

The Infant as Onlooker: Learning From Emotional Reactions Observed in a Television Scenario

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Two studies investigated whether 10- and 12-month-olds can use televised emotional reactions to guide their behavior. Infants watched an actress orient toward 1 of 2 novel objects and react with neutral affect during baseline and with positive or negative affect during test. Infants then had 30 s to interact with the objects. In Study 1, 12-month-olds ($N = 32$) avoided the target object and showed increases in negative affect after observing the negative-emotion scenario. Twelve-month-olds' responses to positive vs. neutral signals did not differ significantly. In Study 2, 10-month-olds ($N = 32$) attended to the televised presentations but showed no consistent changes in their object interactions or affect. Thus, 12-month-olds used social information presented on television and associated emotional signals with the intended target.

Infants spend many of their waking hours watching the actions and reactions of other people as well as participating in social interactions. As a bystander observing everyday events, the infant might watch a parent smile after tasting soup, an older brother cry as his tower of blocks tumbles down, or a babysitter look alarmed when a jar falls and breaks. The infant might also be a participant in these same events: As the parent offers a spoonful of soup while saying "Mmmm good," the sibling gets angry at the infant for touching his blocks, or the babysitter warns the child sharply to keep away from the broken glass. Increasingly, infants are also engaged in observing the actions and reactions of real and animated characters in a wide range of situations on television and video (Schmitt, 2001). Through experience in both of these roles, as bystander and as participant, young children learn how to interpret and predict the behaviors of other people and to relate this understanding to their own behavior.

Making sense of such streams of events in daily experience requires an appreciation at some level of the motivations and goals of others' actions and reactions as well as the possible outcomes and consequences. Most research on social understanding in infancy derives from two traditions that are conceptually and methodologically distinct. One tradition focuses on infants' appreciation of the intentions and goal-directed behaviors of others. Studies using habituation methods revealed that infants in the first year can interpret some actions as intentional or unintentional (e.g., Gergely, Nadasdy, Csibra, & Biro, 1995; Woodward, 1998) and can evaluate attentional and emotional information to predict the future actions of others (Phillips, Wellman, & Spelke, 2002). In such experiments the infant is an onlooker to a sequence of events and is asked to discriminate expected outcomes from outcomes that violate expectations (for review, see Wellman & Gelman, 1998). In the second research tradition, the child is a participant in social interaction rather than an onlooker. In the *social-referencing* paradigm, for example, a familiar adult interacts with the child using social stimuli that are directly relevant to the child's current situation (e.g., Hornik, Risenhoover, & Gunnar, 1987; Moses, Baldwin, Rosicky, & Tidball, 2001; Mumme, Fernald, & Herrera, 1996). Researchers have used analogous methods to investigate infants' use of pragmatic cues in word learning (e.g., Baldwin, 1993; Tomasello & Barton, 1994). In these types of studies in which the child is a participant, the question of interest is how attentional, emotional, and pragmatic cues from the social partner influence the child's own behavior.

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The present research used elements from both of these traditions to investigate how 10- and 12-month-old infants draw implications for their own behavior after witnessing an emotional event. As an onlooker, the infant watches a televised scenario of an actress reacting with neutral, positive, or negative emotion to one of two interesting novel objects before her. As a participant, the infant has an opportunity to interact with two real objects that are identical to those seen on television. The question here was not how the infant expects the actress to act toward the objects depicted on the screen, but how the emotional reactions of the actress influence the infant's own reactions when two real objects are subsequently presented. The infant watches the emotional scene as a passive onlooker in two respects: first, because the actress is a stranger on TV who has no contact with the child, and second, because the novel objects are nonthreatening and do not initially elicit any apprehension. We test the prediction that, by the end of the first year, infants will treat the two real objects differentially after watching the televised scenario, engaging more with the object to which the actress reacted positively and avoiding the object to which she reacted negatively. Such findings would suggest that, even when they are merely present as onlookers and not as participants in social interaction, infants are keenly attentive to the direction of gaze and the affective expressions of others and are able to draw inferences relevant to their own behavior from the emotional reactions they observe.

Because studies of social referencing used an experimental situation modeled on everyday parent-child interaction, they provided the first compelling demonstrations of infants' social-appraisal processes in action. Early discussions of the social referencing results concluded that infants' skills at reading and understanding the emotional responses of the mother in relation to, for example, an ambiguous novel toy were more sophisticated than anyone had imagined (e.g., Klinnert, Campos, Sorce, Emde, & Svejda, 1983). According to this interpretation, the infant attends to emotional signals from the caretaker primarily in situations of uncertainty, when the child is wary and actively seeks out relevant information about whether to approach or withdraw. If the mother smiles at the object that is the cause of the infant's discomfort (in this case the novel toy), the child interprets her emotional expressions in conjunction with gaze direction as evidence of a positive appraisal of the toy and responds accordingly by approaching it. Conversely, if the mother looks at the toy while expressing fear

or disgust, the child infers that the negative emotional reaction is related to the toy and responds with avoidance. Although this rich interpretation was consistent with the results of early social referencing studies, it is not altogether consistent with more conservative claims about preschool children's understanding of mental states that have emerged more recently from research on theory of mind (see Baldwin & Moses, 1996). Moreover, several assumptions central to this account remain in question because they were not tested directly in the original experiments. Three of these assumptions are discussed next to situate the current study in relation to previous research.

The first assumption is that social referencing occurs only when the infant is in a state of apprehensiveness or uncertainty. The original social-referencing studies used stimuli that were potentially disconcerting, such as the apparent drop-off of the visual cliff (Sorce, Emde, Campos, & Klinnert, 1985), an animated dinosaur (Klinnert, 1984), or the approach of a stranger (Boccia & Campos, 1989). Such stimuli elicited both interest and hesitation and were ideally suited to induce a state of fascinated wariness in most infants. More recent studies in this tradition have continued to use ambiguous toys as stimuli (e.g., Moses et al., 2001) on the assumption that infants are responsive to adults' emotional signals primarily under these conditions. It is certainly the case that guidance from the caregiver may be particularly relevant when the child confronts a potentially threatening situation, and that the ability to seek out and learn from the emotional signals of others under these circumstances is crucial. However, this argument overlooks the fact that such occasions may be uncommon in the child's experience and that everyday emotional communication frequently focuses on objects and situations that appear to be innocuous. For example, there is nothing initially unnerving about a hot plate, an electrical outlet, or a piece of broken glass that would deter an infant's interest on first encounter, and it is exactly such commonplace hazards that parents need to teach their child to avoid. The present study extended earlier research by examining infants' use of emotional signals in a context that differed in two important ways from the traditional social-referencing paradigm. First, the infants' starting state was interest rather than wariness, and second, the emotional information was imposed on rather than solicited by the infant. Thus, the infant was a passive onlooker, watching a stranger react to an apparently harmless object in a televised scenario.

A second assumption implicit in most social-referencing studies is that infants understand something about the specificity of emotional messages. This widespread conclusion is based on the finding in many different experiments that infants who saw a positive emotional signal directed toward a particular target object approached the object more than did infants who saw a negative emotional signal directed toward the same target object (e.g., Camras & Sachs, 1991; Moses et al., 2001; Repacholi, 1998; Walden & Ogan, 1988). Although this pattern of results is robust, the logic of the interpretation needs to be examined. Typically, the basis for this pattern of results is a direct comparison of responses to positive and negative signals rather than comparisons between responses to both positive and negative signals in relation to a baseline condition. An analogy from another domain illustrates this point: If a well-controlled study showed that a group of children given a glass of cola at 5 p.m. slept significantly less each night than a group given a glass of milk, it would be legitimate to conclude that the two drinks differed in their effects. However, it would clearly not be legitimate to conclude that cola had a negative effect on sleep whereas milk had a positive effect. When compared with sleep time following a glass of water at 5 p.m., it could be that cola decreased amount of sleep whereas milk had no effect at all, or that milk increased amount of sleep whereas cola had no effect, or that neither cola nor milk had a significant effect although they differed slightly from each other. Only by comparing scores in both experimental conditions with the scores of the same children in an appropriate baseline condition is it possible to determine whether either drink increased or decreased performance relative to no intervention. Yet, studies that directly compare responses to positive and negative emotional signals have commonly ignored this criterion (e.g., Moses et al., 2001; Repacholi, 1998; Walden & Ogan, 1988). That is, they have concluded that infants responded appropriately to both positive and negative emotional signals, although they have failed to demonstrate that the response to either emotional display differed reliably from the response to a neutral display.

A few social-referencing studies have presented infants with neutral expressions in addition to positive and negative emotional expressions to try to address the question of emotional specificity (e.g., Hornik et al., 1987; Klinnert, 1984; Mumme et al., 1996). However, only the study by Mumme et al. (1996) used a neutral expression trial as a baseline trial. In this study, all sessions began with a baseline

trial, which consisted of the infant's caregiver expressing neutral emotion toward an ambiguous toy. The neutral baseline trial was followed by an emotion test trial, which consisted of caregivers expressing either positive or negative emotion to a different ambiguous toy. With this design, Mumme et al. were able to compare the infants' scores in the positive and negative emotion trials with their scores in the neutral baseline trial. The study revealed that, relative to their baseline measures, infants responded to negative vocalizations with increased inhibition and negative affect. Equally important, infants in the positive emotion condition, relative to their baseline measures, did not show significant changes in behavior or affect. Thus, negative vocalizations had the predicted effect on infant behavior, but positive vocalizations had no effect compared with baseline. The present study adopted the same rationale, comparing each infant's response to the target object following a positive or negative emotional display with the response of the same infant following a neutral emotional display. This design allowed us to assess whether positive and negative emotional signals have different effects on the infant overall, as has been shown in previous studies. But this design also enabled us to ask more specifically whether the actress's positive emotional signals actually increased infant engagement with the target object and whether the actress's negative emotional signals actually decreased engagement, relative to a baseline in which the actress attended to the object with neither positive nor negative emotion.

A third assumption drawn from earlier social-referencing research is that infants use the mother's direction of gaze to identify the novel toy as the focus of attention. However, it was not possible to conclude that infants responded selectively based on attentional cues from the mother, because no equally salient object was available as a potential alternative. Although some studies have suggested that infants as young as 6 months can follow the general direction of an adult's gaze when the head is turned (Butterworth & Cochran, 1980; Scaife & Bruner, 1975), more recent evidence has shown that infants do not begin to follow direction of gaze reliably until later in the first year—around 10 to 12 months (Corkum & Moore, 1998). However, the ability to follow the gaze of another person to an interesting object does not necessarily indicate that the infant realizes the adult is focusing on that object or expressing an emotion about it.

Two recent studies have addressed this question directly. Repacholi (1998) presented two objects

simultaneously to 14- and 18-month-olds, but the objects were hidden in separate boxes and thus were not visible to the infant. The experimenter expressed disgust while looking into one box and happiness while looking into the other. Repacholi was interested in whether infants would link the emotional signal with the boxes or with the objects inside. She reasoned that if infants indeed made use of attentional cues they would understand that the emotional signals were directed to the contents and not to the boxes themselves. The children touched both boxes equally but were more likely to search for the happy object than the disgust object. This finding suggests that infants as young as 14 months can use gaze as a referential cue for the target of an emotional display. Moses et al. (2001) extended these findings using a discrepant-labeling procedure. The discrepant-labeling procedure was developed for studies of word learning to show that 18-month-olds attend to an adult's direction of gaze to figure out which of two objects the adult is referring to when the adult uses a novel label (see Baldwin, 1993). To investigate referential understanding in the emotion domain, the experimenter in the Moses et al. study presented two ambiguous toys and waited for the infant to attend to one of them. In the joint-attention conditions, the experimenter directed a positive or negative emotional outburst toward the toy to which the child was currently attending; in the discrepant-attention conditions, the emotional signals were directed toward the toy to which the child was not attending. Moses et al. found that both 12- and 18-month-olds noticed when the experimenter's attentional focus was discrepant from their own and shifted their gaze toward the other toy. Across both attention conditions, infants played more with the toy that was the target of positive emotion than the one that was the target of negative emotion.

These studies by Repacholi (1998) and by Moses et al. (2001) provided convincing evidence that by the beginning of the second year, infants attend to the gaze direction of another person when interpreting the emotional signals of that person during a social interaction. The present study extended these findings by asking whether 10- and 12-month-olds monitor the attentional focus of an actress on television to distinguish between two novel objects, one that is the target of the emotional display and another nearby object that is equally salient and visually accessible to the infant but that the actress ignores.

To summarize, both the stimuli and the experimental design used in this study distinguish it from previous work on infant social referencing. First, the

stimuli consisted of televised emotion scenarios that were imposed on the infant rather than solicited by the infant, and the test objects presented in the televised scenarios were novel but not ambiguous. Second, the study's inclusion of a neutral baseline trial made it possible to test whether positive and negative emotional signals differentially influence infant behavior and affect. Third, each televised scenario contained two equally salient objects as potential targets of the emotional reaction.

This research's final noteworthy departure from traditional social-referencing procedures was the use of televised rather than live presentations of emotional signals. The primary advantage of prerecorded video presentations is increased stimulus control. Previous studies have found considerable variability in individuals' skills at posing convincing facial and vocal emotional signals on cue (Camras & Sachs, 1991; Mumme et al., 1996; Rosen, Adamson, & Bakeman, 1992). Because the current study required not only that the signaler deliver standardized emotional signals with a fixed verbal content but also that she clearly direct the signals toward one object and not the other, a high level of stimulus control was essential. In addition to this methodological advantage, the use of televised presentations raises interesting research questions with implications for parents and policymakers. Can televised emotional communications influence the behavior of children as young as 10 and 12 months of age? Will such young children treat a televised image as a social partner such that they draw implications for their own actions after observing the televised reactions of another person? A precedent for the use of this type of procedure is Meltzoff's (1988) research on imitation in 14- and 24-month-old infants, in which the model's actions were presented on television rather than live. Meltzoff found that even the younger infants attended to the televised image and were able to imitate an object manipulation they had previously seen only on a television monitor.

The main question of interest in the current investigation was will the emotional signal an actress directs toward a target object depicted on television influence infants' subsequent tendency to interact with the real target and distracter objects? To test this question, two different pairs of novel objects were presented across two trials, a neutral baseline trial followed by a positive- or negative-emotion test trial. On each trial, the actress looked at and directed her emotional display toward only one of the two objects before her. From the point of view of the infant watching the scene, the objects were close

together and both plainly visible. When later presented with real objects corresponding to those viewed on the screen, the infant could react in one of several ways. For example, following a display of negative emotion toward the target object, the infant might simply ignore this information and respond to both objects in the same way as on the neutral baseline trial. Alternatively, on this negative-emotion test trial, the infant might respond with general inhibition by avoiding all nearby objects. Or the infant might realize that the negative signal referred to only one of the two objects and avoid only the specific object that was the focus of the emotional display. We would expect such an emotion-specific and referent-specific response of adults, assuming they would pay attention not only to the valence of the emotion the actress was communicating but also to the object that was the apparent cause of her reaction.

The design of this study permitted separate tests for generalization and referential specificity in response to both positive and negative emotions. The *generalization hypothesis* predicted that emotional signals would influence infants' overall tendency to play with the two stimulus objects, thus resulting in more play with both the target and distracter objects following a positive signal compared with a neutral signal, and resulting in less play with both objects following a negative signal. The *referential specificity hypothesis* predicted that emotional signals would influence infants' tendency to play with the stimulus objects selectively, resulting in more or less play with the target object depending on the valence of the signal. That is, infants should play relatively more with the target than with the distracter object following a positive emotional display as compared with a neutral display, and they should play relatively less with the target than with the distracter object following a negative display as compared with a neutral display.

Another question of interest was will infants also respond to the emotional reactions of the actress with a change in their own affective states? The *emotional contagion* hypothesis predicted that infants would respond to positive signals with more positive affect overall and to negative signals with more negative affect overall. It is important to note that these various hypotheses are not mutually exclusive. For example, the generalization and referential specificity hypotheses would both be confirmed if infants became more inhibited and played less with both objects following a negative emotional display than following a positive display, but still played relatively more with the distracter

than with the target object in response to negative emotion. The emotional contagion hypothesis could be confirmed in this case as well, if the child showed more negative facial affect in addition to more inhibited play overall and more play with the distracter than the target object following the negative emotional display.

Study 1

Method

Participants

Participants were 32 full-term, healthy 12-month-old infants recruited from the general population in a predominantly White, middle-class community through county birth records. The sample was 87.5% Caucasian and 12.5% Asian. Infants were between 351 and 382 days old ($M = 367.47$, $SD = 9.45$). Sixteen infants (8 girls and 8 boys) were randomly assigned to each emotional valence condition (positive, negative). An additional 21 participants were not included in the final sample for the following reasons: infant threw an object out of reach within the first 10 s of the play period (3), infant became too distressed to continue the session (6), infant failed to look at the video for at least 5 s during a trial (2), infant refused to sit in the high chair (1), parent laughed or talked during a trial (2), and experimenter error or equipment failure (7).

Design

The study was a mixed design with emotional valence (positive or negative) as the between-subjects factor and trial (neutral baseline, emotion test) and object (target, distracter) as repeated factors. On the first trial, referred to as the *neutral baseline trial*, infants were presented with the neutral-emotion scenario to provide a baseline measure of responsiveness to a novel toy. On the second trial, referred to as the *emotion test trial*, infants were presented with either the positive- or negative-emotion scenario, depending on condition. This design enabled us to compare each infant's responses following a positive or negative emotional display with the same infant's responses following a neutral (baseline) emotional display.

Apparatus

The experiment was conducted in a 3.7 m × 4.0 m carpeted room with a one-way mirror on one wall. As shown in Figure 1, the infant sat in a high chair at



Figure 1. Experimental room setup.

a large table facing a 20-in. (50.8 cm) color television monitor. A 21 cm (height) \times 45 cm (length) \times 75 cm (width) wooden stand in the center of the table supported the television. The parent also sat at the table, to the infant's right. A wall-mounted camera filmed the parent, and a camera mounted under the television stand filmed the infant; the two images were recorded onto a split screen. During the procedure, the experimenter was in an adjacent control room, and an assistant sat behind the television, concealed by a partition. A black curtain, with a hole for the camera lens, was attached to the bottom of the television stand to conceal the assistant as she pushed the objects out to the infant. The objects were pushed out on a 30 cm \times 60 cm plastic platform fitted with long handles so that the infant would not see the assistant's hands. A wooden frame affixed to the table served as a guide for the platform so that the platform moved smoothly and stopped 6 cm from the infant. Both the assistant and parent wore earphones so the experimenter could communicate with them as she controlled the video presentations and the trial timing from the control room.

Materials

Stimulus objects. Four novel objects were used as test stimuli: a 12-cm-long red spiral letter holder; a 7-cm blue bumpy ball with ten 2-cm-long nodules protruding from it; an 11-cm-tall Y-shaped object made by connecting a green and a yellow garden hose adapter; and a 12-cm-tall plastic valve made up of a white tube, a red wing nut, and a blue knob. Through pilot testing, we determined that infants perceived these objects as engaging but not at all threatening. Parents reported that none of the infants had ever played with objects like these.

Video stimuli. In each 20-s video presentation, an actress directed neutral, positive, or negative emo-

tional signals at one of two stimulus objects before her. The video images of the stimulus objects displayed on the television monitor appeared identical in size to the actual objects. The actress was a 22-year-old Caucasian female filmed so that only her head and shoulders were displayed. Within 1 s of appearing on screen, the actress looked directly at one object (target) and away from the other object (distracter) and began to express the appropriate facial and vocal signals. The look to the target involved turning the head and simultaneously shifting the eyes.

In preparation for the taping sessions, the experimenter demonstrated neutral, positive (happy), and negative (fearful) faces to the actress, and reviewed pictures of prototypical facial expressions (from Ekman & Friesen, 1975). The vocal emotional signals were also demonstrated and explained in terms of characteristic acoustic properties described by Scherer (1986). The positive vocalizations included segments that were high pitched and smooth and segments spoken with a relaxed voice that dramatically rose and fell in pitch. The negative vocalizations began with a gasping inhalation and continued with words spoken rapidly with a tense voice slightly elevated in pitch. The neutral signals for the baseline trial involved minimal facial movement and minimal vocal inflection. All vocal signals were scripted descriptions of the objects that did not contain any emotion words. We avoided vocalizations containing semantic cues about the speaker's intentions toward the object (e.g., words such as *yes*, *no*, *nice*, *yuck*) because our aim was to test the influence of emotional information, not linguistic information, on infants' behavior. For example, in response to the spiral letter holder the actress used the words "Look at that. It's plastic. It has four legs. It has lots of loops. It's a cylinder. It's bright red. Look at that." The same description of each object was used for the neutral, positive, and negative trials. Although descriptions varied across objects, they always began and ended with "Look at that" and were closely matched in duration. Complete transcripts of the stimuli are available from the first author.

To counterbalance target object and target side, we created eight orders from these video presentations (see Table 1). Each order had a 20-s neutral presentation for the first trial (i.e., the neutral baseline trial) and a 20-s emotion presentation for the second trial (i.e., the emotion test trial). There were four neutral-positive orders and four neutral-negative orders. The eight orders ensured that each of the four novel objects was the target of neutral,

Table 1
Stimulus Presentation Orders

Order	Trial	Object on infant's left	Object on infant's right
Orders 1 & 2	Neutral	Bumpy ball	Letter holder
	Emotion	Hose adapter	Plastic valve
Orders 3 & 4	Neutral	Bumpy ball	Letter holder
	Emotion	Hose adapter	Plastic valve
Orders 5 & 6	Neutral	Plastic valve	Hose adapter
	Emotion	Letter holder	Bumpy ball
Orders 7 & 8	Neutral	Plastic valve	Hose adapter
	Emotion	Letter holder	Bumpy ball

Note. The objects in bold were the target objects for that order. The odd-numbered orders were the neutral-positive orders, and the even-numbered orders were the neutral-negative orders.

positive, and negative emotion and appeared equally often to the left and right of the infant. In this set of stimuli, the letter holder was always paired with the bumpy ball and the hose adapter was always paired with the plastic valve. Within each order, the side targeted for the neutral and emotion signals was always the same.

Procedure

During the warm-up period, the experimenter explained the procedure to the infant's parent. Parents were instructed to limit interaction with the infant to the intervals between trials. During the video presentation and object play periods, parents were asked to read a magazine and not to look at their infants, talk, or make facial expressions. Because the data tapes included a split screen image of the infant and parent, we were able to ascertain that all parents in the final sample followed these instructions.

Each session consisted of three 50-s trials: a neutral baseline trial, a positive- or negative-emotion test trial, and a final positive trial. Within each trial, there was a presentation period consisting of the 20-s video, and a 30-s play period, during which the infant was able to touch the objects. To end sessions on a cheerful note, on the final trial, the actress expressed positive affect toward a toy boat. This final trial was not coded and will not be discussed further.

At the beginning of each trial, the assistant pushed the two objects out from under the curtain. The objects were pushed out so that each object was directly under the television monitor aligned with its image in the video display. Even though the objects were lined up in this fashion, when viewed from the infant's perspective, the actress appeared to be

looking at the object on the video and not at the real object. During the video presentation, the objects were approximately 70 cm from the infant, well out of reach. The real objects were in view throughout the trial for two reasons: First, infants were not required to remember that they had seen these objects in the video presentation; second, the connection between the video images and the real objects was made maximally transparent (cf. Troseth & DeLoache, 1998).

Once the video presentation ended, the experimenter paused the video and a blue field appeared on the television. The experimenter then signaled the assistant to push the objects to the infant. The timing for the 30-s play period began as soon as the object platform reached the end of the wooden frame or as soon as the infant touched one of the objects, whichever occurred first. It generally took about 4.5 s for the toys to be pushed within the infant's reach ($M = 4.42$ s; $range = 2-7$ s). The play period ended early if an object fell off the table or if the infant became fussy. If either of these events occurred within the first 10 s of the play period, the infant was excluded from the final sample. Most of the play periods (79%) lasted the full 30 s ($M = 28.12$ s; $range = 15-30$ s). At the end of the trial, the experimenter asked the parent to remove the objects from the table and to interact with the infant until the next trial. The assistant then pulled the platform behind the curtain to set up the objects for the next trial.

Coding and Rater Agreement

Three variables in infant behavior were coded offline from the videotapes: duration of looks to the video display and to the target and distracter objects during the presentation period, duration of touching of each object during the play period, and positive and negative facial expressions during both the presentation and play periods. (The brief intervals during which the objects were pushed within the infants' reach were not scored.) Because the cameras focused on only the infant and parent and because coding was done without sound, raters were kept blind to experimental conditions. The experimenter and a research assistant each coded approximately half the participants' data. Both independently coded every fourth participant (25% of the sample) for reliability checks. Rater agreement was assessed by calculating intraclass correlations for each of the measures.

Looks to video display and real objects. The onset and offset times for looks to video display, looks to the

real target object, and looks to the real distracter object during the presentation period were rounded to the nearest 0.5 s. Rater agreement ranged from .95 to .99.

Object touch. Target touch and distracter touch during the play period were not mutually exclusive, as infants could touch both objects, touch neither, or touch one or the other. The amount of time the infant spent touching each object was coded to the nearest 0.5 s. Because not all infants completed the 30-s play period, the touch scores were analyzed using proportions, calculated by dividing the amount of time the infant spent touching the object by the duration of the play period (e.g., total time touching target/total play-period duration). Rater agreement was .99 for both target touch and distracter touch. Based on Cohen and Cohen's (1983) recommendation, the object touch proportions were submitted to the arcsine transformation for data analysis. However, for ease of comprehension, the scores reported in the results and figures are those for the untransformed proportions.

Affect. Infants' facial expressions were used as indicators of their general emotional states. Although we did not have separate predictions for the presentation and play periods, infants' facial expressions may index different responses. For example, infants' facial expressions during the presentation period might be the result of direct imitation of the speaker's facial expressions. In contrast, during the play period, infants' facial expressions might better represent the infants' current affective states. However, there is no way to make these distinctions with the present coding system. Following procedures used in previous studies, positive and negative affect were coded separately on 3-point scales (cf. Fernald, 1993; Hirshberg & Svejda, 1990; Mumme et al., 1996). Judgments were made every 3 s and were based exclusively on facial expressions of affect because the sound was turned down to keep raters blind to experimental condition. A score of 0 indicated that the infant's face appeared neutral during the interval. For positive affect, a 1 was scored for slight smiles and raised brows, and a 2 was scored for big smiles. For negative affect, a 1 was scored for slight frowns, furrowed brows, and worried expressions, and a 2 was scored for crying, big frowns, or scowls. Mean positive affect scores for the presentation and play periods were calculated by totaling the positive affect scores across each period and then dividing by the number of intervals coded in that period. Mean negative scores for the presentation and play periods were

calculated similarly. Rater agreement ranged from .91 to .99.

Results

Preliminary Analyses: Were Infants Attentive to the Stimuli?

Duration of looks to video display. All infants in the final sample watched the presentation for at least 5 s ($M = 12.84$ s, $SD = 3.72$ s; $range = 5.5$ – 19.5 s). A mixed-effects ANOVA, with emotional valence condition (positive, negative) as the between-subjects factor and trial (neutral baseline, emotion test) as the repeated factor, revealed no significant main effects or interactions. Thus, there were no differences in infants' attentiveness to the video presentations as a function of valence condition.

Duration of looks to the real objects. Infants tended to look away from the video display and glance at the real objects only briefly ($M = 1.67$ s, $SD = 1.32$ s; $range = 0$ – 5.5 s). However, all infants looked at one or both objects at least once during the video presentations. The majority (78%) did so during both the baseline and test presentations. Nearly all infants showed the same pattern of gaze shifts: They looked at the television monitor, then at one object or the other, then back at the television. A mixed-effects ANOVA showed that looks to the real objects during video presentation did not vary with valence condition, trial, or object type.

Did Infants Interact With the Objects Differentially?

The primary question motivating this research was whether emotional signals directed toward an object would influence infant behavior toward the target object (the referential specificity hypothesis) or toward all salient objects in view (the generalization hypothesis). To answer this question, we conducted a mixed-effects ANOVA, with emotional valence (positive, negative) as the between-subjects factor and trial (neutral baseline, emotion test) and object (target, distracter) as the repeated factors. The referential specificity and generalization hypotheses make different predictions, although it is possible for both to be confirmed. The referential specificity hypothesis would be supported if we found that infants' behavior toward the target object but not the distracter object changed from the neutral baseline trial to the emotion test trial, depending on the emotional valence condition (i.e., a significant Valence \times Trial \times Object interaction). The generalization hypothesis would be supported if we found that

infants' behavior toward both the target and distracter objects changed from the baseline to the test trial (i.e., a significant Valence \times Trial interaction).

The mean proportions of touch to target and distracter objects on the neutral baseline and emotion test trials in both the positive and negative emotional valence conditions are shown in Figure 2. The ANOVA revealed a significant main effect of trial, $F(1,30) = 10.54, p < .01$, reflecting overall differences in object touch between baseline and test trials. Most important, the Valence \times Trial \times Object interaction was significant, $F(1, 30) = 4.27, p < .05$, as predicted by the referential specificity hypothesis. That is, in the positive valence condition, infants touched the target object more than the distracter object during the test trial, whereas in the negative valence condition, infants touched the distracter more than the target during the test trial. The Valence \times Object interaction was also significant, $F(1, 30) = 5.72, p < .05$. No other main effects or interactions were reliable.

As shown in Figure 2, the most apparent change in infants' object touch was in the negative condition. To determine whether the effects were in the predicted direction and whether they were specific to the target object and not the distracter, follow-up comparisons were made within each valence condition using the Bonferroni procedure to maintain familywise $\alpha = .05$. Infants touched the target object much less during the negative-emotion test trial ($M = .30, SD = .22$) as compared with the neutral baseline trial ($M = .64, SD = .24$), indicating a significant effect of negative emotional signals on infants' behavior, $t(1, 15) = -3.54, p < .01$. In the

positive condition, however, there was no significant change in infants' tendency to touch the target object. Although behavior toward the target object changed in response to negative signals but not to positive signals, behavior toward the distracter did not vary from the baseline to the test trial in either the positive or negative conditions. Thus, 12-month-old infants responded specifically and appropriately to the negative emotional display by avoiding the object that was the target of the speaker's negative reaction. Equally important, they did not respond differentially to the target object following a positive emotional display.

Did Infants Show Changes in Emotional State?

The emotional contagion hypothesis predicted infants would show through their facial expressions that they were influenced overall by the actress' positive or negative emotional reactions to the objects on the screen. This would be evident if infants in the positive condition showed an increase in positive affect from baseline to the positive-emotion test trial or if infants in the negative condition showed an increase in negative affect from baseline to the negative-emotion test trial. Following data-analytic techniques used in previous studies (e.g., Mumme et al., 1996), we calculated difference scores to test for change from the baseline to the emotion test trial. When using difference scores, it is critical first to ensure that there are no systematic differences between valence conditions during the baseline trial. Analyses of infants' affect showed no differences between the infants in the positive and negative valence conditions during this baseline period. For each affect measure for each infant, the neutral baseline trial score was subtracted from the emotion test trial score. The four difference scores (positive presentation and play affect, and negative presentation and play affect) were then submitted to a multivariate ANOVA with valence condition (positive, negative) as the fixed factor.

The multivariate analysis of infants' facial expressions of affect revealed an overall effect of emotional signal valence, $F(4, 27) = 3.78, p = .01$. Subsequent univariate analyses revealed significant effects for negative affect during both the presentation period, $F(1, 30) = 11.30, p < .01$, and the play period, $F(1, 30) = 8.16, p < .01$. As shown in Figure 3, infants in the negative-emotion condition showed the predicted increases in negative affect from the neutral baseline trial to the negative-emotion test trial, whereas infants in the positive-emotion condition showed decreases in negative affect. There were no

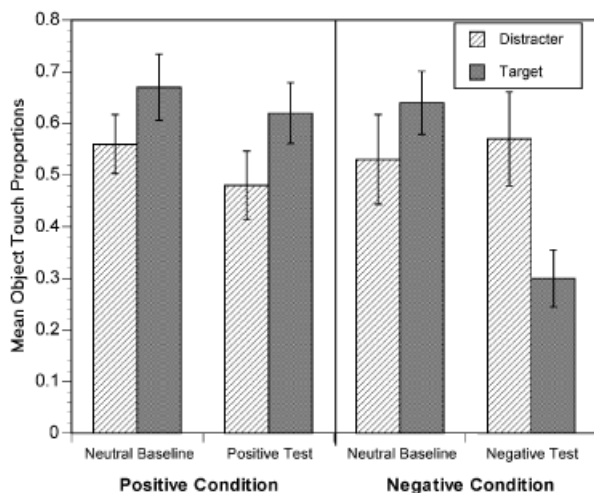


Figure 2. Mean proportions of object touch at 12 months of age as a function of trial and emotional valence condition.

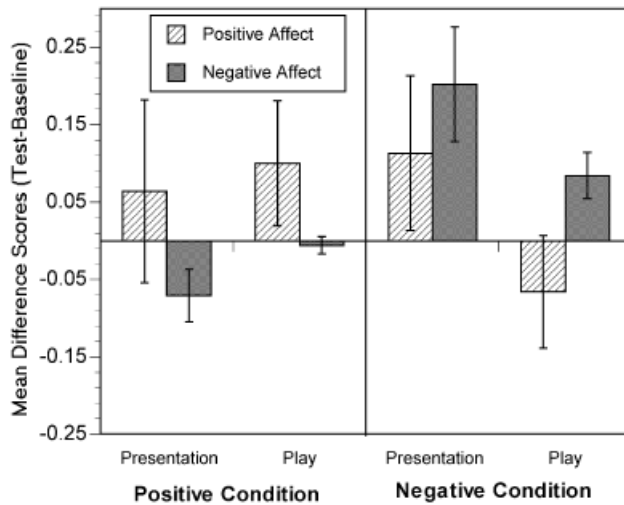


Figure 3. Changes in 12-month-old infants' affect from baseline to test as a function of emotional valence condition.

systematic changes in infants' expressions of positive affect in either the presentation or play periods.

Discussion

The results of Study 1 indicate that 12-month-old infants were able to make use of attentional and emotional cues provided in the televised emotional reaction of a stranger. By responding selectively to the object that was singled out by the actress, infants showed that they could discern that the emotional signal was directed to one object and not to the other. That is, when the actress responded either with neutral or positive emotion while looking at the target object, infants touched the target object more than the distracter object. However, when the speaker reacted negatively toward the target object, infants avoided that object in the play period. Although the referential specificity hypothesis was confirmed, the generalization hypothesis was not. Twelve-month-old infants did not generalize their avoidance during the negative-emotion trial to the distracter object. Instead, they touched the distracter as much in the negative-emotion test trial as they had in the neutral baseline trial. In addition, infants showed evidence of emotional contagion in the negative condition. They showed more facial expressions of negative affect during the negative-emotion test trial, suggesting that the actress' negative reactions also had an effect on infants' emotional states.

These findings extend understanding of the social referencing process in a number of ways. First, they reveal that infants are responsive to others' emotional signals even when not in a state of uncertainty or wariness. Second, this is the second study to show

that, relative to a neutral baseline trial, negative emotional signals have a regulatory effect on 1-year-old infants' interactions with novel objects whereas positive emotional signals do not (cf. Mumme et al., 1996). Third, our findings and those of Moses et al. (2001) provide converging evidence that infants are able to use line of regard to interpret emotional communications at the end of the first year.

Perhaps the suggestion that 1-year-old infants understand that an emotional signal can be directed toward a specific object is not surprising. By this age, infants have already acquired one critical prerequisite: the ability to follow direction of gaze and head turn (Butterworth & Groer, 1988; Butterworth & Jarrett, 1991; Corkum & Moore, 1998). However, an infant may correctly follow a person's gaze to an interesting object but still fail to realize that the person is focusing on that object, labeling it, or expressing an emotion about it. To respond appropriately to the communicative intent of an emotional signal, infants must be sensitive to the tone of the message, selectively relate the signal only to the target object, and ignore other available objects competing for their attention.

A question that arises from these results is whether even younger infants are able to make use of attentional cues in interpreting emotional signals. Recent work on the origins of joint visual attention by Corkum and Moore (1998) suggests that at around 10 months of age infants begin to follow the gaze consistently. The majority of 10- to 11-month-old infants in their study either spontaneously followed the experimenter's gaze or learned to do so reliably during the experimental session; however, very few infants just 1 month younger did so spontaneously, and many were unable to learn this response. Similarly, in their longitudinal study of social cognition in 9- to 15-month-old infants, Carpenter, Nagell, and Tomasello (1998) reported on a number of joint attentional behaviors that emerge near the end of the first year. For example, at 9 months, all 24 infants in their sample participated in at least one joint engagement episode with the experimenter, and by 11 months the majority of infants passed a point-following task. However, it was not until 13 months that a majority passed a gaze-following task. These findings suggest that sometime between 9 and 13 months, infants' abilities to participate in bouts of shared attention are solidifying. In the second study we asked whether infants' skills at using attentional cues for interpreting emotional signals are present at 10 months of age—an age at which their skills at engaging in joint attention are emerging.

Study 2

Method

Participants

Participants were 32 full-term, healthy 10-month-old infants recruited from the same middle-class population as in Study 1. The sample was 84.4% Caucasian, 9.4% Asian, 3.1% Black, and 3.1% Hispanic. Infants were between 289 and 321 days old ($M = 305.91$, $SD = 9.45$). Sixteen infants (8 girls and 8 boys) were randomly assigned to each valence condition (positive, negative). An additional 15 participants were not included in the final sample for the following reasons: infant threw or pushed one of the objects out of reach within the first 10 s of the play period (5), infant became too distressed to continue the session (3), infant failed to look at the video presentation for at least 5 s during the neutral baseline trial (2), infant refused to sit in the high chair (2), and infant did not touch any of the toys during the entire session (3).

Apparatus, Materials, and Procedure

The experimental room, equipment, stimulus objects, video stimuli, procedures, and coding systems were identical to those of Study 1.

Results and Discussion

Preliminary Analyses: Were Infants Attentive to the Stimuli?

Duration of looks to video display. All infants in the final sample watched the presentation for at least 5 s ($M = 13.27$ s, $SD = 3.76$ s; range = 5.5–20 s). Looking times did not vary by condition or trial.

Duration of looks to the real objects. The 10-month-old infants, similar to the 12-month-olds, tended to look at the real objects only briefly ($M = 1.12$ s, $SD = 1.44$ s; range = 0–7 s). Most infants (81.3%) looked at the objects at least once during the session. However, half the sample either failed to look at the objects during one trial (10 infants) or never looked at the objects (6 infants). The 2 (valence condition) \times 2 (trial) \times 2 (object) repeated-measures ANOVA revealed no significant effects of valence, trial, or object status on infants' looking times.

Did Infants Interact With the Objects Differentially?

Given recent findings suggesting that infants' skills at using referential gestures are only just emerging at the end of the first year, we expected

that 10-month-olds would be more likely to generalize the emotional signals to both objects than to interpret them as referring to one object specifically. However, we found no evidence for either generalization or specificity. The Valence Condition \times Trial \times Object repeated-measures ANOVA revealed no significant effects of valence, trial, or object and no interactions. As shown in Figure 4, the mean object touch proportions were similar across conditions and objects.

Did Infants Show Changes in Emotional State?

As in Study 1, the affect scores were converted to difference scores. Before doing so, we examined the baseline trial data to ensure that there were no systematic differences between conditions. There were none, and subsequently the difference scores were analyzed using a MANOVA. There was no evidence that 10-month-olds' moods changed in the direction of the positive tone of the positive signal or the negative tone of the negative signal. If anything, it appeared that infants in both conditions showed decreases in positive affect and increases in negative affect over the course of the session (see Figure 5).

Follow-Up Analyses: How Did 10- and 12-Month-Olds Differ?

In contrast to the differential responding of the 12-month-old infants in Study 1, the 10-month-old infants in Study 2 did not vary their behavior toward the objects in response to positive and negative

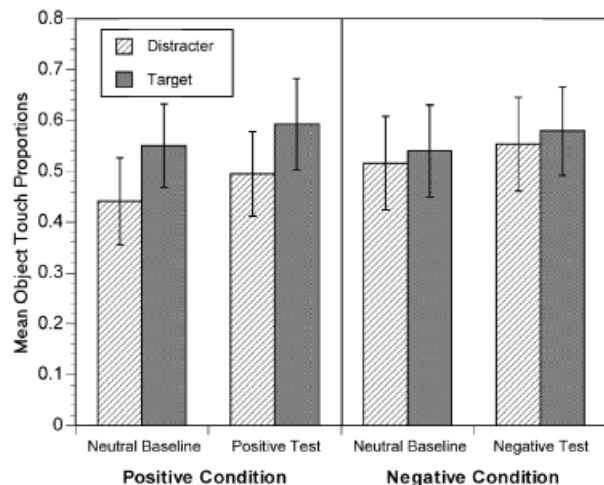


Figure 4. Mean proportions of object touch at 10 months of age as a function of trial and emotional valence condition.

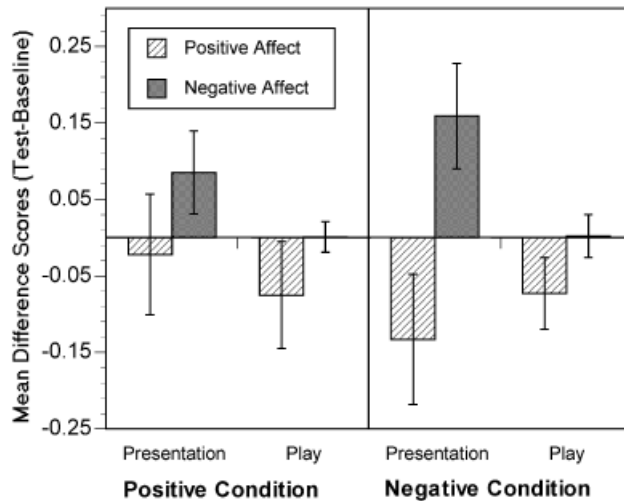


Figure 5. Changes in 10-month-old infants' affect from baseline to test as a function of emotional valence condition.

emotional signals. As expected, they did not appear to use the speaker's line of regard to determine the target of the emotional signal. However, they also did not appear to respond in a more generalized manner to the emotional signals. They were no more likely to touch the objects in response to positive signals than in response to negative signals.

It is possible that the 10-month-old infants failed to show differential responding because they were less engaged in the task than were the 12-month-olds. To test for this possibility, we performed the analyses again for looks to video display, looks to objects, and object touch including age group as a second between-subjects factor. Although there were no differences in how much time the 12- and 10-month-olds watched the video presentation, the 12-month-olds ($M = 1.67$, $SD = 1.32$) did look significantly longer at the real objects during the presentation period than did the 10-month-olds ($M = 1.12$, $SD = 1.44$), $F(1, 60) = 5.99$, $p = .02$. As mentioned earlier, only 50% of the 10-month-olds looked at the real objects on both trials, whereas 100% of the 12-month-olds looked at the real objects at least once during the session and most looked during both trials. It may be that the 10-month-old infants were less able to divide their attention between the video display and the real objects and were, therefore, less able to draw a connection between the two events. Once the toys were within reach, the 10-month-olds were as engaged with them as were the 12-month-olds. Overall, the two age groups touched the objects for similar amounts of time. However, there was a significant interaction of age with trial, $F(1, 60) = 9.26$, $p = .003$, reflecting the fact that 12-

month-olds touched both objects more during the neutral baseline trial than during the emotion test trial, whereas 10-month-olds showed the reverse pattern.

General Discussion

Even when they are merely present as onlookers and not as participants in social interactions, 12-month-old infants attend to the direction of gaze as well as the facial and vocal expressions of others, thus drawing inferences relevant to their own behavior from the emotional reactions they observe. This study extended previous research on social referencing in several important ways. First, because the infants in this study were passive onlookers watching a stranger react to an apparently harmless object in a televised scenario, they were not initially in a state of wariness about the object and the emotional display was unsolicited. Thus, they were not seeking out information from the adult, as in the typical social-referencing paradigm. Nevertheless, the 12-month-olds were influenced by the negative emotional reactions they observed. Second, the experimental design used here included a neutral baseline condition, enabling us to show that negative emotional signals had a significant effect on infants' behavior whereas positive signals did not. Third, by including an interesting alternative object that was not the target of the emotional signal, we found that 12-month-olds could discern that the emotional signal was directed specifically toward one object and not the other. The 12-month-olds showed evidence of referential specificity and did not generalize their avoidance to the alternative object during the negative emotion trial. Fourth, 12-month-olds showed evidence of emotional contagion through their facial expressions during the negative emotion trial. Finally, the findings suggest a period of transition near the end of the first year. In contrast to 12-month-old infants, 10-month-olds were unable to use the attentional and emotional cues presented in the televised scenarios to guide their interactions with novel objects.

In the introduction, we proposed three possible responses infants might have after observing another person's negative reaction to a specific object: (a) they might ignore the emotional information and respond in the same way as they responded to neutral information, (b) they might generalize the emotional communication and become wary of all nearby objects, or (c) they might use it in a referent-specific way and avoid only the object that was the focus of the communication. It appears that

12-month-olds responded in this referent-specific way, but that 10-month-olds either ignored or were unable to put this information to use. Next, we consider why the 12-month-old infants may have responded appropriately and then we consider why the 10-month-olds failed to show any differential responding to the stimuli.

After witnessing the televised adult react negatively toward one object, 12-month-old infants avoided that object once it was within reach. However, they did not avoid the other, equally salient object even though it was also visually available throughout the negative display. This pattern of results supports the referential specificity hypothesis but not the generalization hypothesis. In addition, the 12-month-olds in the negative condition seemed to experience emotional contagion or a change in mood state. Their expressions of negative affect increased over the course of the session, during both the presentation period and the play period immediately following. It is important to note that this change in mood state did not interfere with infants' ability to respond with referential specificity. Infants in the negative condition appeared to catch the emotional tone of the signal and, at the same time, employed their awareness of attentional cues to respond appropriately by avoiding only the target object.

How did 12-month-old infants accomplish this feat? First there is the question of how infants "knew" which object was singled out. One interpretation is that infants understood that the target object was the focus of the speaker's attention and thus the elicitor of the speaker's reaction. A less rich interpretation is that the turn of the speaker's head directed the infant toward the target. The movement of the head and its final resting position may have made the object more salient to the infant and thereby caused the infant to attend more to the target than to the distracter. This interpretation, which does not require an understanding of the speaker's mental state of attention, is similar to Moore, Corkum, and colleagues' interpretations of findings from joint visual attention research (Corkum & Moore, 1995, 1998; Moore, Angelopoulos, & Bennett, 1997). These researchers proposed that infants' success in gaze-following tasks probably starts with the infant following another's dynamic head turns to interesting sights, and that it is not until the middle of the second year that infants consistently use eye direction as a cue to attentional focus. More recent studies, however, suggest that these skills might emerge closer to the beginning of the second year. Caron, Butler, and Brooks (2002) found that 14-

month-olds, but not 12-month-olds, reliably used both eye direction and head turns as referential cues. And Moses et al.'s (2001) recent social-referencing study showed that 1-year-old infants in the discrepant-attention conditions noticed that the speaker was looking at the object the infant was not looking at. Other recent findings (Johnson, Slaughter, & Carey, 1998) suggest that infants as young as 12 months of age followed the attentional cues of objects that appeared to be intentional beings, but they did not follow the "gaze" of objects that failed to behave contingently or that lacked facial features (i.e., did not appear to be intentional). Thus, infants at 12 months may be capable of using direction of eye gaze and head turn as cues to mental focus. The experimental design used here cannot determine the mechanism underlying infants' use of the attentional cues. However, our findings in conjunction with findings from two other laboratories (Moses et al., 2001; Repacholi, 1998) have provided converging evidence for an early appreciation of the object-focused nature of emotional signals. In all three studies, infants at 12 to 14 months of age picked up some aspect of the directionality of the emotional signal and regulated their responses appropriately with respect to the object that was singled out.

Second, there is the question of whether 12-month-olds understood the emotional meaning or the communicative intent of the display. One plausible interpretation of the 12-month-old infants' behavior is that the infants were monitoring the speaker's psychological relationship to the object (see Carpenter et al., 1998). This interpretation implies that infants were able to infer the speaker's mental state from the information provided by her facial display and vocal intonation. In other words, infants in the negative condition understood that the speaker was attending to one particular object and that she either was afraid of it or wanted to convey that it was undesirable or dangerous. This kind of interpretation is not uncommon (Camras & Sachs, 1991; Manstead, 1993; Rochat & Striano, 1999; Tomasello, 1995; Walden, 1991). Some researchers have suggested that positive findings in social-referencing studies have demonstrated that 1-year-old infants have an implicit theory of mind (e.g., Baron-Cohen, 1991; Bretherton, 1992). However, other researchers have urged more caution in interpreting these kinds of findings (e.g., Baldwin & Moses, 1996; Perner, 1991). Perner (1991) argued that infants may respond appropriately to emotional signals without having an implicit theory of mind. For example, they need not have a mental

representation of the relation between a fearful face and the internal experience of fear. Perner suggested that infants' responses could be guided by a simple behavioral rule: When I come upon a novel object and see someone staring at it and displaying fear, then I should avoid that object. Thus, the emotional signal is used as a guide for action but not necessarily as a cue to another's internal state.

Another possibility is that the responses of the 12-month-olds may have resulted from classical conditioning. In this case, the speaker's attention to the target first made the object more salient to the infant. The speaker's negative emotional signal then elicited a similar negative emotional state in the infant. Consequently, the salient object became associated with the negative feeling state, and the infant avoided the object with which the negative experience was associated. Because object-specific responding and emotional contagion co-occurred, we cannot rule out this explanation. Neither this study nor any previous study of emotional signaling has clearly demonstrated that infants are monitoring others' psychological states when they respond appropriately to others' emotional signals. Instead, these studies have demonstrated that infants are skillful at using social information and that emotional signals influence infants' exploratory behaviors (see Moses et al., 2001). The current study did confirm that, for 12-month-olds, this influence was specific to the object that was the target of the emotional signal.

The pattern of results in Study 1 also suggests that 12-month-olds differentiated between negative and neutral signals but not between positive and neutral signals. It is possible that we failed to detect sensitivity to positive signals as a result of the unique context of our study; because the novel objects were attractive, infants' object play might have been at ceiling during baseline. However, a number of other social-referencing studies—all using ambiguous toys—have found a similar asymmetry (see Hertenstein & Campos, 2001; Hornik et al., 1987; Mumme et al., 1996). Infants are not alone in showing a heightened sensitivity to negative information. Cacioppo and Gardner (1999) reviewed research showing this negativity bias in children, adults, and even rodents. They argued that negative information serves as a signal to change behavior whereas positive information is more likely to serve as a signal to stay on course. This is a reasonable explanation for the findings in Study 1, and it highlights the importance of designing studies so that responses to positive and negative signals can be examined independently.

The current study also showed that 12-month-old infants are skillful at using social information even when they are not active participants in a social interaction. In our study, the actress did not directly engage the infants, and the infants did not actively seek out information about the objects from the actress. However, the 12-month-olds were still able to draw inferences relevant to their own behaviors. Akhtar, Jipson, and Callanan (2001) have reported similar findings in the domain of word learning. They found that children as young as 2 years of age were able to learn novel object labels equally well when they simply observed a social interaction between two adults as when they interacted directly with an adult. These and our own findings suggest that young children are adept at gathering certain kinds of social information even when they are mere onlookers to the social exchange.

Although the 12-month-old infants did use attentional and emotional cues to guide their interactions with novel objects, infants just 2 months younger showed no evidence of using such cues. It is possible that 10-month-old infants truly lack the ability to use attentional cues to interpret emotional signals or, more generally, to participate in triadic interactions. In a recent study of infants' understanding of object-directed action, Phillips and Wellman (2000; Wellman & Phillips, 2001) found that 12-month-olds seemed to recognize that reaching actions are goal directed, although 9-month-olds did not. Phillips and Wellman suggest that by 12 months, infants may understand reaches not in terms of just arms and hands but in terms of the whole person. Twelve-month-olds seem able to coordinate information about an object and information about a person's facial orientation, gaze, and emotional expression. Nine-month-old infants, in contrast, may be starting to pay attention to the whole person but are still unable to coordinate information about bodies, faces, and objects. This inability to coordinate information in triadic interactions could be the reason for the difficulties of the 10-month-old infants in the current study.

Another possibility is that the 10-month-olds may have the ability to use attentional cues to interpret emotional signals but were unable to put it to use in this particular procedure. Although the 10- and 12-month-olds did not differ in the amount of time they spent watching the video presentation or touching the objects, half of the 10-month-olds rarely or never looked at the real objects during the video presentation. Thus, the younger infants may not have connected the two-dimensional objects on the television with the real three-dimensional objects they

could touch once the video presentation ended. Other researchers have used videotaped presentations effectively to study causal reasoning and sensitivity to social information in infants younger than 12 months (e.g., Cohen & Amsel, 1998; Csibra, Gergely, Biro, Koos, & Brockbank, 1999). However, a direct comparison of infant ability to imitate televised versus live models revealed that infants' use of televised information lags behind their use of the same information presented live (Barr & Hayne, 1999). Walker-Andrews and Bahrick (2001) argued that young infants best demonstrate their perceptual competencies for social events that are dynamic, multimodal, and contextually rich. Although the stimuli used in the current study were dynamic and multimodal, the videotaped presentation inevitably had less of the contextual richness available in a live presentation.

Unfortunately, we cannot turn to the literature on infants' responses to live emotional displays for definitive data on the abilities of infants younger than 12 months, because no such data are available. Clearly, young infants are able to discriminate one emotional expression from another, even when those expressions are two-dimensional photographs or video images (Nelson, 1987). However, the question in this study was whether they could use attentional and emotional cues to guide their behavior. Nearly all published studies of infant social referencing have focused on infants 12 months of age and older.

Researchers have suggested that social referencing is among the many joint attentional skills that emerge between 9 and 12 months of age (Carpenter et al., 1998). Some have called this period just before the end of the first year a time of "revolutionary" change in infants' social-cognitive development (Rochat & Striano, 1999; Tomasello, 1999). The 10-month-olds in the current study may be in the midst of this revolution. Whatever the reason for our failure to find effects in the 10-month-old group, the findings are noteworthy. They suggest that 10-month-olds are different from 12-month-olds in that they are not able to observe someone else's emotional reaction to an object and subsequently draw implications for their own interactions with that object. By focusing on this transitional period in future research, we will learn more about the mechanisms underlying the appropriate responses that emerge 2 months later.

From the current findings, we can conclude that by the end of the first year, infants are sensitive both to the object-focused nature of directed emotional signals and to their hedonic quality. The current study also reported the surprising finding that

infants just 2 months shy of their first birthday show no such sensitivity. Future studies are needed to sort out why the older infants were able to use emotional signals in this study and why the younger infants were not.

It is also noteworthy that the infants in our study were true onlookers, simply observing the reactions of some other person in some other place. Our findings contribute to the view that much of what infants and children experience and learn about emotions probably comes from observations of others' emoting rather than direct interaction. Cummings and colleagues have documented this idea in their research on the influence of parental conflict on children (e.g., Cummings, Iannotti, & Zahn-Waxler, 1985; Davies, Myers, Cummings, & Heindel, 1999). Their research suggests that the background anger children experience when witnessing conflicts between adults is stressful. Children who are exposed repeatedly to angry adult conflicts are more likely to respond to subsequent conflicts with greater distress, greater desire to avoid the conflict, and more pessimism about future interadult relations. Children appear able to use information gathered as onlookers to interpret and predict others' behaviors as well as to make decisions about their own behaviors. Thus, emotional exchanges that children experience indirectly are one important source of information about emotions and interpersonal relations.

Another potentially significant indirect source of information may be television. In the current study, we found that infants as young as 12 months were able to use social information presented on television. We were initially concerned that infants would not be able to use information viewed on a non-interactive, 20-in., two-dimensional screen. Meltzoff (1988) demonstrated that infants pay attention to televised stimuli and that they can imitate televised actions on objects, but the current research took this one step further. It required infants to draw implications for their own interactions with unfamiliar objects from observing the emotional reactions (not physical actions) of someone on television. To our surprise, 12-month-old infants did this readily. This is a significant finding for both methodological and social policy reasons. With prerecorded stimuli, researchers can carefully manipulate the information presented to participants, which makes television a useful medium for well-controlled experiments with infants and young children. However, television is not only a useful and engaging medium. It also carries messages that can influence the behaviors of very young children. In their monograph on the

relation of early childhood television viewing to later adolescent behavior, Anderson, Huston, Schmitt, Linebarger and Wright (2001) argued that it is the content of television programs that matters. For example, their research showed that preschoolers who were frequent viewers of educational programs, but not pure entertainment programs, were more likely to have higher grades and higher academic motivation during their teenage years. Our conclusion resonates with that of Anderson et al.—television is not just a medium but also a messenger. And it is a potentially informative messenger even for 1-year-old infants.

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