The effects of adults’ affective expression and direction of visual gaze on 12-month-olds’ visual preferences for an object following a 5-minute, 1-day, or 1-month delay

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Between 12- and 14 months of age infants begin to use another’s direction of gaze and affective expression in learning about various objects and events. What is not well understood is how long infants’ behaviour towards a previously unfamiliar object continues to be influenced following their participation in circumstances of social referencing. In this experiment, we examined infants’ sensitivity to an adult’s direction of gaze and their visual preference for one of two objects following a 5-min, 1-day, or 1-month delay. Ninety-six 12-month-olds participated. For half of the infants during habituation (i.e., familiarization), the adults’ direction of gaze was directed towards an unfamiliar object (look condition). For the remaining half of the infants during habituation, the adults’ direction of gaze was directed away from the unfamiliar object (look-away condition). All infants were habituated to two events. One event consisted of an adult looking towards (look condition) or away from (look-away condition) an object while facially and vocally conveying a positive affective expression. The second event consisted of the same adult looking towards or away from a different object while conveying a disgusted affective expression. Following the habituation phase and a 5-min, 1-day, or 1-month delay, infants’ visual preference was assessed. During the visual preference phase, infants saw the two objects side by side where the adult conveying the affective expression was not visible. Results of the visual preference phase indicate that infants in the look condition showed a significant preference for object previously paired with the positive affect following a 5-min and 1-day delay. No significant visual preference was found in the look condition following a 1-month delay. No significant preferences were found at any retention interval in the look-away condition. Results are discussed in terms of early learning, social referencing, and early memory.

Children, including infants, are keen observers of others’ behaviour. While children learn much through their own explorations of the environment (e.g., Adolph, 2008; Gibson, 1988), they also learn from observing the behaviour of others, including others’

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emotional reactions as these guide their own exploratory behaviour. Learning within social interactions involves a repertoire of related behaviours including shared visual attention, comprehending what is being communicated (often affective information), and being able to remember the association or pairing of the communicated emotion and a specific object or event.

Social referencing is said to occur when an infant or child alternates their focus of visual attention between an adult, typically their parent, and an unfamiliar object or event and uses the adult’s affective behaviour in guiding their own behaviour towards that object or event (Feinman & Lewis, 1983; Feinman, Roberts, Hsieh, Sawyer, & Swanson, 1992). For example, Klinnert (1984) found that 12- and 18-month-olds remained closest to their mother when their mother directed a fearful expression towards an unfamiliar moving toy. Likewise, Klinnert (1984) found that infants ventured the farthest away from their mother when she directed a happy expression, and infants ventured a modest distance away from their mother when she directed a neutral expression towards the toy. Similarly, Sorce, Emde, Campos, and Klinnert (1985) found, using the context of a visual cliff, 12-month-olds crossed the cliff with greater frequency when their mother posed a happy compared to an angry or an interested affective expression and no infants crossed the cliff when their mother posed a fearful expression. Finally, between 14- and 22-months age, Walden and Ogan (1988) found that infants looked to their mother’s face when she communicated a positive or negative affective expression in reference to an unfamiliar object; however, the younger infants only visually referenced their mother when she communicated a positive affective expression towards the object. In general, it is well documented around 1 year of age infants are able to use another’s emotional expression in guiding their exploration of a new object or event (see Walden, 1991, for a review).

Studies examining social referencing, including those studies examining various behaviours associated with social referencing, have rich history in the field of infant development. Because social referencing includes the sharing of affective expressions towards an object, it requires that infants are able to discriminate as well as recognize different affective expressions. Research examining infants’ discrimination of affect has consistently shown that by 5 months of age infants are able to discriminate changes in affect based on vocal expressions alone (Flom & Bahrick, 2007; Walker-Andrews & Grolnick, 1983; Walker-Andrews & Lennon, 1991), and by 7 months of age infants are able to discriminate dynamic as well as static facial expressions on the basis of affect (Caron, Caron, & Myers, 1985; Flom & Bahrick, 2007; Kestenbaum & Nelson, 1990; Ludemann & Nelson, 1988; see Walker-Andrews, 1997, for a review). More recently, research has also begun to examine the neurophysiological correlates of affect recognition and discrimination within the context of processing social information (Grossmann, Striano, & Friederici, 2007; Reid, Striano, Kaufman, & Johnson, 2004; Striano, Kopp, Grossmann, & Reid, 2006). Thus infants’ discriminate affective expressions of another sometime around 5- to 7-months of age.

In addition to discriminating affective expressions, another behaviour that occurs within social referencing is joint visual attention. Specifically, the infant must be able to look where another is looking. Research has shown that following another’s direction of gaze (head and eye orientation) develops between 6- and 9 months of age (Adamson, 1996; Butterworth & Cochran, 1980; Butterworth & Jarrett, 1991; Flom, Deák, Phill, & Pick, 2004; Flom & Pick, 2005; Kaye & Fogel, 1980; Scaife & Bruner, 1975; Trevarthen & Hubley, 1978). In addition, sometime between 10- and 18 months of age infants are able to follow another’s direction of gaze towards an object that is occluded by
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a barrier or in some other way outside of the infant’s immediate visual field (Butler, Caron, & Brooks, 2000; Deák, Flom, & Pick, 2000; Moll & Tomasello, 2004). While social referencing requires infants’ discrimination of affect and the establishment of joint visual attention, social referencing also requires that infants comprehend or link the adult’s affective expression to the object or event that is being referenced. Research suggests that comprehending the relationship between where another is looking and the object of their visual reference emerges around infants first birthday (Brooks & Meltzoff, 2002; Carpenter, Nagell, & Tomasello, 1998; Gergely, Nadasdy, Csibra, & Biro, 1995; Tomasello & Haberl, 2003; Woodward, 1998, 2003). Likewise, others have shown that around 12–14 months of age, infants can use an adult’s direction of gaze to identify which object a person is emoting about and use this communicated emotion in regulating their own behaviour (Hertenstein & Campos, 2004; Moses, Baldwin, Rosicky, & Tidball, 2001; Phillips, Wellman, & Spelke, 2002; Repacholi, 1998). For instance, Mumme and Fernald (2003) found that 12-month-olds, but not 10-month-olds, can use a televised actress’s emotional reaction directed towards an unfamiliar household object in guiding their own physical exploration of the object.

Clearly much work has been done examining the development of social referencing and related behaviours. Unfortunately, little research has systematically examined how long infants’ behaviour towards an unfamiliar object continues to be affected following their participation in episodes of social referencing (cf. Hertenstein & Campos, 2004). Research designed to examine whether infants’ behaviour towards an object reflects mood induction or social referencing imposed a short delay (1–8 min) between the adult’s communicated affective expression and allowing the infant to explore the object (e.g., Feinman & Lewis, 1983; Hornik, Risenhoover, & Gunnar, 1987). Results showed that 12-month-olds’ behaviour towards the object (i.e., avoidance) persisted following a delay of 1–8 min. While these two experiments were not designed to examine how long infants’ behaviour towards an unfamiliar object continues to be influenced following a circumstance of social referencing, their results provide evidence that infants’ behaviour continues to be influenced by the adults’ affective expression for a few minutes following participation in social referencing.

More recently, Hertenstein and Campos (2004) examined how long 11- and 14-month-olds’ haptic exploration of an object continues to be influenced following an adult’s emotional display linked to that object. In this experiment, infants watched an experimenter direct a positive or negative affective expression towards one of two toys for two 15 s trials. Following the two exposure trials, and a 60-min retention interval, infants were assessed in terms of their willingness to touch or otherwise explore the object. Fourteen-month-olds, but not 11-month-olds, more frequently touched, and touched for a longer time, the object associated with the positive affective expression. Likewise in the disgust condition, 14-month-olds, but not 11-month-olds, touched the target object less often compared to the control object. In a second experiment, Hertenstein and Campos (2004) found using a 3-min, rather than a 60-min retention interval, that 11-month-olds’ haptic exploration of an unfamiliar toy animal was affected by the adult’s communicated affective expression. Eleven-month-olds touched the object paired with the negative/disgust expression for less time and less often compared the object paired with a positive affective expression. Thus Hertenstein and Campos (2004) found infants’ exploratory behaviour is affected by the adult’s communicated affective expression following a delay of 3 min (11-month-olds) or 1 h (14-month-olds).

The results of Hertenstein and Campos (2004) are encouraging as they are the first to demonstrate that 14-month-olds’ exploratory behaviour towards an object is influenced,
for at least an hour, by an adult’s previously communicated affective expression. In addition, as discussed by Hertenstein and Campos (2004), at least two factors may be responsible for the attenuated results of the 11-month-olds. One possibility is that 14-month-olds, by virtue of being more autonomous than the 11-month-olds, may receive more affective or emotive communication from their parents or other adults. Specifically, Hertenstein and Campos (2004), as well as Mahler (1968) as cited in Hertenstein and Campos (2004), suggest that around 1 year of age infants increase their mobility, and the increase in mobility may promote the intensity, clarity, and frequency of adult’s affective communication. In addition, it is possible that adults may provide a type of ‘follow-up’ in terms of their affective communication to promote compliance on the part of their infant. Thus, it is possible that older infants, in general, receive more, as well as more varied, affective communications from their parent.

A second factor discussed by Hertenstein and Campos (2004) potentially affecting 11-month-olds’ retention following the 1-h, but not 3-min delay, may involve the development of infants’ memory between 11- and 14 months of age. Hertenstein and Campos (2004) suggest that the underlying neurological memory systems that serve infants’ manual exploration may not be fully developed (Diamond, 1995; Hayne, 2004; Hayne, Boniface, & Barr, 2000). Thus even though Hertenstein and Campos (2004) found only limited evidence of 11-month-olds’ manual exploration of an unfamiliar object being affected by an adult’s affective expression, their results are still the first to directly examine how long an infants’ behaviour continues to be influenced by an adult’s communicated affective expression.

One purpose of the current experiment was to attempt to replicate the results of Hertenstein and Campos (2004) as theirs is the first experiment to examine infants’ retention of another’s emotional reaction towards an unfamiliar object. A second purpose was to examine whether increasing 12-month-olds exposure to the object–affect pairing and whether using infants’ looking behaviour, rather than haptic exploration, affects their sustained behaviour (i.e., visual preference) towards an object previously paired with an adult’s positive or negative affective expression. In this experiment, we used an infant controlled habituation procedure to familiarize infants to the object–affect pairings because it allowed us to increase the amount of time infants were exposed to each object–affect pairing. Moreover, this procedure allowed us to examine whether infants learned the initial object–affect association. That is during the habituation phase one object was paired with a positive affective expression and one object with a negative affective expression. Once infants’ reached habituation, and following two no-change post-habituation trials, infants saw two test or ‘switch’ trials. By including the switch/test trials at the end of the habituation sequence, we were able to examine whether infants discriminated the pairings of habituation and the reversed pairings presented during the test trials. The purpose of the habituation-test phase was to (1) familiarize infants to the object and the adult’s communicated affective expression, (2) relative to Hertenstein and Campos (2004), increase infants’ exposure to the object and affect pairings, and (3) assess whether infants’ learned the initial pairing during habituation. By using an infant-controlled habituation procedure as a means of familiarization, we were able to examine the prediction of Hertenstein and Campos (2004) that increasing exposure to the object–affect pairing may promote infants’ retention, and unlike Hertenstein and Campos (2004) we examined, following familiarization, whether infants learned the relationship between each object and its paired affective expression.
Another, and perhaps more central purpose of this experiment, was to assess how long 12-month-olds’ behaviour (in this case looking behaviour) towards a previously unfamiliar object continues to be affected following its pairing with an adult’s affective expression. As described above, many experiments examining the development of social referencing use infants’ manual exploration of or approach/withdrawal from the object as the primary dependent variable and if a delay or retention interval is used it is often only of a few minutes (e.g., Feinman, & Lewis, 1983; Hertenstein & Campos, 2004; Hornik et al., 1987; Walden & Ogan, 1988). In the current experiment, however, we expanded on these differences by increasing the retention interval from a few minutes up to a month and we also modified how we assessed the effects of adults’ affective communication on infants’ behaviour. Specifically, following the habituation or familiarization phase and a retention interval of 5 min, 1 day, or 1 month we assessed infants’ visual preference for one of the two objects as the dependent variable.

A preferential looking procedure was chosen because infants of this age have reliably shown visual preferences as well as memory for various objects, events, faces, etc. following similar retention intervals using this procedure (Feldman, Rose, & Jankowski, 2002; Hayne, 2004). In addition, it has also been shown that neural mechanisms associated with preferential looking and visual recognition memory are well developed by 12-months of age and visual recognition memory is often exhibited prior to tasks using manual search or exploration (Diamond, 1995; Nelson, 1995; Swain, Zelazo, & Clifton, 1993). Retention intervals of 5 min, 1 day, or 1 month were chosen as they represent frequently used retention intervals with infants of roughly the same age when assessing short-term, intermediate, and longer-term memories (Barr & Hayne, 2000; Herbert & Hayne, 2000; Morgan & Hayne, 2002).

In this experiment, we also varied the adult’s direction of gaze. We felt it was important to vary the adult’s direction of gaze because we wanted to control for the possibility that infants were only associating the adult’s communicated affective expression with the object rather than comprehending the referential nature of the adult’s communicated affective expression. Thus for half of the infants the adult’s direction of gaze was directed towards the object and the infant (look condition) and for the other half adults’ direction of gaze was focused away from the object and the infant (look-away condition).

**Predictions**

Based on the results of Hertenstein and Campos (2004), it was predicted that 12-month-olds’ behaviour would be affected by the adults’ communicated affective expression. Because we increased infants’ exposure to the affective expression and the object, relative to Hertenstein and Campos (2004), and we made the retention task somewhat easier, i.e., visual preference versus manual exploration (see Munakata, McClelland, Johnson, & Siegler, 1997, for a review), it was predicted that 12-month-olds would show a visual preference (i.e., look longer) towards the object previously paired with the positive affective expression. Given that 12-month-olds have demonstrated an emerging awareness of the referential nature of another’s looking behaviour it was also predicted that infants would show a visual preference when the adult looked towards the object and no preference would be observed when the adult was looking away from the object. Finally, because we are interested in how long infants continue to show a visual preference for an object previously paired with a positive affective expression, and based on the literature reviewed above, it was predicted that infants would show a
visual preference for the object paired with the positive emotion at each retention interval.

Method

Participants
Ninety-six 12-month-old infants (50 girls) participated. The mean age was 368 days (SD = 5.1). Parents of the participants were initially contacted by telephone and received a certificate of appreciation following participation. Ninety-seven percent of the participants were White not of Hispanic origin, 2% were of Hispanic origin, and 1% of the participants were Pacific Islanders. All infants were full term and healthy and weighed at least five pounds at birth. Thirty-eight additional infants participated but their data were excluded from the final analyses. Fifteen infants failed to return following familiarization. Twelve failed to return following the 1-month delay and three following the 1-day delay. Twelve infants were excluded due to excessive fussiness during the familiarization phase. Interestingly, twice as many infants were excluded due to excessive fussiness in the look-away condition (n = 8) compared to the look condition (n = 4). No infants were excluded due to fussiness during the two-screen visual paired-comparison phase. Three infants were excluded due to experimenter error. Three infants were excluded for failure to habituate within 20 trials. Because a two-screen visual paired-comparison procedure was used to assess infants’ visual preference for the object previously paired with the positive affective expression we included a ‘minimal attention’ criterion. This criterion required that during the visual paired-comparison phase that infants look at least 5% of the time to the least preferred display (see ‘Exclusion criteria: Preferential looking’, for details). If an infant failed to meet this criterion on two or more of the visual comparison trials, their data were excluded from the analyses. The data of five infants were rejected for failure to meet this criterion. Other studies, including our own, have used a similar attention criterion in the context of infants’ preferential looking (Bahrick, 2002; Bahrick, Hernandez-Reif, & Flom, 2005; Bahrick, Hernandez-Reif, & Pickens, 1997; Bahrick & Pickens, 1995).

Events

Habituation events
Two different female actresses created 16 events used during the habituation or familiarization phase (see Table 1). In the look condition, two adult female actresses were filmed while looking towards one object (a plastic cord holder) and saying ‘Oh, wow! Look at that!’ while conveying a happy/positive affective expression. Actresses were also filmed while looking towards a second object (a plastic level) and conveying a disgusted or negative affective expression. During the look condition the actresses alternated their gaze between the object and lens of the video-camera (i.e., looking towards the infant). The look-away condition was identical to the look condition except the actresses were filmed while having their torso, head, and direction of gaze rotated 80° to the left of object. In the look-away condition, the actresses also alternated their gaze downward away from the object and then looking upward. Thus the general movement of the actresses head and eyes was the same in both conditions. Finally, a control event used during the habituation phase was created depicting a plastic green and white toy frog whose front legs spun and generated a clicking sound.
Table 1. Counterbalancing of events used during the habituation or familiarization phase

<table>
<thead>
<tr>
<th>Actress</th>
<th>Gaze condition</th>
<th>Pairing</th>
<th>Object</th>
<th>Affect</th>
<th>No. of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrie</td>
<td>Look</td>
<td>1</td>
<td>Level</td>
<td>Positive (happy)</td>
<td>n = 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Level</td>
<td>Negative (disgust)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Level</td>
<td>Positive (happy)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>Level</td>
<td>Negative (disgust)</td>
<td></td>
</tr>
<tr>
<td>Look-away</td>
<td></td>
<td>5</td>
<td>Level</td>
<td>Positive (happy)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>Level</td>
<td>Negative (disgust)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>Level</td>
<td>Positive (happy)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>Level</td>
<td>Negative (disgust)</td>
<td></td>
</tr>
</tbody>
</table>

Note. For each object–affect pairing, 4 participants were randomly assigned to the 5-minute, 1-day, or 1-month retention interval.

Visual preference events

In the visual preference phase, a silent and static image of each object resting on the table was used. During the visual preference phase, the actress was not visible and no auditory cues were available. Prior to beginning the experiment, we conducted a pilot experiment to determine whether 12- and 13-month-olds show a visual preference for a yellow cord holder or black level. Pilot testing revealed that 12- and 13-month-olds showed no visual preference for either object during 2–20 s silent visual paired-comparison test trials ($p > .1$ at both ages). Figure 1 depicts two events used in the look and look-away conditions and two static images of the objects presented during the two-screen visual preference phase.

Apparatus

All events were recorded using a Sony digital video-camera and were edited using Apple’s iMovie digital editing software. Events were edited to an equal duration of 7 min and were presented with four Sony (DVP-N557P/B) DVD players. The DVD players were connected to two 19-in. (48 cm) colour video monitors (Sony KV-20M10). These video decks were also connected to a Panasonic (VHS NV-A500) edit controller that allowed the experimenter to switch between audio-visual events without distracting the infant. Soundtracks were presented from a speaker located between the monitors at approximately 65 dB as measured from the infant seat. Two video game controllers, connected to a computer, were used to record infants’ looking times for each trial.

Infants sat facing the video monitors approximately 50 cm away. Two apertures cut into the black cloth surrounding the monitors were used to record the infants’ visual fixations. Observers, unaware of the hypotheses of the experiment, and unable to view the visual events, continuously pressed a button while the infant looked towards a given...
Habituation phase

Look condition

Look-away condition

Preferential looking phase

**Figure 1.** Screen captures of the look and look-away conditions and images used in the visual paired-comparison or preferential looking phase.

event and released the button each time the infant looked away. Each observer also listened to an iPod that played music so they could not hear the auditory information presented to the infant. The observers' button boxes were connected to a computer programmed to record visual fixations on-line.

**Counterbalancing**

Infants were randomly assigned to either the look or look-away condition. Within each condition (look or look-away) infants were habituated to two events. For half of the infants during habituation, one event consisted of the positive affect being paired with one object and in the other event the negative affect was paired the other object (e.g., level and happiness; cord holder and disgust) and for the remaining infants the events of habituation were reversed (level and disgust; cord holder and happiness; see Table 1 for details).
Procedure
The experiment consisted of two phases. The first phase consisted of a familiarization phase that used an infant-controlled habituation procedure (Horowitz, Paden, Bhana, & Self, 1972). The second or test phase, following the retention interval, used a visual paired-comparison procedure. We chose to pair an infant-controlled habituation procedure with a visual paired-comparison procedure as this procedural pairing has been used successfully in previous studies assessing infants’ early perceptual and cognitive development (see Bahrick, 2001; Bahrick et al., 2005; Bahrick, Netto, & Hernandez-Reif, 1998, for examples). Moreover, the details of the current habituation phase were modelled after other experiments using an infant-controlled habituation procedure (Bahrick, 2001, 2002; Bahrick & Lickliter, 2000; Flom & Bahrick, 2007). Similarly, the details of the visual paired-comparison procedure used in this experiment were modelled after previous experiments (Bahrick et al., 1998, 2005). The specifics for the infant-controlled habituation procedure and the visual paired-comparison procedure are described below.

Habituation and recovery
Infants were habituated (i.e., familiarized) to two object–affect pairings with each pairing being presented on alternating trials. Each habituation trial began when the infant looked towards the video monitor and terminated when the infant looked away for 1.5 s. Each habituation sequence consisted of at least six infant-controlled habituation trials (3 for each object–affect pair). Sixty seconds was set as the maximum trial length and 20 trials was the maximum number of trials. The first two trials (baseline trials) of the habituation sequence were used to establish the criterion of habituation. The subsequent habituation trials were presented until the infant reached the habituation criterion. An infant was considered to be habituated when its average looking, on two consecutive trials, was 50% below their initial looking time on the first two trials (i.e., baseline trials). After the habituation criterion was met, two no-change post-habituation trials were presented. The events presented during the two post-habituation trials were identical to the events of the baseline and habituation trials and were included to establish a more conservative habituation criterion. Post-habituation trials were also included to reduce the possibility of chance habituation by taking into account any spontaneous regression towards the mean (see Bertenthal, Haith, & Campos, 1983, for a discussion of regression effects in habituation designs). Following the two no-change post-habituation trials, infants received two change trials that depicted a change or reversal in the pairing of the affect and object of habituation. For example, when the level was paired with a happy expression and the cord holder was paired with a disgusted expression during the baseline, habituation, and the two post-habituation trials, then the test trials presented a switch or change in the object–affect pairing (i.e., level now paired with the disgusted expression and the cord holder paired with the happy expression). Infants’ discrimination was assessed by comparing each infant’s average looking during the two test trials minus their average looking during the two no-change post-habituation trials. Figure 2 shows the sequencing of the different trial types used during the habituation phase for the look condition.

Because the test trials represent a switch, or reversal of affect–object pairing seen during habituation, following the two test trials we presented infants with four additional trials of the original object–affect pairing viewed during habituation. That is, we are interested in whether infants can remember the original object–affect pairings of
Affect, gaze and visual preferences

Figure 2. Screen captures and sequencing of habituation trials for the look condition.

habituation, not the ‘switched’ or mismatched pairings presented during the test trials. Finally, prior to beginning the habituation sequence (i.e., baseline trials), and after the four re-familiarization trials, a control event (i.e., moving toy frog) was presented in order to examine infants’ level of fatigue.

Exclusion criteria: Habituation
Prior to including a subject’s data in the analyses, we examined infant’s level of fatigue. Fatigue was assessed by comparing each infant’s looking on the first and the final control trials (i.e., the moving toy frog). On the final control trial, infants were required to look at least 20% of their looking on the first control trial. Other experiments have used an identical measure of infant fatigue (Bahrick & Lickliter, 2000; Flom & Bahrick, 2007). None of the infants tested failed to meet this criterion. Second any infant who failed to habituate within 20 trials was excluded for failure to reach habituation. Three infants were excluded for failure to habituate within 20 trials.

Preferential looking
Following the habituation procedure (i.e., familiarization phase) infants received either a 5-min, 1-day or 1-month retention interval. In the 5-min retention interval, the mother typically held the infant in a room adjacent to the testing room and following this delay the infant was again seated and positioned equidistant from two side-by-side monitors. Only infants who successfully completed the habituation phase were included in the preferential looking phase. Prior to the preferential looking trials, infants received two warm-up trials in which they saw the film of the moving frog for 6 s once on the left and
once on the right monitor. The purpose of these two warm-up trials is to have infants visually notice the monitor on the left and the one on the right. During the preferential looking phase infants were presented with two identical blocks of four 10 s trials. Each trial depicted the two objects (cord holder and the level) seen during habituation side by side on two adjacent monitors. The positioning of the objects within each block was randomized with the restriction that the same object did not appear on the same side on more than two consecutive trials. The second block was identical to the first block. Intertrial and interblock intervals were approximately 3 s long. Trained observers who were unaware of the lateral positions of the video displays recorded the infants' looking times to each object via a button box connected to a computer.

Exclusion criteria: Preferential looking
Two looking criteria were set for the preferential looking data of the participants to be included in the analyses. Infants were required to complete seven out of eight trials. No data were rejected for failure to meet this criterion. We felt that it was important that infants notice that there were two video events side by side. Thus, an attention criterion required that infants look at least 5% of the time to the least preferred display for the trial to be included. If there were not 7 of 8 usable trials remaining, the data of that infant were rejected. The data of five 12-month-olds were rejected for failure to meet this criterion.

Results

Habituation phase
A secondary observer monitored the visual fixations for 36% \((n = 35)\) of the infants. Interoberserver reliability was calculated by correlating the visual fixation scores of the primary and secondary observers across trials for each infant and it averaged .92 \((SD = 0.09)\) across all conditions. An analysis of variance (ANOVA) was first performed with gender of the infants as a main factor and revealed no significant effect of gender for any of the trial types at any age \((all \ p's > .1)\). All remaining analyses were collapsed across gender.

In order to assess whether infants habituated, and subsequently discriminated the events of habituation and the test or 'switch' trials, an overall repeated measures ANOVA with condition (look and look away) as a between-subjects factor and trial type (baseline, post-habituation, and test) as the repeated measure was performed on infants' mean looking times for each trial type.

Results revealed a significant main effect of trials, \(F(2, 188) = 154.2, p < .001, \eta^2_p = .62\) (effect size, partial eta squared) = .62. The effect of looking condition (look or look away) during habituation, \(F(1, 94) = 0.24, p > .1\), and the interaction between looking condition and trial type, \(F(2, 188) = 0.34, p > .1\), did not reach significance.

Planned comparisons exploring the main effect of trial type (baseline, post-habituation, test) were conducted and indicated that the mean looking for each type of trial differed significantly from that of each other trial type \((all \ p's < .01)\), with greatest looking during baseline and least during post-habituation. In both conditions (look; look away), infants' looking was greater during the initial or baseline trials than their looking during the post-habituation trials, \(t(47) = 14.8, p < .01\; t(47) = 15.2, p < .01\), for the look and look-away conditions, respectively. This result reveals that infants became bored with
and were considered habituated to the two object–affect pairings because their looking behaviour decreased from the baseline trials to the post-habituation trials. Important, however, was the result that infants' looking during the two test trials was greater than their looking during the post-habituation trials (i.e., visual recovery), \( t(47) = 7.8, p < .01; \)

\[ t(47) = 7.4, p < .01, \]

for the look and look-away conditions, respectively. In other words, infants in the look and the look-away condition discriminated the events of habituation (e.g., level positive; cord holder disgust) with those of the test trials (e.g., level disgust; cord holder positive). Because infants discriminated between the habituation trials and the test trials we gain confidence that infants during the habituation phase learned that a given affective expression was paired with a particular object.

Secondary analyses examined whether infants differed in their looking behaviour in the look and look-away conditions during the baseline, post-habituation, test trials, visual recovery, and seconds to reach habituation. Results of these analyses failed to reach significance (all \( p \)'s > .1). Thus, 12-month-olds' looking behaviour did not differ between the look and look-away conditions during the habituation phase. The results also indicate that infants' looking behaviour did not significantly differ during the happy and disgusted habituation trials (\( p > .1 \)). In other words, infants' did not appear to habituate more to one object–affect pairing (e.g., the object paired with the disgusted expression) compared to the other object–affect pairing. Likewise, infants' visual recovery (i.e., discrimination), initial or baseline trials, or time to reach habituation did not significantly differ in terms of the object–affect pairing or condition of habituation. Table 2 depicts infants looking behaviour by trial type (baseline, post-habituation, test) and condition.

Thus across both conditions (look or look away), infants showed evidence of habituation and evidence of visual recovery (i.e., discrimination) to a change in object–affect pairing. Because our test trials depicted only a change in object–affect pairings the results of the habituation phase do not indicate that infants' used another’s direction gaze in learning this arbitrary relationship, or that infants’ inferred the actresses’ affective communication was directed towards or away from a particular object. Rather, the results demonstrate that 12-month-olds learned that one object was paired with a negative or disgusted habituation expression and that one object was paired with a happy or positive affective expression and noticed when this pairing was switched.

If, however, 12-month-olds comprehend, or perceive, that another’s direction of gaze was directed towards an object, then one would predict differences in their visual preference for a particular object. Specifically, it was predicted that 12-month-olds would show a visual preference in the look condition and will fail to show a visual preference in the look-away condition.

**Preferential looking phase**

During the preferential looking phase each infant received eight 10 s trials where the objects were presented side by side as static images on the video monitors. The results of the preferential looking phase were expressed in terms of a proportion of total looking time (PTLT). Proportions were derived for each trial separately by dividing the time spent looking to the object paired with the positive affective expression, by the time spent looking at both objects. These proportions were then averaged to obtain the mean proportion for Block 1 (trials 1–4), Block 2 (trials 5–8), and Blocks 1 and 2 combined (trials 1–10) for each infant, and across all infants. An overall PTLT was also derived by averaging across the two blocks for each infant, and then averaging over all infants (see
Table 2. 12-month-olds’ mean looking times and standard deviations (SD) by look and delay conditions during the habituation phase

<table>
<thead>
<tr>
<th>Gaze condition</th>
<th>Delay condition</th>
<th>Baseline</th>
<th>Post-habituation</th>
<th>Test</th>
<th>Visual recovery (test–post-habituation)</th>
<th>Seconds to habituation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Look</td>
<td>5 min</td>
<td>Mean</td>
<td>22.07</td>
<td>5.0</td>
<td>8.9</td>
<td>3.9**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>15.3</td>
<td>3.0</td>
<td>3.0</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>1 day</td>
<td>Mean</td>
<td>23.2</td>
<td>5.8</td>
<td>9.4</td>
<td>3.6*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>12.9</td>
<td>2.8</td>
<td>6.1</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>1 month</td>
<td>Mean</td>
<td>21.2</td>
<td>5.1</td>
<td>9.5</td>
<td>4.4*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>9.3</td>
<td>2.9</td>
<td>6.8</td>
<td>6.2</td>
</tr>
<tr>
<td>Look-away</td>
<td>5 min</td>
<td>Mean</td>
<td>21.9</td>
<td>4.4</td>
<td>9.5</td>
<td>5.1**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>13.2</td>
<td>2.7</td>
<td>6.0</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>1 day</td>
<td>Mean</td>
<td>20.8</td>
<td>4.7</td>
<td>10.1</td>
<td>5.4**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>12.1</td>
<td>3.3</td>
<td>8.5</td>
<td>7.7</td>
</tr>
<tr>
<td></td>
<td>1 month</td>
<td>Mean</td>
<td>28.1</td>
<td>6.0</td>
<td>10.7</td>
<td>4.7*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>15.8</td>
<td>3.7</td>
<td>9.4</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Note. Baseline reflects infants’ average looking time during the first two habituation trials. Post-habituation is the average of two no-change trials immediately following habituation. Test reflects infants’ looking during the two change or switch trials (e.g., level/happy to level/disgusted). Visual recovery is the difference between looking during the test trial average and the post-habituation average. Seconds to habituation is the average amount of looking time required for infants to reach a 50% decrease in looking from infants’ baseline looking. *p < .05; **p < .01.
Table 3. 12-month-olds’ mean PTLT and standard deviation (SD) to the object previously paired with the positive affect for the look and look-away conditions following a 5-minute, 1-day, or 1-month retention interval

<table>
<thead>
<tr>
<th>Gaze condition</th>
<th>Delay condition</th>
<th>Combined (trials 1–8)</th>
<th>Block 1 (trials 1–4)</th>
<th>Block 2 (trials 5–8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Look</td>
<td>5 min</td>
<td>Mean 0.59**</td>
<td>0.58*</td>
<td>0.60*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD 0.09</td>
<td>0.15</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>1 day</td>
<td>Mean 0.54**</td>
<td>0.57**</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD 0.06</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>1 month</td>
<td>Mean 0.49</td>
<td>0.44</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD 0.06</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>Look-away</td>
<td>5 min</td>
<td>Mean 0.51</td>
<td>0.53</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD 0.14</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>1 day</td>
<td>Mean 0.52</td>
<td>0.54</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD 0.09</td>
<td>0.16</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>1 month</td>
<td>Mean 0.48</td>
<td>0.51</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD 0.10</td>
<td>0.22</td>
<td>0.19</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01.

Table 3). An initial ANOVA with gender of the infant as the main factor was performed on infants’ proportion of total looking and failed to reach significance (*p > .1) thus subsequent analyses were collapsed across participant gender. A secondary observer recorded looking times for 30% of the infants at each age. Interobserver reliability was expressed as a Pearson product-moment correlation between the looking proportions of the primary and secondary observers and was .94 (SD = 0.07), averaged across infants of both gaze conditions (look, look away).

In order to determine whether 12-month-olds remembered the object paired with the positive affective expression during the habituation phase, we compared the mean PTLTs against the chance value of .50 (an equivalent proportion of time spent looking towards each object). As predicted, results indicated that 12-month-olds in the look-away condition failed to demonstrate a reliable preference for either object during Block 1, Block 2, or across Blocks 1 and 2 combined at any retention interval (all *p’s > .1). Results of the look condition, however, revealed a preference for the object paired with the positive affect following the 5-min and 1-day delay but not following a 1-month delay (see Table 2). Specifically, following a 5-min delay, infants looked proportionately longer to the object previously paired with the positive affect during Block 1: \( t(15) = 2.33, p < .05 \); Block 2: \( t(15) = 2.31, p < .05 \); and Blocks 1 and 2 combined: \( t(15) = 4.17, p < .01 \). Likewise, following a 1-day delay, infants also looked proportionately longer to the object previously paired with a positive affective expression during Block 1: \( t(15) = 3.20, p < .01 \), and in Blocks 1 and 2 combined: \( t(15) = 2.87, p < .01 \). No significant preference was observed during Block 2 (*p > .1) following a 1-day delay. Finally in
the look condition, no significant preference was observed during Block 1, Block 2, or Blocks 1 and 2 combined following a 1-month delay.

**Discussion**

A primary motivation for this experiment was to examine how long 12-month-olds maintain a visual preference for an object previously paired with an adult’s positive or negative affective expression. We also examined whether an adult’s direction of gaze affected infants visual preference for the previously unfamiliar object. It was predicted that infants would show a visual preference for a previously unfamiliar object when the adult’s visual attention was directed towards the object and not when the adult’s visual attention was directed away from the object. It was also predicted that 12-month-olds would show a preference for the object previously paired with the positive affective expression at all three retention intervals. Results were largely consistent with these predictions. Twelve-month-olds in the look condition showed a reliable visual preference for the object previously paired with the positive affective expression following a 5-min and 1-day retention interval. No visual preference was found in the look condition following a 1-month retention interval and no visual preference was found in the look-away condition at any retention interval.

Over the past thirty-years, a large body of research has emerged examining the development of social referencing in infants and young children. In addition, a vast literature has emerged examining various behaviours coupled with the development of social referencing. For example, research has examined whether infants can link another’s direction of gaze and the communicated affect towards a particular object (e.g., Moses, Baldwin, Rosicky, & Tidball, 2001; Repacholi, 1998), as well as infants’ gaze following and discrimination of different affective expressions (e.g., Flom & Pick, 2005; Striano et al., 2006). Unfortunately, however, research has not examined how long infants’ behaviour towards an object or event continues to be influenced or otherwise affected following circumstances of social referencing. This is unfortunate because much of infants’ early learning occurs within these social contexts and it is important for infants to remember what is learned or experienced within these contexts. Thus the current results, as well as the results of Hertenstein and Campos (2004), are important as they are the first to directly examine how long infants’ behaviour towards a previously unfamiliar object continues to be affected after being paired with an adult’s affective expression.

While the overall pattern of results in the current experiment and those of Hertenstein and Campos (2004) are congruent there are several methodological differences between the two studies. By using an infant-controlled habituation procedure, we were able to increase infants’ exposure to each object–affect pairing, and compared to previous experiments, we were able to examine whether infants had learned or encoded the events of habituation. In this experiment, infants viewed the two object–affect pairings during habituation for roughly 2 min, whereas infants in Hertenstein and Campos (2004) saw one pairing for 15 s. Thus, it is possible the increase in exposure (i.e., familiarization) time in the current experiment may explain, at least in part, why 12-month-olds continued to show a visual preference, following a 1-day delay, for the object paired with the positive affective expression. Another benefit of using an infant-controlled habituation design, in terms of familiarizing infants to the object and its associated affective expression, is we were able to examine whether infants learned this initial
pairing. It is possible in Hertenstein and Campos (2004) that 11-month-olds attenuated performance is due to the fact that they may have failed to encode the initial association of the object and the adult’s communicated affect. In the current experiment, however, we were able to address by including a ‘test phase’ following habituation where the initial object–affect pairing was reversed. In the current experiment, across all conditions, infants learned this initial association as such the 12-month-olds’ performance in the current study is not due to a failure of encoding the object–affect pairing.

Another critical difference between the current study and the study of Hertenstein and Campos (2004) is the fact that we used infants’ looking behaviour rather than their haptic exploration, where we believe we made the retention or memory task somewhat easier for infants (Keen, 2003; Mareschal, 2000). That is infants’ reaching and haptic exploration are often influenced by the size, shape, and location of the object and we reduced the effects of these physical factors by using a visual paired-comparison procedure (Newman, Atkinson, & Braddick, 2001). Thus, by increasing the amount of time infants were exposed to each object–affect pairing, and by using a preferential looking procedure, 12-month-olds show a visual preference for an object previously paired with a positive expression after a 1-day delay.

The fact that we were able to replicate the overall pattern of results found by Hertenstein and Campos (2004) using different procedures is important because together these studies demonstrate that around 1-year of age infants’ behaviour, following a delay continues to be affected by the adult’s affective expression. The current experiment, however, also extends Hertenstein and Campos (2004). For instance in Hertenstein and Campos (2004), it is possible the infants’ exploration of the previously unfamiliar object is reflective of mood induction rather than comprehending that the adult’s communicated affect is reference to a specific object. The current experiment builds upon this by manipulating where the adult was looking when conveying the affective expression. If infants were only associating the communicated affect with the object then infants in both the look and look-away condition should have shown a preference for the object paired with the positive expression. Because only those infants in the look condition showed a reliable preference, it seems 12-month-olds understood or otherwise comprehended whether the adult’s communicated affect was in reference to the visible object. Our pattern of results is consistent with previous research demonstrating infants of the same age are able to use another’s direction of gaze in determining which object that person is directing their affective communication towards or emoting about (Moses, Baldwin, Rosicky, & Tidball, 2001; Repacholi, 1998; Repacholi, Meltzoff, & Olsen, 2008).

As a related point, it is also unlikely our results are due to an a priori visual preference for one object compared to another as pilot testing with 12- and 13-month-olds, where the objects were not paired with the affective expressions, failed to reveal a reliable preference. In addition, we failed to see evidence for an object or object by affect interaction. Thus, during the preferential looking phase, infants’ preference for a particular object was influenced by which affect was paired with the object and whether the adult was looking towards or away from the object.

Within the context of social referencing infants’ behaviour towards the previously unfamiliar object is often assessed immediately after social referencing has taken place (Klinnert, 1984; Sorce, Emde, Campos, & Klinnert, 1985), or in some cases following a delay of a few minutes (e.g., Feinman & Lewis, 1983; Hertenstein & Campos, 2004; Hornik et al., 1987). If social referencing represents a format or context for early learning then it is important that infants learn, and of course remember, what occurs within these contexts for more than a few minutes. The current study extends this limitation
by including both short-term and long-term retention intervals and demonstrating that infants’ visual preference persisted following a 5-min and 1-day delay.

One question raised by these results is why we failed to find a significant visual preference following a 1-month delay. Research with 3- to 7-month-olds, for example, has shown that much younger infants can recall properties of an event or object following a 1-month, and in some cases a 3-month delay (e.g., Bahrick, Gogate, & Ruiz, 2002; Bahrick et al., 1997; Bahrick & Pickens, 1995; Courage & Howe, 1998, 2001; Flom & Bahrick, 2010). In addition, research with 12-month-olds using the visual paired-comparison procedure has shown reliable evidence of recognition memory using similar retention intervals (Hayne, 2007; Morgan, 2003; Morgan & Hayne, 2002; Robinson & Pascalis, 2004; Rose, Feldman, & Jankowski, 2001, 2003). One possibility, and a possibility for future research, may be the fact that our events were digital videos compared with a live presentation thereby attenuating our results at the 1-month retention interval. In other words, it is possible that our events, including the communicated affect, were somewhat less compelling than a live presentation. A related issue concerns the fact that our digital video events lacked any social contingency. Future research is also needed that examines whether, and for how long, the presence or absence of social contingency affects infants’ behaviour towards a previously unfamiliar object or event (Hains & Muir, 1996; Rochat & Striano, 1999).

Our choice to use the visual paired-comparison procedure to assess infants’ memory was in part motivated by the desire to make the memory task somewhat easier for infants (visual recognition vs. manual exploration) and in part to connect the current experiment to other studies examining early memory in infants. However, there is a critical difference in how we structured our visual recognition task compared to other studies. In nearly all studies of early memory using the VPC procedure, with both older and younger infants, the infant views a familiar and novel object and their visual preferences in terms of a novelty–familiarity preference is assessed (see Flom & Bahrick, 2010). In the current study, however, because both objects (and communicated affective expressions) were now familiar to the infant we were not able to make specific predictions regarding infants’ long-term memory based on traditional approaches to examining infants’ visual recognition memory. During the VPC test trials, we chose to present the two objects previously paired with an affective expression (i.e., positive/negative) rather than pair each of the objects with an unfamiliar object in order to avoid confounding object familiarity with affective expression. The above issues aside, the results of this experiment are important as they are the first to show that infants continue to show a visual preference for an object previously paired with an adult’s positive affective expression following a 1-day delay. As for the 1-month delay, given the methodological differences, we feel the most parsimonious explanation is that infants no longer showed a visual preference for object paired previously paired with an adult’s affective expression.

A final issue is whether infants’ looking behaviour during the preferential, or visual paired-comparison phase, is due to infants’ preference for the object paired with the positive expression or whether it is due to their avoidance of the object paired with the negative expression. Unfortunately, our results do not address this question. A possibility for future research would systematically vary whether infants are initially exposed to a positive or negative object-affect pairing. In addition, during the test, or comparison phase, infants would view the object paired with the affective expression and a novel object not paired with an affective expression. This would address the question of whether infants’ preferences are due to a specific emotion, and because a novel object
would be paired with the now familiar object, one could make predictions based on
research examining infants’ long-term memory.

Learning within social exchanges involves a repertoire of interrelated behaviours
including, but not limited to, shared visual attention, understanding the referential link
between where another is looking and the object of their attention, comprehending
what is being communicated, and being able to remember the association of the
communicated emotion and the particular object or event. Studies examining various
behaviours associated with social referencing have a rich history in the field of
developmental psychology. In addition, recent research has begun to examine the
relationship between infants’ discrimination of affect and infants’ establishment of joint
visual attention as well as the neurophysiological correlates of these behaviours and their
relationship to social referencing (Flom & Pick, 2005; Grossmann et al., 2007; Reid et al.,
2004; Striano et al., 2006). Until recently however, we knew little about long-term effects
of social referencing on infants’ behaviour. The results of this experiment are important
as they are among the first to examine this question where continued research is certainly
needed. Such research will not only increase our knowledge of social referencing and
related behaviours, but will also provide insights to the interconnected nature of early
perceptual, cognitive, and social development.

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Affect, gaze and visual preferences


Ross Flom and Sarah Johnson


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