Infants' Use of Attentional Cues to Identify the Referent of Another Person's Emotional Expression

Article *in* Developmental Psychology · October 1998

DOI: 10.1037/0012-1649.34.5.1017 · Source: PubMed

1 author:

Betty Repacholi
University of Washington Seattle
24 PUBLICATIONS **1,581** CITATIONS

Developmental Psychology
1998, Vol. 34, No. 5, 1017–1025

0012-1649/98/$3.00

Infants' Use of Attentional Cues to Identify the Referent of Another Person's Emotional Expression

Betty M. Repacholi
University of California, Berkeley

This study explored 14- and 18-month-old infants' ability to identify the target of an emotional display. In the visual task, infants were presented with 2 boxes. Each box contained an object that could be identified by opening the box lid and looking inside. In the tactile task, the objects had to be pulled out of the boxes before they could be seen. An experimenter expressed happiness as she looked or put her hand inside one box, and disgust as she repeated this action with the other box. Infants were then allowed to explore the boxes. Infants touched both boxes but preferred to search for the happy object. Thus, regardless of age or task, infants identified the target of each emotional display as something inside a box and not the box itself. Infants appeared to use the experimenter's attentional cues (gaze and action) to interpret her emotional signals and behaved as if they understood that she was communicating about the objects.

Understanding the emotional displays of other people is integral to participating in a social world. Such knowledge is especially important during infancy because, until language is acquired, much of the communication between parent and child is of an emotional nature. It is well-known that by late in the first year of life, infants can discriminate and categorize a variety of emotional expressions (see Nelson, 1987, and Walker-Andrews, 1988, for comprehensive reviews). They are able to recognize that fear, for example, looks and sounds different from anger. Furthermore, these young infants can perceive the similarity between displays of the same emotion when produced by different people or when the displays vary in intensity. Although essential, these perceptual skills are only a first step toward interpreting, and adaptively responding to, another's emotional signals. Infants must also come to appreciate that emotional expressions often refer to a specific stimulus and be able to identify this target.

Older children and adults can frequently identify the referent of an emotional signal through the semantic content of the other person's utterances. Infants, on the other hand, may be more reliant on attentional cues such as line of regard or pointing to determine what in particular a person is attending to and thus emoting about. There has been disagreement as to when infants are first able to use these types of cues to identify another person's attentional focus. Scaife and Bruner (1975) reported that infants as young as 2 months occasionally turn their heads in the same direction as their mother's gaze, whereas Butterworth and colleagues (e.g., Butterworth & Cochran, 1980; Butterworth & Jarrett, 1991) claimed that this does not occur until around 6 months of age. More recently, there have been reports that infants do not consistently follow another's gaze until 10–12 months (Moore & Corkum, 1994) and are unable to precisely locate the target among multiple objects until about 15 months (Morissette, Ricard, & Decarie, 1995). In contrast, there is some consensus that most 12-month-old infants can use the pointing finger to locate objects to the side or directly ahead of them (Butterworth & Grover, 1989; Leung & Rheingold, 1981). But, as with gaze, it is not until 15 months that infants will look exactly at the target of the pointing finger, rather than just the correct side or general area (Morissette et al., 1995).

In summary, then, infants possess some ability to follow another's gaze or point by the end of the first year. Although such skills will often enable infants to share the focus of another's affective state, do infants then interpret the emotional display as a message about this specific object? To date, only a few studies have sought to address this question, and all have used some variant of the social referencing paradigm. Social referencing involves infants seeking out and using the emotional information provided by another person to make sense of an ambiguous event. In the standard paradigm, infants are placed in a context designed to elicit uncertainty (e.g., presentation of a novel object) and a search for information about the meaning of the event. Since the first study conducted by Klinnert (1984), it has been consistently shown that infants as young as 10 months regulate their behavior in response to another person's emotional display. Typically, infants will approach the ambiguous stimulus when a positive expression is posed but avoid it when negative affect is conveyed.

Infants' regulatory behavior in the social referencing paradigm appears to be consistent with their understanding that emo-

Betty M. Repacholi, Department of Psychology, University of California, Berkeley.

Portions of this research were presented in April 1997 at the biennial meeting of the Society for Research in Child Development, Washington, DC. This research was supported by a Charles Fish Fellowship at the University of California, Berkeley, and a Graduate Student Research Grant from the Institute of Human Development, University of California, Berkeley.

I thank the children and parents who participated in this study and the research assistants who helped with data collection and coding. I am grateful to Alison Gopnik and Penny Vinden for their helpful comments.

Correspondence concerning this article should be addressed to Betty M. Repacholi, who is now at the School of Behavioural Sciences, Macquarie University, New South Wales, Australia 2109. Electronic mail may be sent to brepacho@bunyip.bhs.mq.edu.au.

tions can refer to specific objects or events. However, if only one stimulus is used, as in most studies of this type, it cannot be concluded that infants truly understand that this object in particular is the focus of the affective message. If more than one potential referent were available, infants might behave as if these too were connected to the emotional signal. Hornik, Risenhoover, and Gunnar (1987) explored this possibility by comparing the responses of 12-month-old infants to an ambiguous object (the emotional target) and to familiar toys that were available in each social referencing trial. Infants spent less time playing with the target object when disgust was exhibited by their mothers, compared with trials with positive or neutral maternal displays. Infants did not differ, however, in their play with the familiar toys as a function of maternal affect. Infants' regulatory responses were specific to the target object, but it is unclear whether they actually understood that their mother was attending to and emoting about this object. Instead of following their mother's line of regard to identify her emotional focus, infants' attention may have been directed toward the target object because it was extremely unusual. This object would then become associated with the emotional display because it happened to be the focus of the child's attention when the message was delivered. Alternatively, infants may have linked the emotional signal with the correct object because it was novel and thus more salient than the familiar toys.

It is obvious from this study that simple associative processes like temporal contiguity or stimulus salience can produce accurate object–affect links. Indeed, these mechanisms may even contribute to the emergence of a referential understanding of emotions. However, infants ultimately need to learn about the significance of attentional cues for locating the target of an emotional signal because these other processes will occasionally lead to referential errors. For example, if there is a discrepancy between their own focus of attention and that of the other person, then infants who rely solely on temporal contiguity will end up linking the affect to the wrong object (see Baldwin & Moses, 1994, for further discussion of this point).

To rule out these nonreferential explanations, one must ensure that the potential targets of the emotional display be of equal ambiguity or attractiveness. Recently, researchers have begun to adopt such an approach. Mumme, Won, and Fernald (1994), for example, presented 12-month-old infants with pairs of equally novel objects, one of which was the focus of the experimenter's attention and emotional signal (fear, happy, or neutral). A videotaped emotional display was used, rather than a live experimenter, to achieve greater stimulus control. Following the videotaped presentation, infants were given 30 s in which to play with the two objects. In the happy and neutral conditions, infants touched the target object more than the distractor, whereas those in the fear condition touched the distractor more than the target object. Most important, there were no differences in the amount of contact with the distractor object as a function of the experimenter's emotional display. Despite the infants behaving as if they understood that only one object was the focus of the experimenter's attention and the elicitor of her emotion, an alternative explanation is possible. As noted by Mumme et al., the experimenter's movements and closer proximity to the target may have increased its salience in relation to the other object. Thus, infants may have connected the affective signal to the correct object simply because it was the more salient stimulus.

Baldwin and Moses (1994) devised a more specific test of infants' referential knowledge. They examined whether 12- and 18-month-old infants will use the other person's attentional focus, rather than their own, to identify the target of an emotional signal. Different pairs of novel toys were presented in each of four social referencing trials. One toy was placed within infants' reach and as they began to look at it, the experimenter produced an emotional expression (facial and vocal). In the joint attention trials, the experimenter expressed disgust or happiness while looking at the same toy that the infant was attending to. In the discrepant attention trials, the target of the experimenter's affect and attention was the toy that the infant was not currently focused on. The toys were then made available to the infant for 2 min. Across both attention conditions, infants as young as 12 months of age regulated their behavior toward whichever toy had previously been the target of the experimenter's attention. Thus, they did not simply connect the affect to whatever they themselves had initially been looking at. Instead, they appeared to use gaze direction to identify the experimenter's emotional focus. Interestingly, however, they also tended to generalize their regulatory response to the other object, playing more with the nontarget toy when positive rather than negative affect had been displayed. Although infants' reactions to the target toy were more strongly influenced by the affective displays than their reactions to this second toy, their response generalization casts some doubt on whether they understood the specificity of the emotional signal.

In summary, it remains unclear whether infants can use attentional cues to identify the target of another person's emotional display. Recent studies are suggestive of such abilities, but their interpretation is still very much open to debate. Hence, the study described here was designed to clarify whether infants rely solely on associative principles (e.g., temporal contiguity and stimulus salience) or whether they can also use attentional cues to identify the target of an emotional signal. If infants are able to use this latter mechanism, it can then be argued that they appreciate the relevance of another person's attentional focus for interpreting their emotional display. Moreover, a stronger argument can be made that infants understand that these displays are communications about particular stimuli.

In this study, a two-object social referencing paradigm was used, but unlike previous research, each object received equal attention from the experimenter, and each was the focus of a unique emotional message. One object was the target of a disgust expression, whereas happy facial and vocal behaviors were directed toward the other object. This procedural change should make the objects equally salient. In addition, each object was concealed inside a box, and the experimenter provided attentional cues to indicate that she was emoting about the contents of the box. Baldwin and Moses (1994) suggested that infants will be less confused about the topic of an emotional communication if they are given clear and strong referential cues, so multiple cues (gaze and action) were used here. In one task, for example, the experimenter opened each box, looked inside, and displayed an emotion in response to seeing its contents.

If infants are able to use these attentional cues to identify the target of each emotional display, then their subsequent regulatory response should be specific to the concealed objects. Thus,

infants might be willing to touch both boxes, but they should prefer to search for the target of the positive expression as opposed to the disgust object. On the other hand, infants may only be responsive to the temporal contiguity between an event and an emotional signal. Infants can see the two boxes during each emotional display, but not their contents. Moreover, the experimenter's manipulation of a box should cause infants to attend to this stimulus rather than the other box. They should then link this particular box with the emotion because it was the focus of their own attention when the emotional message was delivered. Infants would then avoid touching whichever box had been associated with the disgust expression. The same sort of referential error would occur if infants were relying on a salience mechanism. In these tasks, the boxes are highly salient because of their visibility and because the experimenter performs a variety of actions on them (e.g., she picks up and shakes each box). So, during each expression sequence, infants might connect the emotional signal to whichever box the experimenter was handling (i.e., the most salient stimulus at that time).

Although infants have some capacity to follow another's gaze by the end of the first year, 14- and 18-month-old infants were examined here because of the complexity of the tasks. For example, a basic understanding of containment was required, and this is not usually evident until around 14 months of age (Caron, Caron, & Antell, 1988). In addition, infants had to remember which box contained which object and then reproduce the experimenter's search behavior. However, it was not clear whether 14-month-old infants would accurately identify the emotional referents in this study. In the language domain, for instance, there is evidence that infants younger than 18 months are unable to use attentional cues to identify the referent of a speaker's utterance (Baldwin, 1993a, 1993b). It is conceivable that similar referential abilities will not be evident until this age when the message is of an emotional nature.

The design of this study rested on the assumption that infants would avoid whatever stimulus they had linked with the disgust signal. In previous social referencing studies, 18-month-old infants have sometimes ignored the negative message (Klinnert, 1984) or even been attracted to the negative target (Walden & Ogan, 1988). Because older infants might choose to interact with negative stimuli, two tasks were administered here that differed in the type of contact required to identify the target objects. In the visual task, the objects could be revealed by raising the lid of each box and looking inside. In contrast, the boxes in the tactile task were constructed so that an object could only be identified if infants inserted their hands through a narrow opening in the box and pulled it out. In this latter task, it was expected that children in both age groups would be equally hesitant to touch the disgusting object. In the visual task, however, the regulatory effects might be weaker among 18-month-old infants because looking at a disgust object may be less threatening for these older, more experienced children.

Some social referencing researchers have reported that infants' affective state is modified by another's emotional display (i.e., emotion contagion). There is evidence that more negative affect is displayed by infants in response to fear than to happy displays (Sorce, Emde, Campos, & Klinnert, 1985), whereas more positive affect is elicited by the happy condition when compared with that of fear (Hirshberg & Svejda, 1990). This emotion contagion, in conjunction with associative processes like temporal contiguity, could lead to referent-specific responding. For example, a negative emotional display might elicit similar feelings in the infants and then become linked with whatever object is the current focus of their attention. They may subsequently avoid this particular object simply because it was associated with their own negative affect. In the present study, infants' facial expressions were examined to determine whether emotion contagion played any role in guiding their exploratory behavior.

Method

Participants

Forty-four 14-month-old (23 boys, 21 girls) and forty-two 18-month-old infants (19 boys, 23 girls) participated in the study. Participants were recruited from a commercial list of births in the San Francisco Bay Area. The mean age for the two groups was 14.32 months (SD = 0.29; range = 13.87–14.97) and 18.28 months (SD = 0.28; range = 17.73–18.90). Infants were typically from middle-class backgrounds. The ethnic composition of the sample was 70% Caucasian, 12% Asian, 10% Hispanic, 2% African American, and 6% "other" (e.g., mixed-race). Because of procedural problems, one 18- and two 14-month-old infants were only included in analyses for the tactile task. An additional 9 infants were excluded from the study because of parent interference (n = 1), fussiness or inattention (n = 6), and experimenter error (n = 2).

Materials

Stimuli. In the visual task, two opaque plastic boxes with loose-fitting lids were presented to infants. These boxes were identical in their dimensions (17.8 × 11.5 × 11.5 cm) but differed in color. In the tactile task, two modified and different colored Kleenex cubes (13.5 × 11.2 cm) were used. Layers of felt were used to make the plastic aperture on the top side of each box more durable, opaque, and narrow. While infants had some difficulty retrieving objects from these boxes, the apertures had to be sufficiently narrow to ensure that the contents could not be identified simply by peering inside the box. The type of object concealed in each box varied according to the task and the experimenter's affective display. If infants discovered objects of equal attractiveness inside a pair of boxes, they might doubt the validity of any subsequent emotional displays. Thus, small Sesame Street figures were the targets of the happy displays and plastic insects were used as the disgust objects.

Emotional displays. The experimenter's facial expressions of happiness and disgust were based on the descriptions of Ekman and Friesen (1975). These facial expressions were accompanied by verbal scripts that differed primarily in their intonational structure. Words such as "yucky" and "nice" were not used in these scripts, to control for differences in children's verbal comprehension. However, to draw attention to the experimenter's face and maintain ecological validity, the scripts differed in terms of their accompanying exclamations ("Wow!" or "Eww!"). Identical positive and negative scripts were used in the two tasks. An example of a happy script is, "Wow! I've found something! Wow! I can see it! Wow!"

Equipment. Two video cameras were positioned such that one recorded infants' facial expressions and the other focused on the experimenter's face. Images from these cameras were fed through a screen-splitter and the split-screen tapes were later used to determine (a) whether infants' facial expressions were influenced by the experimenter's affective displays and (b) whether the experimenter's displays were recognizable to naive adult coders. A third camera recorded infants' behavior during the emotion trials and the exploration period. A running time-code (in 1/100th s) was imprinted onto all videotapes for later coding.

Design

The testing session included several other tasks unrelated to those reported here. The session was divided into three blocks of two tasks, with each block separated by periods of free play. Because of the number of tasks administered and the use of a mixed experimental design, carryover effects were possible. The visual and tactile tasks were never administered within the same block to control for such effects, and they were presented in a counterbalanced order. The sample size was not sufficient to allow complete counterbalancing, so the visual and tactile tasks were only administered over the first two blocks.

The order of the two emotional displays was counterbalanced across participants and tasks. Thus, if infants observed a happy expression followed by disgust in one task, they received the reverse order (disgust–happy) in the other task. This procedure allowed a check for response biases such as preferences for particular stimulus presentation sides (i.e., left vs. right). Furthermore, the color of the box associated with each expression was systematically varied across participants. For ease of administration, the first emotion expressed was always associated with the box on the experimenter's left.

Procedure

Infants were individually tested in a medium-sized laboratory room. They were placed in a high-chair at a large table with the experimenter seated on the opposite side. Parents were seated to the left of, and slightly behind, their children. They were instructed to remain emotionally neutral and to avoid interacting with their child during each task. A magazine was provided so that parents could pretend to be unavailable should the child attempt to elicit feedback during the tasks. About 9% (n = 8) of the infants refused to remain in the high-chair and were therefore tested at the table while sitting on their parent's lap. Each test session began with a brief period of free play with toys on the table to acquaint infants with the experimenter and the setup of the room.

Visual task. A warmup task was used to demonstrate that objects would be hidden inside the boxes and to ensure that infants understood how to find them. Infants observed the experimenter shaking a box that was identical to the experimental boxes, with the exception of its color. This shaking produced a noise from the object as it moved inside the box. The experimenter then raised the box lid and allowed infants to look inside. After closing the lid, she encouraged infants to open the box themselves. The concealed object was a small plastic block, selected to be of minimal interest.

The two experimental boxes were positioned side by side in front of the experimenter and completely out of infants' reach. While shaking the box situated on her left, the experimenter exclaimed, "What's in here?" After opening the box, the experimenter looked inside, produced the appropriate exclamation (e.g., "Wow!"), and began to pose the matching facial expression (e.g., happiness). She then finished the script and maintained the facial expression for another few seconds. The emotion trial lasted about 10 s and was terminated by closing the box lid. This procedure was repeated with the second box and other member of the emotion pair. Because of the depth of the boxes and their position on the table, the contents were not visible to infants when the lids were raised by the experimenter.

Following the two emotion trials, the experimenter pushed the boxes forward, and these came to rest in front of infants, at positions marked on the table. The boxes were 17.5 cm apart and just out of easy reaching distance (20 cm from the 14-month-old and 25 cm from the 18-month-old infants). Infants were given 45 s in which to explore the boxes. Timing of the exploration period typically began as soon as the boxes reached their designated positions. In some instances, infants touched the boxes before they were in place, so timing began with this first touch of a box. No verbal instructions were initially given to infants. However, if infants failed to touch a box within 15 s, the experimenter pushed both boxes forward, so that they were within easy reach. If infants did not respond to this behavioral prompt within 10 s, they received verbal prompting ("Do you want one? You can have one"). A total of 7 (8%) infants required prompting, and 4 of these infants received both prompts. Parents were instructed not to give any facial or vocal feedback to their infants about what to do with the stimuli during the exploration period. If infants attempted to show the object, or request help, parents pretended to read a magazine. The experimenter likewise pretended to be occupied during this time. The exploration period was terminated if infants dropped or threw either box on the floor before discovering its contents. The average length of the exploration period was 43.97 s (SD = 3.59).

Tactile task. In the warmup task, the experimenter shook a modified Kleenex box and then demonstrated how to find the hidden object (a small plastic ring) by inserting her hand into the aperture and pulling it out. After replacing the ring inside the box, the experimenter encouraged infants to find the object themselves. Two new boxes were subsequently presented side by side. Each box was shaken before the associated emotion trial, and this action was accompanied by the question, "What's in here?" As the experimenter placed her hand inside the box, she began to express the appropriate affect (e.g., "Wow! I've found something!"). After withdrawing her hand, she pretended to look through the aperture and then completed the verbal script (e.g., "Wow! I can see it! Wow!"). The same actions were repeated with the other box. Each emotional display was terminated when the experimenter placed the box back on the table. These emotion trials followed the same format described in the visual task, except the order of the two emotions was reversed for each participant. Once again, infants were given an opportunity to explore the boxes for a maximum of 45 s. Three infants (4%) received prompting in this task, but only 1 infant required both prompts.

Coding and Reliabilities

It was expected that infants would eventually search for the negative objects because (a) they would become bored with the positive toys, (b) they might forget that an object was associated with disgust, and (c) the experimenter did not model avoidance of the negative stimuli. Therefore, infants' initial exploration of the boxes was of primary interest rather than their behavior over the entire 45 s. The videotapes were examined without sound to ensure that coders were unaware of the emotion associated with each stimulus. Two coders, one for each age group, noted which box infants first touched and first searched (opened or inserted). To determine whether the regulatory effects were maintained over time, coders indicated whether infants touched or searched the other box during the exploration period. An additional coder scored about 25% of the data. Kappa coefficients ranged from .89 to 1.00. The reliability data were examined according to age group to ensure that there was no age confound in the coding. The 14- versus 18-month-old reliabilities were identical for six of the eight measures, and the kappa coefficients did not differ significantly for the remaining two (visual task/first touch: 1.00 vs .88, respectively, z = 1.02, $p > .05$; tactile task/other box touched: 1.00 vs .84, respectively, z = 1.27, $p > .05$).

Infants' facial expressions were coded during each emotion trial.[1] Because of equipment failure, facial expressions were not recorded in the visual task for 1 infant and for a 2nd infant, the data were missing in both tasks. In addition, the facial expressions of 1 infant were uncodable during the tactile task because she used a pacifier. The split-screen videotapes were examined without sound, and the experimenter's face was covered by a screen to ensure that coders were unaware of her

[1] An attempt was made to measure the frequency and duration of infants' looks to the experimenter's face during each emotion trial. Because of the camera angle and the experimenter's manipulation of each box, it was often difficult to determine whether infants were attending to her face or the box in her hands. This coding was found to be unreliable and was therefore excluded from any further analyses.

affective display. During each emotion trial, infants' facial expressions were rated every second using separate 3-point scales for positive and negative hedonic tone (derived from Hirshberg & Svejda, 1990). A score of 2 on the positive affect scale indicated a broad smile or laughter; a score of 1 was assigned for mild pleasure (e.g., a slight smile), and a score of 0 indicated the absence of any positive affect. On the other scale, a score of 2 indicated distress (e.g., cry-face, crying) or big frowns, a score of 1 was for mild frowning/furrowing of the brows or slight wariness, and a score of 0 was given when there were no signs of negative affect. Mean positive and negative affect scores were calculated for each emotion trial because the number of codable intervals varied for each infant (e.g., no scores could be assigned when the infant turned away from the camera). A second coder rated 25% of the data, and reliabilities were high for the mean positive (r = .90) and negative (r = .86) affect scores.

A manipulation check was conducted to confirm that recognizable examples of disgust and happiness had been displayed by the experimenter. Two naive coders, one for each age group, classified the experimenter's videotaped facial expressions. These tapes were examined without sound so that coders would only use the experimenter's face to make their judgments. Each expression was categorized in terms of hedonic tone (positive, negative, or neutral) and the presence of any discrete emotions (happiness, interest, neutral, surprise, anger, disgust, fear, sadness, or "other"). Coders were required to indicate which of the discrete emotions was predominant in those cases when more than one was detected. An additional coder examined 35% of the data. Interrater agreement for hedonic tone was 100% for all four emotion trials. The kappa coefficients ranged from .94 to 1.0 for the predominant emotion classifications. These coefficients were compared across the two age groups and were found to be identical in three of the four emotion trials (i.e., all κs = 1.0). In the remaining trial (tactile task/first display), there was no significant difference in the kappa coefficients for the 14- versus 18-month-old groups, 1.00 versus .88, respectively, $z = 1.41$, $p > .05$. A manipulation check was not performed on the experimenter's vocalizations because her exclamations ("Wow!" and "Eww!") would have signaled the intended affect to adult coders.

Results

Manipulation Check

All of the experimenter's happy expressions were categorized as positive in hedonic tone, and her disgust faces were all identified as negative. Discrete emotion coding indicated that the appropriate emotions (disgust or happiness) were predominant in all of the displays. In each task, coders detected an additional element of surprise in about half of the happy expressions. This was presumably because the display began with a raising of the eyebrows as the experimenter first encountered the hidden object. Preliminary analyses failed to reveal any differences in infants' exploratory behavior as a function of whether they received a blended versus a "pure" display of happiness.

Infants' Exploratory Behavior

Infants' initial box and initial search preferences were examined separately for each task using chi-square analyses. All tests were two-tailed with the exception of infants' initial search preferences, in which the alternate hypothesis was directional (i.e., infants were expected to initially search for the happy object). A series of forward stepwise logistic regression analyses were conducted to examine whether infant gender, age (14- vs. 18-month-old), task order (visual–tactile vs. tactile–visual), and box position (left vs. right) were related to infants' exploratory behavior.

Referential errors. In each task, infants' initial box preferences (i.e., which box was first touched) were examined to determine whether they had mistakenly linked the boxes with the experimenter's emotional signals (see Figure 1). In the tactile task, about 16% (n = 7) of the 14-month-old and 24% (n = 10) of the 18-month-old infants touched both boxes simultaneously. Among those infants initially touching only one box, there was no significant difference in the proportion who made contact with the happy (.57) versus the disgust (.43) box, $\chi^2(1, N = 69) = 1.17, p > .05$. A logistic regression analysis revealed an Age × Box position effect, $\chi^2(1, N = 69) = 10.20, p < .001$. This interaction indicated that 18-month-old infants were more likely to initially touch whichever box was located on their right-hand side, whereas the younger infants responded randomly.

In the visual task, about 20% (n = 17) of the infants touched both boxes simultaneously (see Figure 1). In the remainder of the sample, there was no significant difference in the proportion of infants who touched the happy (.58) versus the disgust (.42) box first, $\chi^2(1, N = 66) = 1.52, p > .05$. The final model generated by the logistic regression analysis included a box position effect and an Age × Task Order interaction, $\chi^2(2, N = 66) = 19.30, p < .001$. Thus, as a group, infants initially preferred to touch the box located on their right-hand side. In addition, 18-month-old infants who received the visual task before the tactile one were more likely to touch the happy box than those who received the tasks in the reverse order (i.e., tactile–visual). Task order did not influence the younger infants' initial touch.

Referent-specific responding. Infants' initial search preferences (i.e., which box was first opened or first inserted) were examined to determine whether they had identified the contents of the boxes as the targets of the emotional displays (see Figure 2). Although every infant in the tactile task made contact with

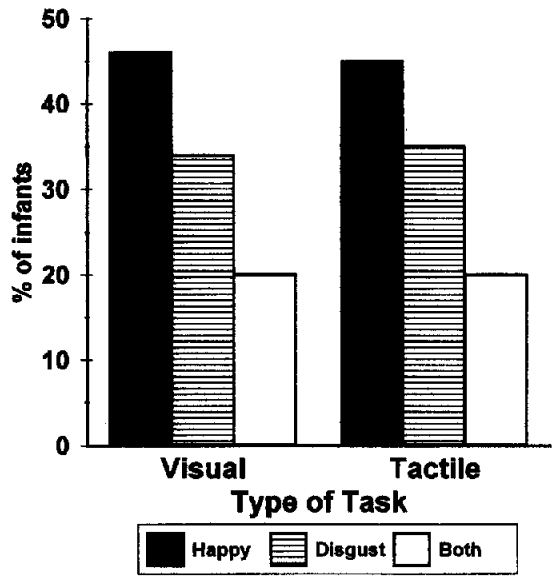

Figure 1. Initial box preference as a function of task.

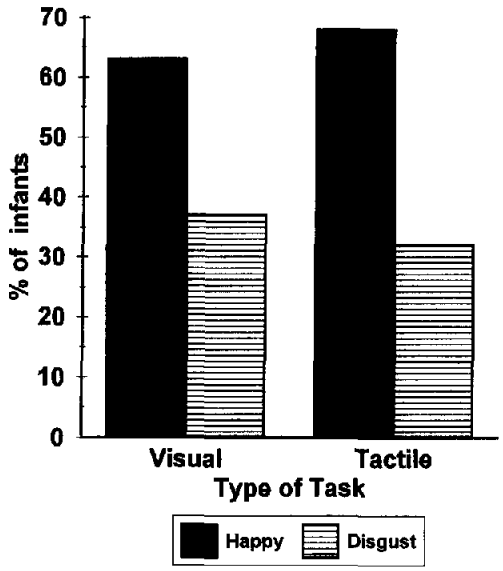

Figure 2. Initial object search preference as a function of task.

at least one box, 27% (n = 12) of the 14-month-old and 12% (n = 5) of the 18-month-old infants failed to insert their hand into either box (i.e., no response). A significant proportion of those infants who searched for an object inserted their hand into the happy box first, .68 versus .32, $\chi^2(1, N = 69) = 9.06$, $p < .005$, one-tailed. Logistic regression indicated that this search preference was unrelated to infant gender, age, box position, or task order.

In the visual task, 5% (n = 2) of the 14-month-old and 7% (n = 3) of the 18-month-old infants failed to open either box, despite their willingness to touch at least one box. One (2%) of the older and 4 (10%) of the younger infants opened both boxes simultaneously. Interestingly, 2 of these 14-month-old infants failed to look inside either of the opened boxes (i.e., behaved as if they did not know that objects would be found inside). Among those who initially opened only one box, a significant preference was displayed for the happy box, .63 versus .37, $\chi^2(1, N = 73) = 4.95$, $p < .025$, one-tailed (see Figure 2). The logistic regression analysis yielded an Age × Task Order effect, $\chi^2(1, N = 73) = 8.65$, $p < .01$. This interaction indicated that 18-month-old infants who received the visual task first (V-T) were more likely to open the happy box than those in the other task-order condition (T-V). Task order did not influence the initial search behavior of the 14-month-old infants.

Maintenance of the regulatory effects. In each task, the proportion of infants who searched the disgust box during the exploration period was compared with the proportion who searched the happy box, to determine if their avoidance of the disgust object was maintained over time. These comparisons were made using McNemar's z statistic for correlated proportions (see Ferguson & Takane, 1989, p. 201). Infants who failed to search either box were excluded from these proportions. In the tactile task, infants were more likely to insert their hands into the happy box in comparison with the one containing the disgust object, .84 versus .55, respectively, $z = 3.05$, $p < .01$. On the other hand, in the visual task, identical proportions of infants (.82) searched for each type of object during the exploration period. In both tasks, there were no differences in the proportion of infants who eventually touched each box (visual: happy = .89 vs. disgust = .88; Tactile: happy = .88 vs. disgust = .94; all ps > .05).

Infants' Facial Expressions

Infants' scores on the positive and negative affect scales were separately analyzed for each task (see Table 1 for group means). To determine whether their affective state was influenced by the experimenter's emotional displays, I conducted mixed-factorial analyses of variance with infant gender, age, task order (V-T vs. T-V), and display order (happy first vs. disgust first) as between-subjects variables, and infants' affect score during each display (happy vs. disgust) as a within-subjects variable. Significant effects were further examined using paired t tests, and the Bonferroni procedure was used to maintain $\alpha = .05$.

In the visual task, infants showed more positive affect during the experimenter's happy (M = .39) than disgust (M = .20) display, $F(1, 65) = 10.80$, $p < .01$, and more negative affect in response to the disgust (M = .18) than happy (M = .07) expression, $F(1, 65) = 9.16$, $p < .01$. Likewise, in the tactile task, infants exhibited lower levels of negative affect during the happy (M = .09) than the disgust (M = .19) display, $F(1, 68) = 7.36$, $p < .01$. The findings were more complex, however, when the positive affect ratings were examined in this task. There was a significant main effect for display, $F(1, 68) = 21.30$, $p < .001$; an Age × Display interaction, $F(1, 68) = 8.02$, $p < .01$; a Display × Task Order × Display Order interaction, $F(1, 68) = 5.81$, $p < .01$; and a Gender × Display × Task Order × Display Order interaction, $F(1, 68) = 4.30$, $p < .05$. Detailed analysis of the four-way interaction indicated that girls were more positive during the experimenter's happy (M = .31) than disgust (M = .09) display, $F(1, 38) = 20.85$, $p < .001$. When boys received the tactile task first (T-V), they also exhibited more positive affect in response to the happy (M = .44) than disgust (M = .16) expression, $F(1, 21) = 7.85$, $p < .01$. However, when task order was reversed (V-T), boys were equally positive across the two displays. Analysis of the Age × Display interaction indicated that 18-month-old infants exhibited more positive affect during the happy than the disgust display, paired $t(41) = 5.06$, $p < .001$, whereas younger infants displayed similar levels of positive affect across the two expressions (see Table 1 for means).

Because the experimenter's displays appeared to modify infants' feelings, the question then arises as to whether these affective responses mediated their subsequent exploration. In each task and age group, point biserial correlation coefficients indicated that there was no significant relationship between which box children initially searched and any of the four affect scales (all ps > .05). It was possible that infants who failed to search for any object had experienced intense negative affect during the disgust display and were subsequently inhibited in their overall exploration. However, regardless of age or task, t tests indicated that there were no significant differences in the affect scores of infants who searched at least one box and those who failed to search either (all ps > .05).

Discussion

This study demonstrated that children as young as 14 months of age were able to correctly identify the specific target of

Table 1
Mean (and Standard Deviation) Infant Affect Scores During the Happy and Disgust Signals

	Happy display		Disgust display	
Task/age	+ Affect	− Affect	+ Affect	− Affect
Visual				
14-month-olds	.38 (.41)	.06 (.18)	.20 (.37)	.15 (.27)
18-month-olds	.39 (.52)	.08 (.21)	.19 (.44)	.21 (.33)
Tactile				
14-month-olds	.29 (.45)	.06 (.21)	.18 (.40)	.14 (.28)
18-month-olds	.46 (.54)	.11 (.26)	.09 (.23)	.24 (.36)

another person's emotional communication. This finding was most clearly illustrated in the tactile task. Infants in both age groups were more likely to initially search for the happy rather than the disgust object. Furthermore, this referent-specific responding was maintained over the entire 45-s exploration period (i.e., infants remained loathe to insert their hand into the box containing the disgust object). In contrast, infants failed to display a preference for touching the happy box, with most of them eventually touching each box at some point in the exploration period. Thus, it was only in terms of infants' search for the concealed objects that differences arose as a function of the experimenter's emotional signals. Taken together, the preference data suggest that infants did not mistakenly link the affective displays with the boxes. Instead, infants appeared to understand that the emotional signals only referred to the objects.

These findings are impressive because in addition to identifying the referents, it was essential that infants did not subsequently confuse the two boxes, which were identical with the exception of their color and position on the table. The task proved to be quite challenging, especially for the 14-month-old infants. Nearly one third of these younger participants failed to insert their hand into either box, despite demonstrating a willingness to touch the boxes. It is unlikely that all of these infants failed to understand that the boxes contained objects because, in the visual task, only 2 infants appeared to lack this knowledge (i.e., they opened both boxes but failed to look inside them). It is possible that some of these infants were simply wary about touching an object without first being able to see it. This seems plausible given that infants in the warmup procedure sometimes required encouragement from the experimenter before they would place their hands inside the box.

The findings were less straightforward in the visual task, because of order effects. Overall, infants initially preferred to search for the happy object, despite showing no initial preference for touching the happy box. So, once again, even 14-month-old infants seemed to respond to the directionality of the emotional signals. However, a more detailed analysis indicated that 18-month-old infants who received the visual task after the tactile one (T-V) did not demonstrate a preference for opening the happy box. Given their success in the preceding task, it is unlikely that these infants were unable to determine the target of each message in the subsequent visual task. Instead, these older infants may have become increasingly curious about the identity of the disgust object because they had not been exposed to it in the first task. Moreover, they were now in a situation in which this object could be identified with little risk of an adverse outcome. They could simply open the lid of the box and look inside. Consequently, some infants now preferred to search for the disgust object. Such behavior is not surprising given that Rozin and colleagues (Rozin & Fallon, 1987; Rozin, Hammer, Oster, Horowitz, & Marmora, 1986) have shown that children do not consistently reject things that adults find disgusting until some time after 2 years of age.

Taken together, the visual and tactile data are compelling in their demonstration of referent-specific responding at both 14 and 18 months of age, but one needs to address the question of *how* infants were able to identify the referent of each emotional signal. As noted earlier, infants have already acquired a basic understanding of containment by 14 months, so they should have understood that the boxes were containers. In addition, the warmup tasks would have created the expectation that something was inside each of the experimental boxes. Although such knowledge was essential, infants were still faced with the problem of determining whether the experimenter was emoting about the box, its contents, or both. Was it possible for infants to solve this referential dilemma simply by noting the temporal contiguity between the emotional signal and whichever stimulus they themselves were looking at? The only stimuli visible during each emotion trial were the two boxes. Moreover, the experimenter oriented toward and handled one of the boxes during each trial, thereby drawing infants' attention to that specific box. This temporary attentiveness to a particular box would be insufficient by itself to produce referent-specific responding and, in these tasks, would most likely result in referential errors. Infants would simply connect each emotion to whichever box was the current focus of their attention and would subsequently avoid the one associated with the disgust display.

Could a salience mechanism account for infants' behavior? Infants would certainly be curious about the concealed objects but the box itself would also be salient because of its visibility. More important, the experimenter's manipulation of the box would actually increase its salience in relation to the object. For example, in the tactile task, the box was picked up, shaken, peered into, a hand was inserted, and then the box was put back on the table. The invisible object would only become the more salient stimulus if infants actually understood that the experimenter's looking or hand insertion specifically referred to the contents of the box. Therefore, a salience mechanism would only lead to a correct object–affect link if infants also understood the referential nature of one or both of these behaviors.

It is worthwhile considering whether infants were connecting the experimenter's affect to her search behavior rather than the

objects.[2] In other social referencing studies, the person who sends the emotional message looks at, but does not handle, the target object. It is then argued that infants' appraisal of the object is altered by the emotional information (e.g., "X" is a negative object). To date, whether infants can interpret emotional displays as communications about actions (e.g., "X" is a negative action) has not been demonstrated. In addition, an action-based explanation is less viable in the visual task because the experimenter did not emote until after she removed the lid of the box. Finally, the actions associated with the happy and disgust signals were identical. Thus, infants would have to go beyond an affect–action link (e.g., opening a box is unpleasant) to one encompassing a specific box (e.g., opening the pink box is unpleasant). In such circumstances, infants would be at risk of generalizing the emotion to the box (e.g., the pink box is unpleasant). Infants would therefore avoid any type of contact with the disgust box, rather than just the act of opening or inserting their hands into the box.

In summary, not one of these nonreferential mechanisms is sufficient by itself to produce a regulatory response specific to the concealed objects. A more satisfactory and plausible explanation is that infants as young as 14 months of age used cues such as the experimenter's gaze and action to identify the referent of each emotional display (i.e., a referential mechanism). If infants used the cues in this manner, then they presumably understood that these behaviors index an individual's attentional focus. This interpretation is consistent with recent findings in the joint-attention literature. At around 14 months, infants begin to look at the specific target of another person's pointing gesture or gaze when other potential referents are available instead of just scanning the general area (Morissette et al., 1995). This implies that infants are not looking in the same direction as the other person simply because they have learned that this will lead to an interesting sight. Instead, it suggests that infants are now searching for the correct object rather than just any visual event. It is also noteworthy that infants begin to produce referential gestures (e.g., pointing) of their own at this time (Masur, 1983). However, the present study suggests that infants not only use these types of cues to locate the target of another person's attention but also to interpret their emotional signals. Infants identified the experimenter's attentional focus (e.g., by following her gaze) and then, because she was emoting while attending to the concealed object, they inferred that this was also the referent of her emotional communication.

These findings are significant not only in terms of clarifying how infants interpret emotional signals but also as indicators of their emerging theory of mind. For instance, it could be argued that infants understood something about the experimenter's internal, psychological experiences. They may have recognized that she was mentally attending to, and experiencing disgust about, an object. Although this is a very generous interpretation of the data, there are a variety of other skills evident in the 2nd year that likewise point to some rudimentary understanding of people's mental lives. These include teasing (Dunn, 1988), empathy (Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992), symbolic play (Leslie, 1987), internal-state language (Bretherton & Beeghly, 1982), and, more recently, the ability at 18 months to infer another person's intentions (Meltzoff, 1995) and desires (Repacholi & Gopnik, 1997).

Finally, it is also important to note that infants appeared to understand something about the emotional content of the experimenter's expressions. It was not merely the case that the experimenter's disgust elicited negative affect in the children and that they later avoided the target object because it had been linked with their own negative feelings. Infants' affective behavior was modified to some extent during each emotion trial but did not seem to predict their subsequent exploration. The absence of an affect–behavior relationship suggests that infants appreciated the meaning of the displays in terms of a positive–negative distinction and used this information to form some initial evaluation of the concealed objects. For example, one object was appraised as pleasant, whereas the other was perceived to be potentially unpleasant. It was these appraisals, then, that guided their object search. On the other hand, it could be argued that the affective data are an artifact of the way in which infants' emotional responses were measured. It is possible, for instance, that some children were only imitating the experimenter's expressive behavior and did not actually experience any corresponding change in their feeling state. Alternatively, if any affective change did occur, this may have been too low in its intensity or too fleeting to have any observable impact on their instrumental behavior. Further research is clearly needed to clarify whether, and under what circumstances, emotion contagion contributes to infant social referencing.

Conclusion

In summary, infants as young as 14 months of age responded to the directionality of another person's emotional signals. A variety of mechanisms were examined to account for this finding, and it was concluded that processes like temporal contiguity and stimulus salience were insufficient by themselves to produce a response that was specific to the contents of the boxes. Instead, infants appeared to use cues like gaze and action to disambiguate the referent of the experimenter's attentional focus and inferred that the emotion was related to this particular object. It would appear that, in the 2nd year of life, infants are beginning to understand something about the referential intent of another person's emotional communications. Longitudinal studies are required, however, to describe more precisely the relationship between infants' comprehension and production of attentional cues (e.g., gaze, pointing), their ability to interpret emotional signals, and their other communication skills. It also remains to be determined why infants' use of gaze and other referential cues is restricted to attention and emotion at 14 months, and does not become evident in the language domain until around 18 months (Baldwin, 1993a, 1993b). Finally, one must not overlook the implications of these findings for the emergence of the child's theory of mind. It could be argued, for example, that understanding the referential nature of emotional expressions at 14 months of age represents an early appreciation of humans as psychologically engaged with objects.

[2] I would like to thank an anonymous reviewer for this suggestion.

References

Baldwin, D. A. (1993a). Early referential understanding: Infants' ability to recognize referential acts for what they are. *Developmental Psychology, 29,* 832–843.

Baldwin, D. A. (1993b). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language, 20,* 395–418.

Baldwin, D. A., & Moses, L. J. (1994). Early understanding of referential intent and attentional focus: Evidence from language and emotion. In C. Lewis & P. Mitchell (Eds.), *Children's early understanding of mind* (pp. 133–156). Hillsdale, NJ: Erlbaum.

Bretherton, I., & Beeghly, M. (1982). Talking about internal states: The acquisition of an explicit theory of mind. *Developmental Psychology, 18,* 906–921.

Butterworth, G. E., & Cochran, E. (1980). Towards a mechanism of joint visual attention in human infancy. *International Journal of Behavioral Development, 3,* 253–272.

Butterworth, G. E., & Grover, L. (1989). Joint visual attention, manual pointing and preverbal communication in human infancy. In M. Jeannerod (Ed.), *Attention and performance XIII* (pp. 605–624). Hillsdale, NJ: Erlbaum.

Butterworth, G. E., & Jarrett, N. L. M. (1991). What minds have in common is space: Spatial mechanisms serving joint visual attention in infancy. *British Journal of Developmental Psychology, 9,* 55–72.

Caron, A. J., Caron, R. F., & Antell, S. E. (1988). Infant understanding of containment: An affordance perceived or a relationship conceived? *Developmental Psychology, 24,* 620–627.

Dunn, J. (1988). *The beginnings of social understanding.* Cambridge, MA: Harvard University Press.

Ekman, P., & Friesen, W. V. (1975). *Unmasking the face: A guide to recognizing emotions from facial cues.* Englewood Cliffs, NJ: Prentice Hall.

Ferguson, G. A., & Takane, Y. (1989). *Statistical analysis in psychology and education* (6th ed.). New York: McGraw-Hill.

Hirshberg, L., & Svejda, M. (1990). When infants look to their parents: I. Infants' social referencing of mothers compared to fathers. *Child Development, 61,* 1175–1186.

Hornik, R., Risenhoover, N., & Gunnar, M. (1987). The effects of maternal positive, neutral and negative affective communications on infant responses to new toys. *Child Development, 58,* 937–944.

Klinnert, M. D. (1984). The regulation of infant behavior by maternal facial expression. *Infant Behavior and Development, 7,* 447–465.

Leslie, A. M. (1987). Pretense and representations: The origins of "theory of mind." *Psychological Review, 94,* 412–426.

Leung, E. H., & Rheingold, H. L. (1981). Development of pointing as a social gesture. *Developmental Psychology, 17,* 215–220.

Masur, E. F. (1983). Gestural development, dual-directional signalling, and the transition to words. *Journal of Psycholinguistic Research, 12,* 93–109.

Meltzoff, A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology, 31,* 838–850.

Moore, C., & Corkum, V. (1994). Social understanding at the end of the first year of life. *Developmental Review, 14,* 349–372.

Morissette, P., Ricard, M., & Decarie, T. G. (1995). Joint visual attention and pointing in infancy: A longitudinal study of comprehension. *British Journal of Developmental Psychology, 13,* 163–175.

Mumme, D. L., Won, D., & Fernald, A. (1994, June). *Do one year old infants show referent specific responding to emotional signals?* Poster presented at the meeting of the International Conference on Infant Studies, Paris, France.

Nelson, C. A. (1987). The recognition of facial expressions in the first two years of life: Mechanisms of development. *Child Development, 56,* 58–61.

Repacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology, 33,* 12–21.

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Bulletin, 94,* 23–41.

Rozin, P., Hammer, L., Oster, H., Horowitz, T., & Marmora, V. (1986). The child's conception of food: Differentiation of categories of rejected substances in the 1.4 to 5 year range. *Appetite, 7,* 141–151.

Scaife, M., & Bruner, J. S. (1975). The capacity for joint visual attention in the infant. *Nature, 253,* 265–266.

Sorce, J. F., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signalling: Its effects on the visual cliff behavior of 1-year-olds. *Developmental Psychology, 21,* 195–200.

Walden, T. A., & Ogan, T. A. (1988). The development of social referencing. *Child Development, 59,* 1230–1240.

Walker-Andrews, A. S. (1988). Infants' perception of the affordances of expressive behaviors. In C. Rovee-Collier (Ed.), *Advances in infancy research* (Vol. 5, pp. 173–221). Norwood, NJ: Ablex.

Zahn-Waxler, C., Radke-Yarrow, M., Wagner, E., & Chapman, M. (1992). Development of concern for others. *Developmental Psychology, 28,* 126–136.

Received June 13, 1996
Revision received November 24, 1997
Accepted November 24, 1997 ■