to-face interactions, and show more negative affect and decreased looking to a still face (D'Entremont & Muir, 1997; Gusella, Muir, & Tronick, 1988). Thus, dynamic events provide a rich and varied source of learning about diverse properties of the world for the infant.

Despite the large body of research on perception of dynamic events, to date few studies have assessed infants' ability to discriminate or remember everyday activities that people perform. Everyday activities, however, provide a rich source of information for the infant about social contingencies, the self, and about salient affordances provided by feeding, sleeping, or play time. Research on nonsocial events, however, indicates that infants can perceive and remember object motions over long periods of time. For example, they can detect and remember the relation between their own motion and that of an overhead mobile across weeks (see Rovee-Collier & Fagen, 1981, for a review). Infants also show remarkably long-lasting memory for the motions of inanimate objects. They can remember and discriminate a swinging motion versus a circular motion across a period of at least 3 months (Bahrick, Hernandez-Reif, & Pickens, 1997; Bahrick & Pickens, 1995). This research also demonstrated that infant attention shifts as a function of retention time. Recent memories are expressed as a novelty preference, intermediate memories as a null preference, and remote memories as a familiarity preference (see also replications by Courage & Howe, 1998; Spence, 1996). Evidence of this shifting preference now enables us to assess very long-term memory in young infants as indexed by a preference for familiar stimuli. Given that little, if any, prior research has investigated long-term memory for social events, the present study uses the methods and measures developed by Bahrick and Pickens (1995) for the study of nonsocial events to examine discrimination and memory for social events across a period of many weeks.

In particular, the present study investigated infant memory for the faces and actions of women performing different repetitive activities. The relative salience of the faces versus actions was assessed. Infants viewed films of the face and shoulder area of a woman as she performed a repetitive activity such as brushing her hair, brushing her teeth, or blowing bubbles. Discrimination and memory were tested following delays of 1 min and 7 weeks. Similar to the findings of Bahrick and Pickens (1995), it was predicted that infants would show memory by displaying a novelty preference after the 1-min delay and a familiarity preference after the 7-week delay. Further, a control study assessed discrimination and memory for the faces when they were static, across both retention intervals. This comparison enabled us to draw more appropriate conclusions regarding infant perception and memory for faces under moving versus static conditions. Finally, another control study explored infants' discrimination of the objects embedded in the actions (hairbrush, toothbrush, and bubble wand) to assess their role, if any, in infant discrimination of the actions.

Infants of 5.5 months of age were chosen for this study. By 3 to 5 months, infants are skilled at perceiving and discriminating static displays of faces and dynamic displays with limited motion, as well as perceiving a variety of properties in moving faces (see Johnson & Morton, 1991; Walker-Andrews, 1997, for reviews). Further, they are especially attracted to motion and are able to perceive form through motion by the age of 5 months (see Kellman & Arterberry, 1998, for a review). Also, by 5 months, movement of the internal features of faces becomes important for discriminating face versus nonface patterns (Johnson, Dziurawiec, Bartrip, & Morton, 1992). Thus, given that infants appear to possess the requisite capabilities for perceiving faces and motions by 5 months when each is examined separately, this age was chosen as a starting point for assessing the perception of faces and actions when they are integrated in the context of dynamic faces engaged in repetitive activities.

EXPERIMENT 1

Method

Participants. Twenty-four 5.5-month-old infants (M = 164 days, SD = 6 days), 12 males and 12 females, participated. Three additional subjects were excluded from the final sample due to external interference (n = 1), experimenter error (n = 1), or failure to meet the attention criterion (n = 1; see Procedure section for details). All infants were healthy and full-term, weighing at least 2.27 kg at birth, with Apgar scores of 9 or higher. They were primarily from middle-class families. Seven were White, 13 were Hispanic, 1 was Asian, and 3 were of mixed ethnic backgrounds. Seventeen of the 24 infants returned to the laboratory after 7 weeks (M = 49 days, SD = 18) for the second memory test.

Stimulus materials. The events consisted of nine video displays of three different women performing three different repetitive actions: brushing their teeth, blowing bubbles, or brushing their hair (see Figure 1). These actions were selected because they were repetitive, everyday events that attracted attention to the area of the face. While performing the activities, the women were shown changing position to face a different direction every 10 s (center, left, right, and again center). A special effort was made to perform the activities in the same way and to control for affect as closely as possible across the various actresses. While performing the actions during filming, each woman viewed the same video of a model actress performing the actions. The model always maintained a neutral expression during the 10-s cycle and then smiled once at the end of each cycle. The woman mimicked the rhythm and rate of the actions, as well as the affect of the model. The women were selected to be highly distinguishable based on appearance. Each was of a different ethnicity. One was White with light skin and long, light brown hair reaching to her waist (Woman 1). The second was Asian–Indian with brown skin and wavy, dark brown, shoulder-length hair (Woman 2). The third was Chinese with a light complexion and long, straight black hair reaching just past her shoulders (Woman 3; see Figure 1).

The three displays were selected from among five, to be comparable in initial interest value to infants of 5 months. Films of five different women performing five different activities (brushing their teeth, brushing their hair, blowing bubbles, tying a scarf, and putting on rouge) were pretested in a two-choice preference test (N = 12) counterbalanced such that each possible pair occurred together equally often. The display that recruited the most attention (putting on rouge, M = .70, SD = .13) and the display that recruited the least

Figure 1 Photographs of the dynamic faces and activities displayed to infants.

attention (tying a scarf, $M = .36$, $SD = .16$) were eliminated. The remaining three events—brushing teeth, brushing hair, and blowing bubbles—were selected because interest levels to them were quite comparable (brushing teeth, $M = .48$, $SD = .26$; brushing hair, $M = .50$, $SD = .13$; and blowing bubbles, $M = .47$, $SD = .22$).

Apparatus. Infants sat in a standard infant seat facing two color TV monitors (Sony KV-20M10) approximately 50 cm away. The video displays were presented using three video decks (Panasonic AG 6300 and Panasonic AG 7750). A set of bells on a string, located between the monitors, was used to center the infant's attention between trials. Two apertures cut into a black poster board placed above the monitors served as peepholes for monitoring infants' visual fixation to the displays. Visual fixation was measured by one or two observers, who pressed one of a pair of buttons while the infant visually fixated on the right monitor, and the other while the infant fixated on the left monitor. The observers' button presses were recorded on-line using a computer (AT 386, IBM compatible personal computer) and printed (Epson LQ-850 printer) in an adjacent room.

Procedure. Twenty-four infants were familiarized during four 40-s trials to one of three dynamic displays of an unfamiliar woman performing a repetitive activity in a procedure similar to that of Bahrick and Pickens (1995). The woman could be seen across four changes in orientation, for 10 s in each position. Infants were presented with one of three standard visual displays: one of the three women performing one of the three activities: Woman 1 brushing her teeth, Woman 2 brushing her hair, or Woman 3 blowing bubbles ($n = 8$ per group). Two identical films of the same event were displayed side-by-side, but out of phase with one another, on the two side-by-side video monitors. An attention criterion was imposed to eliminate the data of infants who had not attended sufficiently during familiarization to support later memory for the displays (see Bahrick & Pickens, 1995). Infants were required to attend for at least 80 s of the total of 160 s available (50% of the time).

One minute following familiarization and again after a 7-week delay, infants received a two-choice novelty preference test for the faces and the actions across four 30-s trials, two trials for each type of test. The face tests consisted of trials of the familiar person's face shown side by side with a novel face, while both performed the familiar action. The action tests consisted of trials of the familiar action alongside a novel action, with both actions performed by the familiar person. The face and action test trials were presented in an alternating pattern and their order of occurrence was counterbalanced such that 12 subjects received an action test trial first and 12 subjects received a face test trial first. In addition, the lateral positions of the novel display were varied across trials and counterbalanced across subjects. Half the infants received the novel display on the left or right monitors in one sequence (RLLR) whereas the other half received the opposite sequence (LRRL). Further, having three standard visual displays allowed us to present a different novel face and action for each of the two memory tests. For example, if an infant was familiarized with Woman 1 brushing her teeth, he may receive Woman 2 as the novel face after the 1-min delay, and Woman 3 as the novel face for the 7-week delay. Similarly, the same infant may receive brushing hair for the novel action at the 1-min delay, and blowing bubbles as the novel action after the 7-week delay. Thus, each standard served as the familiarization display, the 1-min, and the 7-week memory tests equally often (with the exception of missing data in the 7-week delay group) and each pair of faces and each pair of actions were contrasted equally often within each retention interval condition.

Trained observers, blind to the lateral positions of the displays, the person, and type of activity, recorded infants' visual fixation to the displays. Reliability was calculated by comparing the judgments of right and left looking scores across two observers for 7 subjects (29% of the data). The Pearson product-moment correlation for the primary and secondary observers' scores was .99 ($SD = .01$) for the familiarization phase, .98 ($SD = .02$) for the 1-min memory test, and .95 ($SD = .14$) for the 7-week memory test.

Results and Discussion

Familiarization phase. The mean number of seconds of looking to the familiarization displays out of a total of 160 s was 152.5 s ($SD = 15.76$) or 95%. The mean proportion of infants' visual fixation time across the four familiarization trials was evaluated to assess stimulus preference across the three standard events: Woman 1 brushing her teeth, Woman 2 brushing her hair, and Woman 3 blowing bubbles. A one-way ANOVA on the proportion of looking during the familiarization trials showed no main effect of stimulus event, $F(2, 21) = .10$, $p > .1$. Infants showed no a priori preferences for one stimulus display over another.

Test phase: 1-min and 7-week memory. For the 1-min delay condition, the mean number of seconds that infants spent looking at one of the two side-by-side test displays during the action test trials was 50.2, and during the face test trials was 50.5. These means did not differ from one another, $t(23) = .158$, $p > .1$. For the 7-week retention interval the mean number of seconds that infants spent looking at one of the two side-by-side test displays during the action test trials was 51.6, and during the face test trials was 51.1. These means also did not differ from one another, $t(16) = .385$, $p > .1$.

The proportion of infants' total looking time (PTLT) to the novel faces or actions served as the primary dependent variable. It was calculated for each subject and each trial of the two delay periods by dividing the time spent looking at the novel display by the total time spent looking at both concurrent displays. The mean PTLT for the action test was obtained by averaging the PTLTs for the two action test trials for a given subject, and the mean for the face test trials was obtained by averaging the PTLT for the two face test trials. These proportions are depicted in Figure 2.

To determine whether infants showed significant evidence of memory for the faces and actions, the mean PTLTs were compared against the chance value of 50% in single sample t tests. Results indicated that after the 1-min delay, infants showed a significant preference for the novel action, $t(23) = 2.72$, $p = .012$, whereas after the 7-week delay they showed a significant preference for the familiar action, $t(16) = 2.37$, $p = .031$. These results indicate memory for the actions at both retention intervals, and the direction of the preferences is consistent with our prediction based on Bahrick and Pickens' (1995) four-phase model of attention. Recent memories are expressed as a novelty preference, whereas remote memories are expressed as a familiarity preference. In contrast, infants showed no preference for the faces after either delay period in these overall results: 1 min, $t(23) = .07$; 7 weeks, $t(16) = -.73$, $ps > .1$, indicating no evidence of memory for the faces.

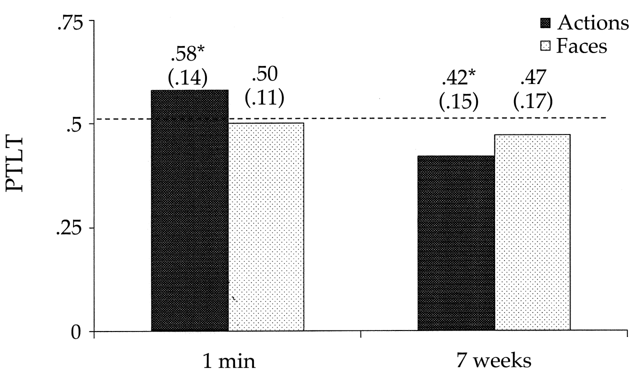

Figure 2 Experiment 1, dynamic displays: Proportions of total looking time (PTLT) and standard deviations to the novel actions and faces across retention intervals of 1 min and 7 weeks. $^*p < .05$.

The data were also examined at the individual subject level and evaluated with nonparametric tests. This pattern of results parallels that of the parametric tests. For the action test trials, 17 of the 24 infants showed a novelty preference at the 1-min delay, $p = .021$ according to a binomial test. At the 7-week delay, 14 of the 17 infants showed a familiarity preference during the action test trials, $p = .005$ according to a binomial test. To evaluate the predicted shift from novelty to familiarity preferences as a function of retention time (see Bahrick & Pickens, 1995) at the individual subject level, data from the 17 infants who participated in both visits were classified into one of four patterns describing their change in preference from the 1-min to the 7-week retention interval: novelty–novelty ($n = 2$), familiarity–familiarity ($n = 5$), novelty–familiarity ($n = 9$), and familiarity–novelty ($n = 1$). Results of a χ^2 test were significant, $p = .028$. Further, a binomial test indicated that the probability of 9 of the 17 infants showing the shift from novelty to familiarity was also significantly greater than chance, $p = .009$. In contrast, results of the face test trials showed no significant effects at the individual subject level: 10 of the 24 infants showed novelty preferences at the 1-min delay and 7 of the 17 infants showed familiarity preferences at the 7-week delay; all $ps > .1$. Thus, these analyses indicate that the findings at the individual subject level converge with those at the group level, attesting to the robustness of the effects. Infants showed significant evidence of memory for the actions at the 1-min delay as indexed by a novelty preference, and at the 7-week delay as indexed by a familiarity preference, but they showed no evidence of memory for the faces. Further, these results also provide support at the individual subject level for Bahrick and Pickens' (1995) four-phase model of infant attention where preferences were found to shift across retention time such that more accessible memories are reflected by novelty preferences and less accessible memories are reflected by familiarity preferences.

Secondary analyses assessed evidence for side bias during the face and action test trials for both delay periods. Single sample t tests on the PTLT that infants fixated on the right video monitor versus .50 showed no evidence of side bias, $M = .52$, $t(23) = .47$, $p > .1$; $M = .42$, $t(16) = 1.61$, $p > .1$, for the action tests for the 1-min and 7-week delays, respectively; $M = .51$, $t(23) = .18$, $p > .1$; $M = .46$, $t(16) = .19$, $p > .1$, for the face tests for the 1-min and 7-week delays, respectively.

Further analyses were performed to assess the effects of type of test (face [F] or action [A]) and test order (i.e., whether the infants received an action test trial or a face test trial first) on infants' memory. For the

1-min delay test, an ANOVA was performed on the PTLT to the novel display with type of test (face or action) and test order (face or action trial first) as main factors. The analysis showed a significant main effect of test type, $F(1, 22) = 7.04$, $p = .015$. Infants showed a significantly greater PTLT to the novel stimulus when it was an action than a face, suggesting that action perception was superior to face perception. The analysis also showed a significant main effect of test order, $F(1, 22) = 12.09$, $p < .01$, and no interaction between type of test and test order, $p > .1$. The test order effect indicated that PTLTs to the novel display were greater for infants who received the action test trial first ($n = 12$; AFAF) than for infants who received the face test trial first ($n = 12$; FAFA). More-fine-grained post hoc analyses for type of test within each order revealed that infants who received the face test trials first, looked significantly less than chance (.50) to the novel face on the two face test trials taken together, $M = .45$, $t = -2.50$, $p = .029$. That is, these infants showed a preference for the familiar face. Thus for one of the test orders (FAFA), there was evidence of discrimination and immediate memory for the faces. Memory, however, was expressed as a familiarity preference. Bahrick and colleagues (Bahrick et al., 1997; Bahrick & Pickens, 1995) have argued that less accessible memories are expressed as preferences for familiarity, whereas more accessible memories are expressed as preferences for novelty. Thus, these findings reveal limited evidence of face discrimination and memory—it appeared less accessible and less robust than memory for the actions, and occurred only for one of the test orders and at one retention interval, the 1-min delay. At the 7-week delay, the PTLTs to the novel displays were also analyzed for effects of type of test (face, action), test order (action trial or face trial first), and interactions. This analysis showed no main or interaction effects, $ps > .1$.

Secondary analyses were also conducted to determine whether infants showed any preferences for one face over the other. The mean PTLT to each face when it was novel was calculated and these means were compared in an ANOVA. Results indicated no significant main effect of face at the 1-min delay, $F(2, 20) = .197$, $p > .1$, but a significant effect emerged at the 7-week delay, $F(2, 14) = 4.83$ $p = .025$, with the greatest proportion of looking to the face of the White woman ($M = .56$, $SD = .07$), then to the Chinese woman ($M = .49$, $SD = 16$), and least to the Asian–Indian woman ($M = .31$, $SD = 15$).

Another fine-grained analysis was undertaken to examine whether infants showed any initial or eventual evidence of face discrimination in the 1-min delay condition during the course of each 30-s test trial. Each test trial was subdivided into 10-s components and PTLTs were calculated for each 10-s component separately. Results indicated no evidence of initial or emerging novelty or familiarity preferences across the duration of the test trials, all $ps > .1$. In general, variability was greater for the 10-s components (SDs ranged from .26 to .39, with a mean of .33) than for the 30-s trials taken as a whole (SDs ranged from .22 to .29, with a mean of .25) across both the face and action test trials, indicating that the longer trials provide more stable estimates of preference. Further, just taking the first 10 s of each of the four test trials into account, no significant novelty preferences were found for either the mean of the two action test trials, $M = .53$, $SD = .20$, $t(23) = .65$, $p > .1$, or the mean of the two face test trials, $M = .51$, $SD = .14$, $t(23) = .38$, $p > .1$. These findings suggest that the longer trials are the better units of analysis and that in the trials where novelty preferences were found, they emerged over the course of the 30-s trials.

In summary, these results demonstrate robust memory for actions across the 1-min and 7-week retention intervals and the superiority of memory for actions over faces. In contrast, only weak evidence of memory for the faces was evident at the 1-min retention interval for one of the test orders. Thus, actions appear to be more salient and memorable than faces to 5-month-olds viewing people performing repetitive events.

Furthermore, memory for actions was expressed by a novelty preference after the 1-min delay and a familiarity preference after the 7-week delay. These results support the four-phase model of infant attention (Bahrick et al., 1997; Bahrick & Pickens, 1995) proposing that infants' preferences shift as a function of retention time. Novelty preferences are indicative of more accessible memories, whereas familiarity preferences are indicative of less accessible memories.

EXPERIMENT 2

Experiment 1 revealed only attenuated evidence of memory for faces after a 1-min delay in dynamic displays of women performing repetitive actions. In the context of dynamic events, infants' attention may be selectively focused on the activity, causing the face to become "background." If so, by presenting still faces in different orientations, the faces may become salient and infants should attend to them selectively. If this is true, then the faces should be much easier to discriminate when they are static rather than dynamic and part of a repetitive action. Therefore, Experiment 2 evaluated the attentional salience hypothesis by investigating whether the faces would be discriminated and remembered when the displays were static.

Method

Participants. Twelve healthy 5.5 month-old infants (M = 164 days, SD = 4 days), 4 males and 8 females, participated. Of these infants, four were White, 6 were Hispanic, 1 was of mixed ethnic background, and 1 was of unknown background. Three additional infants were not included in the final sample for failure to meet the attention criterion (n = 2) and computer failure (n = 1). In addition, only 8 of the 12 infants returned 7 weeks later for the second memory test.

Stimulus materials and apparatus. Static images were taken from the nine video displays used in Experiment 1, depicting the three women each performing one of three activities: brushing their teeth, blowing bubbles, or brushing their hair. Two static frames were taken from each of the four poses (center, left, right, center) of each woman performing each activity. The apparatus was identical to that of Experiment 1.

Procedure. The procedure was identical to that of Experiment 1, except that static images were used, and infants were tested only for face memory. Infants were familiarized during four 40-s trials to two similar, side-by-side, static images of one of the three faces taken from the standard displays (Woman 1 brushing her teeth, Woman 2 brushing her hair, or Woman 3 blowing bubbles). The three faces and types of activity were counterbalanced across subjects and retention interval as before. Infants were shown the woman in a different pose across the familiarization trials (center, left, right, and then center) paralleling the poses of the dynamic displays of Experiment 1.

One minute following familiarization and again after a 7-week delay (M = 47 days, SD = 12.65), subjects were given a novelty preference test to assess memory for the faces across four 30-s trials. As before, a different novel face was used for each of the two memory tests. The face tests consisted of trials of the familiar woman's static face shown alongside one of the novel static faces, both depicting a static version of the same action, with the faces in the same orientation. Trained observers blind to the conditions recorded infants' visual fixations to the displays as before. Reliability between two observers for the PTLTs (averaged across four trials) to the novel face, calculated for 4 subjects (25%) was .98 (SD = .025) for the familiarization phase, .91 (SD = .07) for the immediate memory test, and .92 (SD = .11) for the long-term memory test.

Results and Discussion

Familiarization phase. The mean number of seconds of looking to the familiarization displays out of a total of 160 s was 101.23 s, SD = 23.44 or .63 of the total time. The mean proportion of infants' visual fixation time across the four familiarization trials was evaluated for stimulus preference across the three standard familiarization events, Woman 1 brushing her teeth, Woman 2 brushing her hair, and Woman 3 blowing bubbles. A one-way ANOVA on the proportion of looking during the familiarization trials showed no main effect of type of event, $F(2, 9) = .12$, $p > .1$. Thus, infants showed no a priori preference for one static display over the other.

Test phase: 1-min and 7-week memory. The mean number of seconds that infants spent looking at the two side-by-side displays during the four, static 30-s face test trials was 71.6 for the 1-min delay test, and 72.6 for the 7-week delay test. The PTLT to the novel faces was calculated for each subject for the two delay periods as before (see Figure 3). The means were analyzed using single sample t tests against the chance value of 50% to determine whether infants showed memory at either retention interval. Consistent with our predictions, after the 1-min delay, infants showed a significant preference for the novel face, M = .59, $t(11)$ = 2.52, p = .029. At the individual subject level, 9 of the 12 infants showed novelty preferences, p = .054. Thus, when infants viewed static displays, rather than the dynamic displays of women performing actions in Experiment 1, they demonstrated discrimination and memory for the faces after a 1-min delay by showing a novelty preference. This is consistent with findings of prior research using static faces (e.g., Barrera & Maurer, 1981; Bushnell, 1982; Fagan, 1976). In contrast, after the 7-week delay, infants showed no significant preference for either the familiar or novel face, M = .49 to novel face, $t(7) = -.40$, $p > .1$. Thus, infants demonstrated recent memory but no evidence for remote memory for the static faces.

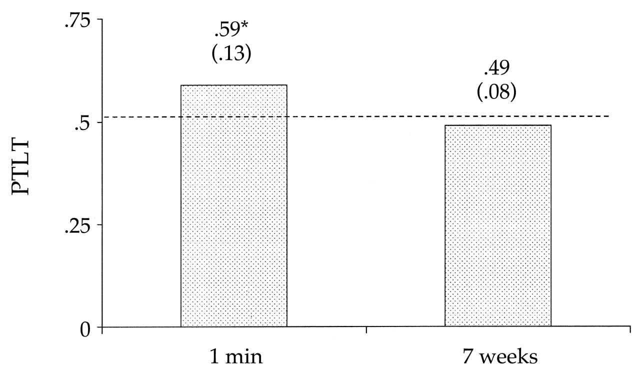

Figure 3 Experiment 2, static displays: Proportions of total looking time (PTLT) and standard deviations to the novel faces across retention intervals of 1 min and 7 weeks. *$p < .05$.

Further, analyses were conducted to examine any differences in PTLT as a function of pose following the 1-min delay and the 7-week delay. For each retention interval, a mean PTLT was calculated for the two trials in which infants viewed the center poses of the faces (Trials 1 and 4), and for the two trials in which infants viewed the three quarter poses of the faces (Trials 2 and 3). These proportions were submitted to a repeated-measures ANOVA for pose (center, side) and retention interval (1 min, 7 weeks). The two-way analysis revealed a marginally significant main effect of retention interval, $F(1, 18) = 3.7$, $p < .07$, but no main effect of pose, $F(1, 11) = .65$, $p > .1$, and no interaction between these factors, $F(1, 18) = 2.5$, $p > .1$.

Secondary analyses assessed infants' side bias during test trial looking for both delay periods. Single-sample t tests against .50 (chance) on the PTLTs to the right video monitor showed no side preference during the face tests for either the 1-min, $M = .47$, $t(11) = -.75$, $p > .1$, or the 7-week, $M = .49$, $t(7) = -.25$, $p > .1$, delay period.

Analyses assessing any face preferences were also conducted as before by looking at the PTLT to each face when it was novel. An ANOVA indicated a significant main effect at the 1-min delay, $F(2, 9) = 12.69$, $p = .002$, with the greatest proportion of looking to the Chinese woman ($M = .72$, $SD = .06$), then to the White woman ($M = .59$, $SD = .04$), and least to the Asian–Indian woman ($M = .46$, $SD = .09$). However, at the 7-week delay there were no longer any significant face preferences, $F(2, 6) = .123$, $p > .1$.

Further analyses were undertaken to compare the results of face discrimination and memory across Experiments 1 and 2. Is face discrimination superior when infants view faces in static poses as compared with dynamic motions? An ANOVA was performed on the PTLTs to the novel face at the 1-min retention interval (where evidence of static face discrimination was found) with type of display (dynamic, Experiment 1; static, Experiment 2) as the main factor. Results indicated a significant main effect of type of display, $F(1, 34)= 4.83$, $p = .035$, and demonstrated that discrimination and immediate memory for faces was superior when the displays were static rather than moving. Given that infants typically find moving stimuli more interesting and attend to them longer than to static stimuli, this question was addressed in the present experiment by comparing the number of seconds looking to the familiarization displays out of the total 160, across the two studies ($M = 152.5$, dynamic faces; $M = 101.23$, static faces). Results of a t test indicated a significant difference in familiarization time across the two studies, $t(34) = 7.78$, $p < .001$. As expected, infants looked significantly longer to the moving face events than to the still faces during familiarization. The superiority of memory and discrimination for the static faces should be viewed in the context of these findings. Despite the fact that infants found the moving stimuli more interesting and attended to them longer, they showed superior discrimination and memory for the static faces. One interpretation of this finding is that infants attend to different information in dynamic versus static displays. It suggests that when infants view people performing different activities, the activity is treated as "foreground," whereas once the motion is stopped, the appearance of the face is treated as "foreground."

In summary, the results of Experiment 2 support the attentional salience hypothesis as an interpretation of the findings of Experiment 1. That is, actions appear to be more salient to 5.5-month-old infants than the faces of individuals performing those actions. Once the actions were eliminated and the faces were static, infants attended to and showed memory for the faces across a 1-min delay.

EXPERIMENT 3

In order to draw firm conclusions regarding the salience of actions over faces, one additional explanation for the salience of actions was evaluated. The actions each entailed the use of a distinctive object—a hairbrush for the hair brushing activity, a toothbrush for brushing teeth, and a bubble wand for blowing bubbles. Did infants in Experiment 1 notice the different objects and could this account for their discrimination and memory of the activities? In order to evaluate this possibility, we explored whether the distinctive objects were necessary for discrimination of the different activities, or whether the activities were discriminable without the aid of distinctive objects. We also wanted to establish whether the distinctive objects were attended to and discriminated by infants when they were embedded in the actions, as in Experiment 1. Thus, a third study was conducted to test for action discrimination in the absence of differences across objects, and for object discrimination in the context of actions.

In this study, infants were familiarized with videos of a woman (the White woman from Experiments 1 and 2) engaged in one of the three actions using one of the three objects. Then infants were given an action test and an object test. Unlike Experiment 1 in which the actions and objects covaried, in this study they were manipulated independently. The action test assessed discrimination of the new and old actions; however, the object was not changed. Thus, if familiarization occurred with the woman brushing her teeth with a toothbrush, the novel action might show the woman brushing her hair with a toothbrush. Thus, any preference obtained for the novel activity could not be accounted for or facilitated by attention to a novel object. Only the action itself differed from familiarization to test. Similarly, the object test assessed discrimination of the new and old objects in the context of the familiar action. Thus, if an infant was familiarized with the woman brushing her hair with a hairbrush, the novel object display might depict the woman brushing her hair with a bubble wand. Thus, if infants discriminated the hair brush from the bubble wand in the context of the action, they should show a preference for the novel object. It was expected that infants would show discrimination of the different actions despite the lack of change in the object if the actions per se are salient to infants. Also, given that infants had not discriminated the faces in the context of the actions in Experiment 1, it was hypothesized that they would show no evidence of discriminating the objects in the context of the actions.

Method

Participants. Eighteen healthy 5.5-month-old infants (M = 162.3 days, SD = 6.4) participated. There were 12 males and 6 females. Of these infants, five were White, 12 were Hispanic, and 1 was of mixed ethnic background. Five additional infants were tested, but their data were rejected for excessive fussiness (n = 2), experimenter error (n = 2), and equipment failure (n = 1).

Stimulus materials and apparatus. New events were filmed with one of the women depicted in Experiment 1, the White woman. The events consisted of nine video displays of the woman performing the three repetitive actions presented in Experiment 1: brushing her teeth, blowing bubbles, and brushing her hair. Each action was filmed with each of the three objects used in Experiment 1: the hairbrush, the toothbrush, and the bubble wand. The objects were integrated into the actions as before and made to look as natural as possible. Thus, the woman was shown brushing her hair with a hairbrush, a toothbrush, and a bubble wand; brushing her teeth with a hairbrush, a toothbrush, and a bubble wand; and blowing bubbles with a hairbrush, a toothbrush, and a bubble wand. (The appearance of blowing bubbles with the hairbrush and toothbrush was accomplished by affixing the bubble wand to the back side of the hairbrush and toothbrush, as unobtrusively as possible, and holding the object as before, so that the brush was visible and only the small portion of the wand from which the bubbles emanated protruded.) The woman was careful to perform the actions in the same way regardless of which object she used. Otherwise the films were as similar as possible to those of Experiment 1, including the change in position (center, left, right, and center) every 10 s. Special attention was paid to controlling for affect across all the activities. As in Experiment 1, the woman maintained a neutral expression during the 10-s action cycle and smiled once at the end of each cycle. Further, by using the same woman in all films, more precise control over affect and any idiosyncratic characteristics could be achieved. The apparatus was identical to that of Experiments 1 and 2.

Procedure. The procedure was similar to that of Experiment 1 for the 1-min delay condition. Eighteen infants were familiarized during four 40-s trials to one of the three repetitive actions (brushing teeth, brushing hair, blowing bubbles, n = 6 per action) performed by the White woman with one of three objects. Objects were counterbalanced during familiarization such that 2 infants received each object (hairbrush, toothbrush, bubble wand) within each action condition. As in Experiment 1, two identical events were shown side by side, but out of phase with one another, on the two side-by-side video monitors. One minute following familiarization infants received a 60-s novelty preference test to assess discrimination of the actions and a 60-s novelty preference test to assess discrimination of the objects (with total test time identical to that of Experiment 1). The action test consisted of a presentation of the familiar action alongside a novel action, both performed with the familiar object. The object test consisted of a presentation of the familiar object alongside a novel object with both objects embedded in the familiar action. The selection of the novel stimulus display was counterbalanced within each test condition such that each object occurred equally often as the novel stimulus during the object test, and each action occurred equally often as the novel stimulus during the action test. The lateral positions of the novel and familiar objects were counterbalanced across trials within subjects. The order of the two tests (action–object versus object–action) was randomly determined.

Trained observers, blind to the conditions, recorded infants' visual fixations to the displays as before. Reliability between the primary and secondary observers was computed for 6 infants (33% of the sample). For the familiarization phase, the Pearson product-moment correlation was computed on the proportion of available looking time, and averaged and was .95 (SD = .03). For the object and action tests it was computed on the PTLTs and was .97 for the object test, and .97 for the action test.

Results and Discussion

Familiarization phase. The mean number of seconds looking to the two displays during familiarization was 119 ($SD = 27.74$) out of the total 160 s, or 74%. The mean proportion of infants' visual fixation time across the four 40-s familiarization trials was evaluated to assess any a priori stimulus preferences. A two-way ANOVA on the proportion of looking during the familiarization trials out of the available looking time showed no main effect of action, $F(2, 9) = .315$, $p > .1$, or object, $F(2, 9) = .372$, $p > .1$, or interaction, $F(4, 9) = .012$, $p > .1$. Thus, infants showed no a priori preferences for one object or action over the other.

Test phase. During the action test, the mean number of seconds spent looking at one of the two side-by-side displays out of 60 s was 38.71 ($SD = 8.32$), and during the object test it was 38.76 ($SD = 8.65$). These means did not differ from one another, $t(17) = .016$, $p > .1$. The PTLTs to the novel display were calculated as before for the action and the object test trials (see Figure 4). These means were analyzed with single sample t tests to determine whether infants showed any evidence of discrimination and memory for the actions or objects. Results of the action test replicated those of Experiment 1, indicating a significant preference for the novel action, $t(17) = 2.28$, $p = .036$. Thus, infants discriminated and remembered the actions despite receiving no change in the object used during each of the activities. Results of the object test, however, indicated no evidence of discrimination or memory. Infants showed no significant preference for either the novel or familiar object in the context of the activity, $t(17) = .16$, $p > .1$. Secondary analyses also assessed any evidence of side bias, stimulus bias, or effects of test order during the test trials. Single sample t tests on the PTLTs to the right monitor versus .50 were conducted on the two test trials combined and demonstrated no evidence of side bias, $M = .49$, $t(17) = .15$, $p > .1$. Two one-way ANOVAs were conducted to determine if there was any effect of test order (object–action versus action–object) on PTLTs to the novel display for the action test and for the object test. Results indicated no significant effect of test order for either type of test, $F(1, 16) = .074$, $p > .1$, $F(1, 16) = .663$, $p > .1$, respectively. Finally, analyses were also conducted to determine whether infants showed any preferences for one object over the other or one action over the other during the test trials. Two one-way ANOVAs were conducted, one with the mean PTLT during the object test to each object (hairbrush, toothbrush, bubble wand) when it was novel, and the other with the mean PTLT during the action test to each action (brushing hair, brushing teeth, blowing bubbles) when it was novel. Results indicated no significant main effect of type of object during the object test, $F(2, 15) = 1.42$, $p > .1$, and no significant effect of type of action during the action test, $F(2, 15) = 2.45$, $p > .1$. Thus, infants showed no evidence of any preferences for one action over the other or one object over the other.

A more fine-grained analysis was undertaken to determine whether infants had any emerging preference for the object during the course of the 60-s test trial. The 60-s test trials were subdivided into two 30-s components and PTLTs were calculated for each infant for each half separately. Results indicated no evidence of initial or final preferences for novelty or familiarity, $ps > .1$, according to single sample t tests against the chance value of .50.

In summary, these results demonstrate discrimination and memory across a 1-min delay for actions even when the object embedded in the action is held constant. Thus, the distinctive object was not necessary for discriminating among the actions in Experiment 1 and the actions were discriminated and remembered without the aid of distinctive objects. In fact, infants showed no evidence of discriminating among the distinctive objects used in the activities. This is consistent with the findings of Experiment 1 in which infants showed no evidence of discriminating among the faces in the context of these activities. These findings support the attentional salience hypothesis offered as an explanation for Experiment 1. That is, infant attention is drawn to the repetitive actions at the expense of attention to the faces of the individuals performing the activity or the objects used in the activities. Actions are apparently more salient to infants than are the identity of the faces or the objects that are part of the activities.

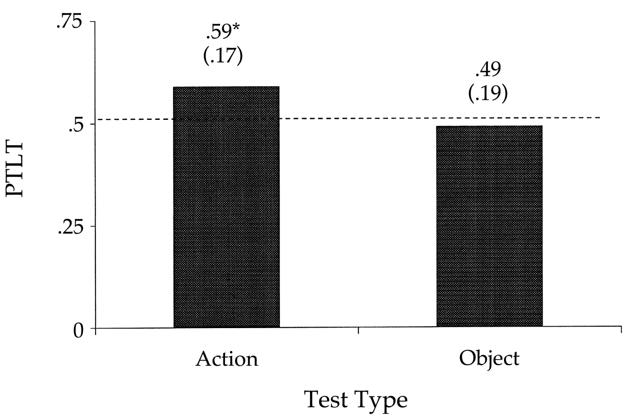

Figure 4 Experiment 3: Proportions of total looking time (PTLT) and standard deviations to the novel actions and objects after a 1-min retention interval. * $p < .05$.

GENERAL DISCUSSION

Several conclusions emerge from these experiments. The results of Experiment 1 suggest that the repetitive actions of people are more salient to infants by the age of 5.5 months than are the appearance of the faces of individuals performing the activities. Infants showed robust discrimination and long-lasting memory for actions across a 7-week retention interval. They discriminated and remembered films depicting three distinctive-looking women (each from a different ethnic background) on the basis of their activity: brushing her teeth, brushing her hair, or blowing bubbles. The attentional salience of actions was evident even though the actions were presented in the context of close-up films of the women's faces. In contrast, infants showed no evidence in the overall results at the 1-min or the 7-week retention interval of discriminating or remembering the faces of the individuals performing the actions, despite the fact that the actions were chosen to highlight the facial area. Only attenuated evidence of face discrimination was demonstrated at the 1-min but not the 7-week delay in half of the infants who received a particular test order. Further, at the 1-min retention interval, the novelty preference for actions was significantly greater than that for faces, demonstrating the superiority of action discrimination and memory over discrimination and memory for faces in close-up displays of persons. The findings of Experiment 1 are thus interpreted in terms of an attentional salience hypothesis. That is, the repetitive actions performed by people are highly salient and are therefore attended to, perceived, and remembered to a greater extent and longer than the faces of the people performing the actions.

Experiment 2 evaluated the attentional salience hypothesis by assessing discrimination and memory for the faces when they were presented in static poses. If the attentional salience of actions diverted attention away from the faces, causing the actions to become "foreground," then by eliminating the actions, attention should be redirected to the faces and face discrimination should be enhanced. Results indicated that under the static presentation conditions, infants showed a significant preference for the novel face after the 1-min retention interval, but no significant preference at the 7-week retention interval. Thus, results supported the attentional salience hypothesis; once the action was stopped and the faces were still, infants showed discrimination and immediate memory for the faces. Further, a comparison across studies revealed that at the 1-min delay, memory for the faces was significantly better for the static displays of Experiment 2 than for the dynamic displays of Experiment 1. Thus, at 5.5 months, face perception appears to be superior when infants view the faces still rather than when they view them in the context of performing repetitive activities. This was true despite the fact that infants spent significantly less time attending to the faces when they were still as compared with moving.

Experiment 3 further evaluated the attentional salience hypothesis by assessing whether the presence of the distinctive objects embedded in the activities (hairbrush, toothbrush, and bubble wand) in Experiment 1 was necessary for discrimination and memory for the actions. We also assessed the discriminability of the objects in the context of the actions. These questions were addressed by independently manipulating the objects and actions. Infants were familiarized with one woman performing one of the three actions with one of the three objects. Then they received a test for object discrimination with a new object embedded in the familiar action, and a test for action discrimination with a new action using the familiar object. Results indicated that infants discriminated and remembered the actions even when the objects were held constant. This demonstrates that distinctive objects are not necessary for discrimination and memory for the actions. Rather, the actions themselves appear to be salient and discriminable, and this accounts for the discrimination and extended memory observed in Experiment 1.

Further, results of Experiment 3 revealed that infants were unable to discriminate a change in object when it was in the context of an action. For example, a change from a person brushing her teeth with a hairbrush was not discriminated from the same person brushing her teeth with a toothbrush or a bubble wand. These findings converge with those of Experiment 1 and suggest that the appearance of objects or individuals involved in an action is relatively unattended to in relation to the salience of the action itself. Together, the results of Experiment 3 converge to support the attentional salience hypothesis as an explanation for the robust discrimination and memory for actions observed in Experiment 1.

Further, Experiments 1 and 2 together suggest that 5.5-month-old infants attend to different properties in dynamic versus static displays depicting similar information. When infants of this age observe people performing repetitive actions, their attention is first focused on the activity such that it becomes "foreground," and the face of the individual becomes "background." Infants attend to, discriminate, and remember activities at the expense of the identity of the faces. However, once the activity is stopped, and static views of the face are available, infant attention is focused on the appearance of the face and it becomes "foreground." Consequently, discrimination and memory for faces becomes evident when the displays are static, at least after a short delay. In contrast with the findings of long-lasting memory for actions, however, there was no evidence of long-term memory for the faces after a 7-week delay. Thus, in this respect, too, actions appear more salient to infants than do faces in the context of social events. It should be noted, however, that in this research, discrimination and memory for facial identity was assessed. It remains possible that other information conveyed by faces (e.g., affect, direction of gaze, bimodal speech) that was not examined in the present study is salient and discriminable, even during performance of repetitive actions.

The attentional salience hypothesis also implies that infants would be capable of discriminating faces while individuals were performing repetitive activities, if their attention were focused on the face. That is, perception of faces in the context of naturalistic, repetitive actions is not inherently difficult for infants by 5 months of age. Rather, infants apparently attend to the actions first whereas the faces are relatively ignored. If infants could be encouraged to attend to faces by, for example, habituating to the actions first, face discrimination and memory should become apparent. Further, this hypothesis would also suggest that after extended exposure to displays of people performing repetitive actions, interest in the actions should eventually habituate, and attention should shift to other aspects of the display, including the faces. Thus, there may be a salience hierarchy for properties of events that regulates attentional allocation to those properties, and in essence creates a processing sequence in which the most salient properties are attended to first. If the exploration episode continues longer, then the less salient properties would eventually be attended to.

Results of the present experiments also support the growing body of research demonstrating that preferences shift across retention time, from novelty for recent memories to familiarity for remote memories (Bahrick et al., 1997; Bahrick & Pickens, 1995; Courage & Howe, 1998; Spence, 1996). In Experiment 1, memory for the actions was expressed as a novelty preference at the 1-min retention interval and as a familiarity preference at the 7-week retention interval. This parallels findings of Bahrick and Pickens (1995) in which 3-month-old infants expressed memory for motions of inanimate objects as a novelty preference at a 1-min retention interval and as familiarity preferences at retention intervals of 1 and 3 months. These findings thus provide further support for Bahrick and colleagues' four-phase model of infant attention (see Bahrick et al., 1997; Bahrick & Pickens, 1995) in which infant preferences are thought to shift from novelty, to null, to familiarity, and back to null preferences as retention time increases. Further, the present findings extend those of prior studies to infants of an older age (5 versus 3 months and younger), different stimulus events (social versus nonsocial), and different retention intervals. Finally, the results of Experiment 1 underscore the viability of the familiarity preference as an index of long-term memory in infancy research.

The present findings also highlight the need for reconceptualizing the implications of prior research on face perception. In particular, they point out that it is inappropriate to generalize on the basis of research conducted with static faces or faces with relatively little movement to infant perception, attention, or memory for faces in the context of everyday activities. Further, investigators have argued from a body of research conducted with representations of faces or relatively still faces that face perception is special (Fagan, 1972, 1979; Kleiner, 1987; Kleiner & Banks, 1987; Maurer & Young, 1983) or even that faces are innately preferred (e.g., Goren et al., 1975; Morton & Johnson, 1991). In the context of the present findings, we must remember to ask—special or preferred with respect to what, and in what context? Research has demonstrated that neonates preferentially follow facelike patterns over scrambled patterns (Goren et al., 1975; Johnson, Dziurawiec, Ellis, & Morton, 1991; Maurer & Young, 1983); that infants discriminate and prefer still and schematic faces as compared with scrambled faces, facelike patterns, and some, but not all, abstract patterns by 2 months, and—in some studies—even as neonates (Fantz & Nevis, 1967; Kleiner, 1987; see reviews by Mauer, 1985; Nelson & Ludemann, 1989); and that young infants are able to discriminate relatively still presentations of the mother's face from that of a stranger (e.g., Barrera & Maurer, 1981; Bushnell, 1982; Caron et al., 1973). Together, these findings, along with the present findings, provide a broader picture for understanding which properties are more versus less salient to infants in social events. Apparently infants find motion especially salient, spend more time viewing moving displays than similar static displays, and by 5.5 months, attend to and remember the nature of the motion better than the appearance of the moving face. However, when there is minimal or no motion, 5.5-month-old infants attend to, discriminate, and remember the appearance of the face. Findings of face perception studies further suggest that static representations of faces are more salient than static representations of many other objects. Thus, further research should address the issue of the relative salience of different properties of objects and events and seek to establish and clearly specify the boundary conditions for the effects observed. In particular, generalizations based on studies of still faces should be limited to the perception of static or relatively still faces. In contrast, research on the perception of faces in the context of dynamic events should serve as the basis for generalizing about the perception of faces of moving people engaged in activities.

Research in the area of the "still face effect" has made some progress toward identifying which aspects of dynamic faces are salient to young infants during social interaction (e.g., D'Entremont & Muir, 1997; Gusella, Muir, & Tronick, 1988). These studies have found that infants attend to changing affect and social contingency in face-to-face interactions, and respond with negative affect and decreased looking to a still face. Infants attend less to the loss of sound and/or movement per se. However, typically the mother or a familiar adult has served as the model and thus this research has not yet examined infant recognition of the appearance of the faces of the individuals engaged in social interaction. The present findings suggest it would be of value for future research to assess the infant's ability to abstract facial identity during face-to-face contingent, noncontingent, and still presentations. It may be that early in infancy, social contingency is so salient that facial identity is relatively unattended during the dynamic phases of face-to-face interactions. It is also likely that detection of facial identity is facilitated through certain types of motion unless other properties of the event are highly salient.

In a more general sense, the present findings point out that different results are obtained from research designs testing infants depending on whether the stimuli are presented still or with substantial movement. Movement is known to be a powerful attractor of infant attention (e.g., Haith, 1980). Similarly, Bahrick and Lickliter (2000) have demonstrated that different results are also obtained from infant research as a function of whether information is presented unimodally or bimodally. Their research showed that intersensory redundancy (the simultaneous occurrence of the same information in two sense modalities) is highly salient and that a property presented bimodally (e.g., rhythm, tempo, intensity) is attended to and discriminated better than the same property presented unimodally. Infants appear to attend to different properties when a given event is perceived unimodally versus bimodally. Similarly, the present research also suggests that infants attend to different properties when stimuli are presented in motion versus still. Further research on infant attention, perception, and memory for stimulus properties in everyday events is needed to improve our understanding of how these processes develop in the context of the multimodal, dynamic environment in which they emerge. In particular, it will be important to learn more about which properties of natural events are selectively attended to and under what conditions, in order to more appropriately generalize research from laboratory settings to the way in which perception develops in the real world. In other words, the "ecological validity" (J. J. Gibson, 1979; Neisser, 1976) of research is determined in large part by the way research is generalized. Research findings will be ecologically valid to the extent that they are neither overgeneralized nor undergeneralized across stimulus attributes, domains, developmental level, and context. Systematically delineating the boundary conditions for observed effects will foster a deeper understanding of the basis of development and will create more ecologically valid research by allowing researchers to generalize more appropriately to the specific conditions of the everyday environment in which the effects emerge.

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ADDRESSES AND AFFILIATIONS

Corresponding author: Lorraine E. Bahrick, Department of Psychology, Florida International University, Miami, FL 33199; e-mail: bahrick@fiu.edu. Lakshmi J. Gogate is at the State University of New York at Brooklyn; and Ivonne Ruiz is at Nova Southeastern University, Fort Lauderdale, FL.

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