Published in final edited form as:
Child Dev. 2007 ; 78(2): 503–521.

Emotional Eavesdropping: Infants Selectively Respond to Indirect Emotional Signals

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Abstract

Two experiments examined whether 18-month-olds learn from emotions directed to a third party. Infants watched an adult perform actions on objects, and an Emoter expressed Anger or Neutral affect toward the adult in response to her actions. The Emoter then became neutral and infants were given access to the objects. Infants' actions were influenced by their memory of the Emoter's affect. Moreover, infants' actions varied as a function of whether they were currently in the Emoter's visual field. If the previously angry Emoter was absent (Experiment 1) or turned her back (Experiment 2), infants did not use the prior emotion to regulate their behavior. Infants learn from emotional eavesdropping, and their subsequent behavior depends on the Emoter's orientation toward them.

In the course of their everyday lives, infants have many opportunities to observe people acting on objects, interacting with other people, and emotionally responding to these events. Thus, there is the potential for infants to acquire a rich set of social knowledge from observation alone. Infants seem remarkably well equipped to engage in "socially guided" learning (Feinman, 1992; Vygotsky, 1934/1962), as indicated by the growing literature on imitation, social referencing, and joint visual attention.

Human infants can learn to perform novel acts on objects simply by observing how others interact with those objects. For example, in Meltzoff (1988b), 14-month-old infants watched an adult demonstrating how to turn on a light panel by touching it with his forehead. One week after observing this novel act, 66% of the infants imitated this behavior, although 0% of the control infants did so spontaneously, in the absence of the demonstration. Moreover, imitation of simple actions on objects has been noted as early as 6 – 9 months of age (e.g., Barr, Dowden, & Hayne, 1996; Meltzoff, 1988a). From an early age then, infants can acquire information about objects and how to manipulate them simply by observing other people's instrumental behaviors.

Another avenue whereby infants can expand their knowledgebase about objects is by paying attention to how people emotionally respond to these stimuli. This can be seen most clearly in the context of social referencing. Numerous studies (see Feinman, Roberts, Hsieh, Sawyer, & Swanson, 1992, for a review) have demonstrated that, by 12 months of age, infants can use emotional cues (e.g., facial expression, tone of voice) from other people to regulate their own actions. In these laboratory-based studies, the emotional information is directly communicated to infants by their social partner. However, in the real world, infants also frequently eavesdrop —they see and hear emotional exchanges between other people from a distance. For example,

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This research was supported by grants from the University of Washington Royalty Research Fund (65-2685) to Betty M. Repacholi and NIH (HD-22514) to Andrew N. Meltzoff. We thank Berit Olsen, Nina Petrie, Dawn Kragness, Jacque Mullen, and Mary Wald for their assistance with this research. Portions of these data were presented at the Biennial Meeting of the Society for Research in Child Development, Atlanta, GA, April 2005, and a conference at Duke University, Durham, NC, May 2005.

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an infant might observe his mother scolding an older sibling for throwing a baseball at a window. What does the infant do when he later has an opportunity to play with the ball? One possibility is that he copies his sibling and tosses it at the window. After all, his mother was not angry at him, just his sibling. On the other hand, the infant might use the emotional information to regulate his own behavior. For instance, he might avoid reproducing his siblings' actions and consequently avoid his mother's anger. Whether infants can use "indirect emotional information"—emotional reactions that are directed at *someone else* and not the infant—has not been studied, despite its relevance to the developing child. It is the primary focus of the two experiments reported here.

Previous Social Referencing Research

In the standard social referencing paradigm, infants are presented with a novel object that is designed to elicit uncertainty, and their mothers are instructed to produce a specific emotional expression in response to seeing this stimulus. The mothers do not touch the object nor do they provide verbal instructions about what to do. Instead, infants must rely on maternal emotional cues to determine how to deal with the object. By 12 months of age, infants will interact with the object when a positive expression is posed but exhibit delayed and/or reduced object contact if negative affect (e.g., fear) is conveyed. When neutral expressions are shown, infants' responses often resemble those of infants exposed to positive messages (Hornik, Risenhoover, & Gunnar, 1987; Mumme, Herrera, & Fernald, 1996). Thus, the regulatory effect appears to largely be a function of the negative message. Social referencing has also been observed when the affective signals are provided by infants' father (Hirshberg & Svejda, 1990), their day-care provider (Camras & Sachs, 1991), or an adult stranger (Hertenstein & Campos, 2004).

There has been debate about the mechanism underlying infants' behavioral regulation in social referencing studies. It could be argued that infants appreciate the other person's emotional state (e.g., "she's afraid") or communicative intent (e.g., "she's telling me that this is dangerous") and then use this information to reappraise the situation (often referred to as a cognitive account of social referencing). Alternatively, the other person's expression might directly modify infants' own feelings, which would then mediate their subsequent behavior. If such a mechanism is operating, behavioral regulation could occur without infants understanding anything about the meaning of the emotional display and without appraising the situation for its relevance to the self (often referred to as an emotional contagion account of social referencing). They might simply become scared.

To distinguish between these two alternatives, some researchers have examined infants' affective responses in the social referencing paradigm. There have been reports that infants express more negative affect in response to an adult's negative than positive display (e.g., Hirshberg & Svejda, 1990; Mumme et al., 1996). However, when infants are found to have an affective response to the other person's emotional signal, this does not rule out a cognitive mechanism. If infants' object appraisal is altered because they understand the emotional message, this new appraisal may influence both their instrumental behavior and their own affective state (e.g., the appraisal that mom is scared of the object may then arouse fear in the infant). Based on the extant literature, no definitive conclusions can be reached about the role of cognitive appraisal versus emotional contagion in explaining infant social referencing.

In the typical social referencing study, emotional information about a novel object is directly communicated to infants by their social partner. However, when infants simply witness an emotional exchange between two other people, this also provides an important opportunity for them to gather information that might be relevant to their own situation. To date, there are two potentially relevant studies. In one (Feinman & Lewis, 1983), 10-month-old infants were exposed to a stranger. In the direct condition, mothers spoke to their infants about the stranger, using either a positive or a neutral tone of voice. In the indirect condition, mothers greeted the stranger with either a positive or a neutral tone of voice. Infants were less wary of the stranger after their mother had spoken positively to them about this person than when she had been neutral. On the other hand, infants' behavior toward the stranger was not influenced if the emotional message was indirect. In the second study (Feiring, Lewis, & Starr, 1984), 15-month-old infants observed either: (a) their mother interacting positively with a stranger, (b) two strangers interacting in a positive manner, or (c) a stranger reading a magazine in the presence of their mother and the other stranger. In all conditions, the stranger subsequently tried to befriend the infant. Infants were less wary and more willing to interact with the stranger in the two positive interaction conditions than in the no-interaction condition. Although this finding is consistent with infants being able to use indirect emotional cues to regulate their behavior, there are clearly several other explanations. For instance, infants may have been responding to whether or not the stranger had interacted with the other adults in the room. When the stranger was ignored, especially by their mothers, this might have induced infants to avoid this individual. Because there was no neutral interaction condition, this interpretation cannot be ruled out.

In the aforementioned studies, the emotional information was in reference to a person. If infants are facile at using indirect emotional signals, then similar effects should also be evident when the referent is an object. Two recent social referencing studies (Friend, 2001; Mumme & Fernald, 2003) are relevant. In both of these studies, infants watched videotaped images of an adult emoting about a novel object. Twelve- and 15-month-old infants spent less time touching the object when it had been the target of a negative rather than a positive expression. The emotional information in these videotapes was indirect in the sense that infants did not actively participate in a social interaction with the emoting adult. On the other hand, the videotaped adult alternated her gaze between the object and the infant and/or appeared to be speaking directly to the infant as she repeated phrases such as "look at that." Consequently, infants may have experienced the emotional display as a communication directed at or intended for them. In summary, it remains to be determined whether infants' will regulate their behavior in a situation where they simply eavesdrop on the interaction between two other people—one in which it is another person, not themselves, who is the recipient of an emotional communication.

Current Studies

The primary goal of this research was to explore infants' responses to indirect emotional signals. In particular, when infants observe one person expressing an emotion toward another person, do they then use that emotional information to regulate their own object-directed actions? In order to examine this question, a new test procedure was developed that integrates into one episode both social referencing and object-directed imitation (see Meltzoff, 1988b, for further details about this type of imitation). In the current "Emotion-Imitation" test procedure, infants watch an Experimenter demonstrating an action on an object. After two demonstrations, the Emoter enters the room and sees the Experimenter perform the action a third time. The Emoter responds by expressing either Anger or Neutral affect *toward the Experimenter*. Infants are then given an opportunity to play with the object. During the response period, both the Emoter and the Experimenter have neutral facial expressions and are silent. Thus, infants are given no additional information at this time about what they should do.

We expected that infants would differentially regulate their interaction with the object as a function of the Emoter's prior emotional display. Anger is often used by parents to prohibit children from performing a specific action or to communicate to children that they have performed a forbidden act. Moreover, during the second year of life, children are held more responsible for their own actions and there is an increase in the amount of parental anger directly communicated to them (Saarni, Mumme, & Campos, 1998). It is during this time that infants may learn that anger can communicate that an act is forbidden. Thus, when infants observe the

Emoter's anger being directed to the Experimenter who is performing a certain act on an object, they may interpret this as a "forbidden" act and be hesitant to copy that action themselves.

A second goal of the present research was to begin exploring the conditions under which this indirect emotion effect might operate. Are there some situations in which infants *disregard* the indirect emotional information and perform the forbidden act despite eavesdropping on the emotionally laden exchange between Emoter and Experimenter? For example, adults may know that "Katherine will become angry if I touch her things," but what happens if Katherine is not present to observe this event? In Experiment 1, we manipulated whether the previously angry adult remained in the room or was absent during the response period when infants had access to the object. In Experiment 2, the Emoter remained in the room, but her physical orientation was manipulated so that she either faced the infant or had her back turned during the response period. There is abundant evidence that very young infants are drawn to faces. For example, they preferentially attend to real faces and face-like patterns in comparison with other complex visual stimuli (Johnson & Morton, 1991), and by 2 months of age, they are more attentive to eyes than any other component of the face (Maurer, 1985). Over the first year of life, infants also become increasingly able to discriminate gaze direction. They begin to look in the direction indicated by another person's turning eyes and head (Butterworth & Jarrett, 1991; Flom, Lee, & Muir, 2007), and by 10 months of age, they do this when the person's eyes are open but not when the eyes are closed (Brooks & Meltzoff, 2005). Given this sensitivity to faces, and eyes in particular, we hypothesized that whether the Emoter's face was visible in the response period, when infants had access to the object, might be an important factor in their behavioral regulation.

Although infants can engage in social referencing by 12 months of age, older infants were examined here due to the complexity of the Emotion-Imitation procedure. For example, the ability to respond appropriately to indirect emotional cues might emerge later than direct social referencing. We expected that this ability might be evident, however, by 18 months of age. At this time, infants are becoming more skilled at attending to and understanding conversations between two other people (Barton & Tomasello, 1991; Dunn & Shatz, 1989). Moreover, Floor and Akhtar (2006) demonstrated that 18-month-old infants can learn new words by overhearing others' conversations. It would likewise be adaptive for infants to also be able to learn about the affective consequences of performing an action by "overhearing" and "seeing" emotional exchanges between other people.

Experiment 1

Method

Participants—The final sample consisted of ninety-six 18-month-old infants (M = 18.14 months; SD = 5.43 days; range = 17.65 – 18.38 months), with equal numbers of boys and girls. Participants were recruited from the University of Washington's infant studies participant pool. All infants were full term (37 – 43 weeks) with normal birth weight (2.5 – 4.5 kg) and had no known physical, sensory, or mental handicap. The ethnic composition of the sample was 79% Caucasian, 1% Asian, and 20% other (e.g., mixed race). An additional 12 infants were excluded from the study because of parent interjections (n = 3), fussiness/inattention (n = 7), or procedural errors (n = 2).

Design—Infants were randomly assigned in equal numbers (n = 32) to one of three conditions: Anger-present; Neutral-present; or Anger-absent. An equal number of boys and girls were assigned to each condition. All infants participated in three trials, each involving a different test object and target action. In this first experiment, the object – action pairs were presented in a fixed order: dumbbell, cup, and buzzer.

Materials

Test objects: Three novel test objects were used and each was the target of a different one-step action. These test objects were replicas of those used in Meltzoff's (1988b) previous studies of imitation with this age group. One object was dumbbell shaped, consisting of two 2.5 cm wooden cubes, each with a 7.5 cm white plastic tube extending from it. One of the tubes was solid and smaller in diameter than the other hollow piece of tubing. The solid piece of tube fit snugly inside the other and some force was required to pull the tubes apart. The demonstrated (or target) act was to grasp the dumbbell by the wooden cubes on each end and pull outward. As the object came apart, a "popping" sound could be heard. Another object was an orange collapsible plastic cup that measured 6.5 cm in height and was made of a series of graded rings. The target act was to collapse the cup by pushing down on the top with a flat hand. This action produced a "scraping" sound as the plastic rings slid down to the base of the cup. The third object was a black box (16.5 cm × 15 cm × 5.5 cm) with a slightly recessed rectangular button (3.0 cm × 2.2 cm) on the top surface. The box was supported by a base that tilted 30° off the table so that the front surface with the recessed button was facing the infant. A wooden stick (10 cm × 1.7 cm × 1.0 cm) was presented along with the box. The target act was to press the recessed button with the wooden stick, thereby creating a "buzzing" sound.

Emotional stimuli: In the Anger-present and Anger-absent conditions, the Emoter's angry facial expression was based on the description of Ekman and Friesen (1975). Her eyebrows were lowered and drawn together, and there was a narrowing and squinting of her eyes and an elevation of the cheeks. When she was not speaking, her lips were pressed tightly together. This angry facial expression was accompanied by matching vocalizations. The intonation was angry, and emotionally relevant words were used to help the Emoter produce a convincing and consistent facial and vocal expression. This strategy has been employed in other social referencing studies (e.g., Mumme et al., 1996). In addition, in our pilot studies, this was found to be the most naturalistic presentation format for the Emoter and the infant. Because we were interested in infants' responses to emotional as opposed to linguistic information, we selected emotion words that infants would not typically understand at this age. Parents often spontaneously commented that they did not think their child understood the words. Thus, it was assumed that infants would respond to the Emoter's tone of voice in combination with her facial expression (see Walker-Andrews, 1997 for a discussion of infants' recognition of multimodal affective displays). Of course, we cannot completely rule out the possibility that individual infants understood some of the emotion words.

Different verbal scripts were employed in each anger trial; these were similar in their structure and the syllable length was identical. An example of an Anger script is as follows (see Appendix for the complete set):

> Emoter (in an angry tone): "That's aggravating! That's so annoying!"
>
> Experimenter (in a neutral tone): "Oh, I thought it was really interesting."
>
> Emoter (in an angry tone): "Well, that's just your opinion! It's aggravating!"

The Emoter practiced the facial and vocal expressions extensively so that she would be consistent both within and across testing sessions.

In the Neutral-present condition, the Emoter produced a "neutral face" that involved minimal facial movement, a relaxed mouth, and a smooth forehead. This neutral facial expression was accompanied by a "matter of fact" vocalization in which the Emoter's tone of voice was relatively uniform. The Neutral verbal scripts were identical in syllable length and similar in sentence structure to the angry vocalizations. Because it was difficult to find a set of neutral words that mapped onto the structure of the emotion words from the angry scripts, words with a more positive meaning were used instead. Once again, the emotion words were selected to be beyond infants' comprehension. An example of a neutral script is as follows (see Appendix for the complete set):

> Emoter (neutral tone): "That's entertaining. That's so enticing."
>
> Experimenter (neutral tone): "Oh, I thought it might have been too distracting."
>
> Emoter (neutral tone): "Well, you could be right. But it is entertaining."

Across all conditions, the Experimenter's facial and vocal expressions were neutral when she interacted with the Emoter. The emotional exchange between the Emoter and the Experimenter (i.e., the emotional display period) lasted about *7* s (M = 6.86 s, SD = 0.21 s).

Equipment: Three digital video cameras were used in this study. One video camera recorded a close-up view of infants' faces to examine their facial expressions and looking behavior. Another camera recorded the infant (head, torso, hands) and part of the table surface in front of the infant and was used to examine infants' instrumental behavior. A third camera was positioned so that it recorded a wide-angle view of the Experimenter and the Emoter. This latter videotape was used to determine whether the Emoter's expressions were recognizable to naïve adult coders and to check that the Emoter remained neutral during the response period.

Procedure—Infants were tested in a laboratory room while seated in their parent's lap (usually the mother) and faced a female Experimenter who was seated on the other side of the table. Infants remained seated throughout the testing procedure. Parents were asked to remain emotionally neutral and to avoid interacting with their child during the experiment (e.g., to avert their gaze if the child looked at them). Infants were seated in the parent's lap to decrease attrition, but this raises concerns as to whether parents were providing haptic cues. Infants were excluded from the experiment if such cues were detected (e.g., a parent stroked the infant's arm), but their presence cannot be completely ruled out. Anecdotally, parents themselves did not become visibly tense during the Anger displays; indeed, many parents were amused by the procedures. Thus, if haptic cues had been detected by infants, it is likely that this would have biased them to interact with the object and weakened our findings.

The Experimenter maintained a friendly demeanor throughout the testing. Each test session began with a brief warm-up with age-appropriate toys, to familiarize infants with the Experimenter and the setup of the testing room. In all three trials, the Experimenter initially demonstrated the target action twice on the test object. After each demonstration, the object was placed under the table and out of sight, in preparation for the next demonstration. The Experimenter did not express any particular emotion during or after performing the target act (i.e., she maintained a neutral expression).

After the second demonstration, an unfamiliar adult female (the Emoter) entered the room. The Experimenter introduced the Emoter by stating in a natural and friendly voice, "This is Nina. Nina is going to sit here and read a magazine." The Emoter seated herself to the right of the Experimenter, at the corner of the table, and briefly pretended to read a magazine. The Experimenter then elicited the Emoter's attention ("Nina, look at this") and demonstrated the action a third time. On completion of the action, the Emoter immediately expressed either Anger (Anger-present and Anger-absent conditions) or Neutral affect (Neutral-present condition) toward the Experimenter. The Experimenter always responded in a neutral fashion and the Emoter then expressed further Anger or Neutral affect (see Emotional stimuli). In all three conditions, the Emoter stopped emoting at the conclusion of her interaction with the Experimenter, and adopted a neutral facial expression. In the Anger-present and Neutral-present conditions, the Emoter remained seated; however, in the Anger-absent condition, the Emoter left the room at this point in time. As the door was closing, the Experimenter drew attention to the Emoter's absence by stating "Nina's gone. Nina's gone bye-bye." This statement was accompanied by a waving gesture.

In all three conditions, the Experimenter then placed the test object on the table, directly in front of the infant, and said "Here" in a neutral tone of voice. A 20-s response period was timed from the moment the object was positioned on the table. During this time, the now neutral and silent Emoter oriented toward the Experimenter, in order to avoid making direct eye contact with the infant. The Emoter did not directly face and look at infants during the response period because, in pilot testing, we found that this occasionally upset infants. However, the infant was well within the Emoter's visual field and her face was fully visible to the infant. The Experimenter likewise maintained a neutral facial expression, and silently looked down at a stopwatch in her lap during the response period. After the response period terminated, the Experimenter retrieved the object and in the Anger-present and Neutral-present conditions the Emoter left the room so that the next trial could commence (she was already out of the room in the Anger-absent condition). As the door was closing, the Experimenter stated "Nina's gone. Nina's gone bye-bye" and produced a waving gesture.

The next two trials followed an identical procedure, with the following exceptions. First, the Experimenter did not reintroduce the Emoter when she entered the room; only her departure was noted in each trial. In addition, different object – action pairs were employed. Finally, different words were used in the verbal scripts employed in each trial but these contained the same number of syllables and maintained a similar sentence structure (see Appendix). The scripts were identical in the Anger-present and Anger-absent conditions.

Coding—The video records of infants' instrumental behavior were edited so that the coding DVD's only included the three 20-s response periods from each infant, thereby ensuring that coders were completely uninformed as to infants' experimental condition. A naïve coder used these edited video records to score infants' performance of the target act in each response period. This behavior was coded using a dichotomous (yes/no) measure, adopting Meltzoff's (1988b) scoring definitions. For the dumbbell, a "yes" was scored if the infant pulled the object apart. A "yes" was scored for the cup if it was fully or partially collapsed without being thrown or banged. The buzzer was scored as a "yes" if the infant used the stick to push the button and the buzzing sound was then heard. Each infant's responses were summed across the three trials to yield a single score reflecting the total number of target acts produced (range of 0 – 3). A second naïve coder scored 35% of the data set. Interrater agreement was 100%.

We also examined several other aspects of infants' object-directed behavior to see if they varied as a function of the Emoter's expressions. In each response period, naïve coders recorded infants' latency to touch the object, timed from the moment the object was placed in front of the infant. If the infant did not touch the object, the latency was recorded as 20 s. Duration of object touch (in seconds) was measured starting from the moment the object was first touched by the infant. No duration score was recorded in those instances in which infants did not touch the object. Intercoder agreement (based on 35% of the data set) was high for both the latency and duration measures (both r's = .98).

The duration of infants' looks (in seconds) toward the Emoter, Experimenter, and Parent during each response period were also scored by a naïve coder. Every look toward one of the three adults that lasted for at least 0.17 s (five video frames) was tallied. The durations of these individual looks were then summed to yield separate duration scores for looks to each adult during the response period. A second naïve coder scored 35% of the data set and once again, high intercoder reliabilities were obtained with r's ranging from 0.97 to 1.00.

Infant affect (indexed by facial expression) was measured both during the emotional display period (i.e., the emotional exchange between the Emoter and the Experimenter) and the response period. The close-up recordings of infants' faces were examined without sound to ensure that coders had no artifactual way of knowing the infants' experimental condition. Infant facial expressions were rated every 2 s in each of these periods, 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 a slight smile, and a 0 indicated the absence of any positive affect. On the negative scale, a score of 2 was given for a cry-face/crying, big frowns, grimaces, or scowls; a score of 1 was for mild frowning/furrowing of the brows or slight wariness/worried expressions, and a score of 0 was given when there were no signs of negative affect. Mean positive and negative affect scores were then calculated for the emotional expression and for the response periods, based on the number of codable intervals for each infant. A second coder rated 25% of the data and reliabilities were high for both the positive (r = .86) and negative (r = .83) affect scores.

Finally, a manipulation check was performed to determine whether the Emoter had expressed the appropriate affect. A naïve coder rated the hedonic tone of the Emoter's facial expressions, without sound, during the expression period. A 5-point scale, ranging from −2 (*very negative*) to +2 (*very positive*), was used to rate hedonic tone. The coder was also required to indicate which discrete emotion was predominant in each facial expression, using the following list: happiness, interest, neutral, surprise, sadness, anger, disgust, and fear. The Emoter's facial expression was coded in the same manner during the response period for those conditions in which she remained in the room. A second naïve coder examined 25% of the data set. Interscorer reliabilities were high for both hedonic tone (r = .93) and predominant emotion classification (K = .84). The few cases of disagreement only occurred with respect to the Emoter's neutral displays, such that one coder sometimes classified the predominant emotion as "interest" when the other classified it as "neutral."

A manipulation check was also performed on the Emoter's vocalizations during the expression period. Using digital editing software, the Emoter's vocal expressions were low-pass filtered at 475 Hz, to make the lexical content unintelligible. The resulting audio files were then scored by two naïve coders, one examined the entire data set and the other scored 25%. Both coders reported that they were unable to identify any of the words uttered by the Emoter. Like the facial expressions, these vocalizations were coded in terms of hedonic tone (ranging from −2 to +2) and good interrater reliability was achieved (r =.80).

Results

Manipulation Check—In this experiment, α was set at .05 and thus all results reported as significant are $p < .05$ or better. The manipulation check showed that the Emoter followed the procedure very accurately. In the emotional expression period, all of the Emoter's angry facial displays were rated as negative (M = −1.95, SD = .10), and all of her neutral faces received a score of 0. There was no significant difference between the Anger-present (M = −1.96, SD = .11) and the Anger-absent (M = −1.94, SD = .08) conditions in the degree to which negative affect was expressed by the Emoter. Discrete emotion coding indicated that all of the Emoter's facial displays of anger were classified as "anger." Fully 82% of the neutral facial displays were classified as "neutral" for predominant emotion, which conforms to the procedural requirements, with 28% identified as "interest." The majority (84%) of the filtered anger vocalizations were rated as negative in hedonic tone (M = −1.29, SD = .46) and the remainder were assigned a score of 0. As expected, there was no significant difference between the Anger-present (M = −1.04, SD = .38) and Anger-absent (M = −1.10, SD = .43) conditions. About 86% of the filtered neutral vocalizations were rated as mildly positive in hedonic tone (i.e., a score of +1), and the remainder were assigned a score of 0. All of the Emoter's facial expressions during the response period were assigned a score of 0 for hedonic tone. Consistent with the hedonic ratings, 89% of these facial expressions were classified as “neutral” for the predominant emotion and 11% were classified as “interest.”

Latency to Touch the Object—Latency to first touch of the object was analyzed using a 3 (condition) × 2 (gender) × 3 (trial) analysis of variance (ANOVA), with repeated measures on the last factor. This analysis yielded significant effects for condition, $F(2, 90) = 11.87$, η^2_p (partial effect size) = .21, and trial, $F(2, 180) = 7.92$, $\eta^2_p = .08$. There was also a condition × trial interaction, $F(4, 180) = 3.76$, $\eta^2_p = 08$. Simple effects analyses were performed to explore the interaction effect. All post hoc comparisons in this experiment were conducted using Fisher’s least significant difference (LSD) procedure. The latency to touch was compared across the three experimental conditions for each trial taken separately. There was a significant condition effect in each of the trials. Follow-up comparisons indicated that, in each trial, latency to touch was significantly longer in the Anger-present than in each of the other conditions. There were no significant differences between the Anger-absent and Neutral-present conditions for any of the trials. Mean latency to touch (in seconds) for each condition are presented in Table 1.

The source of the interaction effect was revealed when latency to touch was compared across the three trials for each condition. Although there was a tendency for infants to become increasingly delayed in touching the test object over the three trials, this trial effect was only significant in the Anger-present condition, $F(2, 62) = 6.04$. In this condition, infants touched the object more slowly on the second ($M = 5.48$ s, $SD = 8.54$) and third ($M = 6.40$ s, $SD = 8.78$) trials than in the first trial ($M = 2.91$ s, $SD = 6.17$). There was no significant difference between Trials 2 and 3.

Duration of Object Touch—In order to analyze whether the duration of infants’ touching of the object varied as a function of trial, a repeated measures ANOVA was conducted with the subset of infants who touched the objects on all three trials ($n = 86$). There was a significant trial effect, $F(2, 160) = 8.15$, and follow-up tests revealed that infants spent a longer time touching the object in the first trial than in either of the other two trials. In the absence of a significant Condition × Trial interaction, a mean duration score (see Table 1) was calculated for each infant based on those trials in which the object was touched. This maximized the number of infants that could be included in the analysis. Only two infants were excluded and this was because they did not touch the test object in any of the trials.

Because the 20-s response period was timed from the moment the object was presented to infants, duration of touch was not independent of the latency measure. Consequently, mean duration of touch was analyzed with mean latency to touch entered as a covariate. A 3 (condition) × 2 (gender) analysis of covariance (ANCOVA) yielded a marginally significant condition effect, $F(2, 87) = 3.20$, $p = .05$, $\eta^2_p = .07$. Infants in the Anger-present condition spent significantly less time touching the object than did infants in either of the other two conditions. There was no significant difference between the Neutral-present and Anger-absent conditions.

Imitation—Cochran *Q* tests were calculated for each experimental condition to determine whether infants’ imitative behavior differed across the three trials. Infants were no more or less likely to imitate on one trial relative to another. Infants’ total imitation scores (range: 0 – 3) were then analyzed with a 3 (condition) × 2 (gender) ANOVA. As predicted, there was a significant condition effect, $F(2, 90) = 9.05$, $\eta^2_p = .17$ (Figure 1). Infants in the Anger-present condition ($M = 1.69$) had significantly lower imitation scores than did infants in either of the other conditions. Infants in the Anger-absent condition ($M = 2.78$) tended to imitate more than did infants in the Neutral-present condition ($M = 2.28$), $t(62) = 1.95$, $p = .055$. Nonparametric analyses of the imitation scores were also conducted, and yielded the same basic pattern as the parametric analyses. A Kruskal –Wallis test indicated that the number of target acts infants produced significantly differed as a function of experimental condition, $\chi^2(2, N = 96) = 15.07$. A series of Mann – Whitney *U*s revealed significantly higher imitation scores in the Anger-present than in either of the other conditions. As in the parametric analysis, there was marginally more imitation in the Anger-absent than in the Neutral-present condition, $p = .05$. There was also a significant main effect of gender, such that across all conditions, boys ($M = 2.48$, $SD = 0.92$) were more likely to imitate the Experimenter's actions than were girls ($M = 2.02$, $SD = 1.26$), $F(1, 90) = 4.76$, $\eta^2_p = .05$.

Infant Looking During the Response Period—The duration of looks to the Emoter during the response period in the Anger-present and Neutral-present conditions are presented in Table 1. (This behavior was not coded for the Anger-absent condition because the Emoter left the room before the response period began.) The duration scores were analyzed with a 2 (condition) × 2 (gender) × 3 (trials) ANOVA. Infants spent significantly more time looking at the Emoter when she had previously been angry than when she had expressed neutral affect toward the Experimenter, $F(1, 60) = 12.36$, $\eta^2_p = .17$. This difference occurred despite the fact that, in the response period, the Emoter was now showing a neutral expression in both conditions. No other effects were significant.

Preliminary analyses indicated that there were no trial effects for looks to Parent or Experimenter during the response period, so this variable was not included in the subsequent analyses. These two looking measures (see Table 1) were analyzed in a 3 (condition) × 2 (gender) multivariate analysis of variance (MANOVA). There was a significant multivariate gender effect, $F(2, 88) = 4.38$, but no other effects were significant. A more detailed investigation of the gender effect was conducted using a Roy – Bargmann stepdown analysis (see Tabachnick & Fidell, 2001), to take into account the correlation between the two looking measures. A Bonferroni corrected α level of .025 was used in the two subsequent analyses to maintain familywise $\alpha = .05$. Looking to the Experimenter was examined first because this dependent variable yielded the highest *F* value in the univariate 3 (condition) × 2 (gender) ANOVA. Girls ($M = 4.08$, $SD = 1.87$) spent significantly more time looking at the Experimenter than did boys, ($M = 3.24$, $SD = 1.87$), $F(1, 90) = 5.02$. Duration of looks to the Parent was then analyzed using a 3 (condition) × 2 (gender) ANCOVA, with looks to Experimenter entered as a covariate. There was no significant gender difference, but the pattern was for girls to spend more time looking at the Parent.

Infant Facial Expressions—Infants displayed very little positive or negative affect during the emotional expression period, that is, the emotional exchange between the Emoter and Experimenter (see Table 1). Preliminary analyses indicated that there were no trial effects so this variable was not included in the main analysis. A 3 (condition) × 2 (gender) MANOVA was then conducted with the two sets of affect scores. There were no significant effects. Infants' affect during the subsequent response periods (when the adults were neutral) was analyzed in a similar manner and this revealed a significant multivariate condition effect, $F(4, 180) = 3.53$. In the stepdown analysis, the condition effect was only significant for infants' positive affect scores, $F(2, 90) = 6.51$, $\eta^2_p = .13$. Infants in the Anger-present condition had significantly lower positive affect scores during the response period than did infants in either of the other conditions (Table 1). Infants were equally positive in the Anger-absent and Neutral-present conditions.

Discussion

These results indicate that indirect emotional signals can influence infants' behavior on a variety of measures, including imitation, looking time, object touching, and facial expressions.

As predicted, infants' object-directed behavior varied as a function of the emotions that were shown. For instance, in the Anger-present condition, infants were less likely to imitate than were infants in the Neutral-present condition. In both conditions, the Emoter remained in the room and her behavior was identical during the response period (i.e., she maintained a calm, neutral expression). The only difference between the two conditions was in terms of the Emoter's *prior* emotional reaction to the Experimenter's actions. Interestingly, the indirect emotion effect was not restricted to infants' imitative behavior. Infants were more hesitant to touch the object when the previously angry Emoter was present than when the previously neutral person was present. It is also noteworthy that, in this Anger condition, infants looked more at the Emoter during the response period than did infants in the Neutral condition. Infants may have been monitoring the Emoter for any signs of further anger. Finally, infants in the Neutral-present condition had higher positive affect scores in the response period than did those in the Anger-present condition. This affective difference may be due, in part, to the fact that infants in the Neutral condition were engaged in a pleasurable activity (i.e., reproduction of the target act) during the response period.

Infants' behavior was also influenced by whether the Emoter was physically present or absent during the response period. When the Emoter had been angry, and then left the room, infants were more likely to imitate the target act than were infants in the Anger-present condition. In addition, even though both groups of infants had witnessed the Emoter's angry outburst, those in the absent condition were less hesitant to touch the object and had higher positive affect scores during the response period.

Why did behavioral regulation occur in the presence of the previously angry adult but not in her absence? One explanation is that infants were scared of the Emoter as a result of her angry display and that her physical presence maintained their fear, even though she was now silent and neutral. This is inconsistent, however, with the affective data. There were no differences across conditions with regard to infants' negative affect, in either the expression or the response period. Another possibility is that the presence of the Emoter served as a memory cue for her previous angry display and, in her absence, infants could no longer remember what had been associated with the negative emotional expression. Although such an explanation can not be completely ruled out, it seems less likely given Hertenstein and Campos' (2004) finding that, after 1 hr, 14-month-old infants could still remember which of two objects had previously been the target of a (now absent) person's emotional display.

What, then, was governing infants' behavior in the Anger-present condition? It is important to consider that in this condition, the Emoter was not simply in the room during the response period, but her face was visible to the infant. Thus, perhaps it was not the Emoter's physical presence per se, but something about her physical orientation that was leading infants to regulate their behavior (despite the fact that she remained silent and neutral in the response period). A second experiment was conducted to explore this possibility.

Experiment 2

This second experiment was designed to determine whether infants simply respond to the previously angry adult's physical presence or whether the fact that she was facing the infant in one condition and not in the other might be important. To distinguish between these two alternatives, we introduced a new manipulation. In all of the conditions, the Emoter remained in the room (i.e., was "physically present") during the response period. However, after her emotional outburst and before the infant was given the object in the response period, she either faced the infant (Anger-face and Neutral-face) or turned around so that her back was to the infant (Anger-back). We predicted that infants in the Anger-back and Neutral-face conditions would display higher levels of imitation relative to those infants in the Anger-face condition.

We also refined the test procedure. In the first experiment, there was a tendency for infants in the Neutral-present condition to imitate less than those in the Anger-absent condition. Although this might seem counter intuitive, even adults might become disconcerted or self-conscious if a stranger looked at them, in silence, for an extended period of time. Thus, in the second experiment, we attempted to address this issue by training the Emoter to adopt a more relaxed facial expression during the response periods for the Anger-face and Neutral-face conditions. The revised expression was intended to give the impression that the Emoter was "watching with friendly interest." It was expected that this modification would help to minimize any consternation that might arise when the Emoter becomes silent and still in the response period. Second, pilot testing revealed that if she adopted this modified neutral face after an angry outburst, the Emoter could now look directly at infants during the response period, without causing any undue upset.

Method

Participants—A total of seventy-two 18-month-old infants were included in the final sample (36 girls, *M* = 18.18 months, *SD* = 3.48 days, range = 17.85–18.38 months). Infants were recruited in the same manner as in Experiment 1. The ethnic composition of the sample was 77.5% Caucasian, 1.4% Hispanic, and 21.1% other (e.g., mixed race). An additional 12 infants were excluded due to parental interjections (n = 3), procedural errors (n = 4), and fussiness/ inattention (n = 5).

Design—Infants were randomly assigned in equal numbers (n = 24) to one of three conditions: Anger-face; Neutral-face; or Anger-back. An equal number of boys and girls were assigned to each condition. Infants participated in three trials, each involving a different object and target action. There were six possible orders for presenting the objects and these orders were counterbalanced across males and females in each condition.

Materials and Experimental Setup—The Emoter, the setup of the testing room, and the three test objects were identical to those used in Experiment 1.

Procedure—The procedure was identical to that employed in Experiment 1 except for the Emoter's behavior following her emotional outburst. In the Anger-face and Neutral-face conditions, the Emoter swiveled her chair at the conclusion of the emotional exchange, so that she completely faced the infant and she looked toward the infant's waist (just above the table surface). The Emoter was silent, and adopted the modified neutral facial expression described earlier. After expressing anger toward the Experimenter in the Anger-back condition, the Emoter swiveled her chair so that she completely turned her back on the infant, and she pretended to read a magazine. She likewise became silent and neutral. In each condition, once the Emoter had assumed the correct orientation, the Experimenter placed the test object on the table directly in front of the infant. At the end of the 20-s response period, the Experimenter retrieved the object and the Emoter left the room. This procedure was then repeated with the other two test objects.

Coding—The video records were scored in the same manner as in Experiment 1. There were no disagreements as to whether the infant had performed the target act. Agreement was also high for latency to touch (r = 0.99) and duration of touch (r = 0.99). The interrater reliabilities for duration of looks to the Emoter, Experimenter, and Parent during the response periods ranged from r = 0.83 to 1.00. In this experiment, coders also recorded the duration of infant looks to the test object during the response period. As with the other looking measures, there was high scorer agreement, r = 0.98. The agreement was likewise high for infant-positive (r = 0.90) and for infant-negative affect (r = 0.83) during the emotional expression and response periods. Finally, a manipulation check was conducted on the Emoter's facial and vocal displays.

Interrater agreement for hedonic tone were high (face $r = 0.95$; voice $r = 0.89$). The two coders had 100% agreement as to the predominant emotion classifications for the facial expressions.

Results

Manipulation Check—Once again, α was set at .05. The results show that the Emoter followed the desired procedure. All of the Emoter's angry facial expressions were rated as negative in hedonic tone ($M = -1.83$, $SD = .24$) and all of her neutral expressions were assigned a score of 0. There was no significant difference in hedonic tone for Anger-face ($M = -1.84$, $SD = .25$) versus Anger-back ($M = -1.83$, $SD = .24$). The discrete emotion coding indicated that the appropriate emotions (Neutral or Anger) were predominant in all of the facial displays. The majority (87%) of the filtered anger vocalizations were rated as negative in hedonic tone ($M = -1.32$, $SD = .37$), and the remainder were assigned a score of 0. There was no significant difference between Anger-face ($M = -1.12$, $SD = .49$) and Anger-back ($M = -1.10$, $SD = .44$) for vocal hedonic tone. About 93% of the filtered neutral vocalizations were rated as mildly positive in hedonic tone (i.e., a score of +1), and the remaining expressions were assigned a score of +2. Finally, the Emoter's facial expression during the response period was examined in the Anger-face and Neutral-face conditions. All of her expressions were assigned a score of 0 for hedonic tone, indicating that she was neutral.

Latency to Touch the Object—Latency to touch the object was analyzed with a 3 (condition) × 2 (gender) × 3 (trial) repeated measures ANOVA. This analysis yielded a significant main effect of condition, $F(2, 66) = 4.54$, $\eta^2_p = .12$ (see Table 2). All post hoc comparisons in this experiment were conducted using the LSD procedure. Infants in the Anger-face condition took significantly longer to touch the object than did infants in either of the other conditions. There was no significant difference between the Neutral-face and the Anger-back conditions.

Duration of Object Touch—Preliminary analyses did not reveal any trial effects, so the duration scores were averaged across those trials in which infants made contact with the object (see Table 2). As in Experiment 1, mean duration of touch was analyzed in a 3 (condition) × 2 (gender) ANCOVA, with mean latency to touch entered as a covariate. No infants were excluded from this analysis because they all touched an object in at least one trial. There were no significant effects.

Imitation—Cochran *Q* tests indicated that there were no significant trial effects for imitation in any of the experimental conditions. Infants' total imitation scores were then analyzed with a 3 (condition) × 2 (gender) ANOVA. There was a significant main effect of condition, $F(2, 66) = 7.20$, $\eta^2_p = .18$ (see Figure 2). As predicted, infants in the Anger-face condition ($M = 1.67$) had significantly lower imitation scores than infants in either of the other conditions. There was no significant difference between infants in the Anger-back ($M = 2.71$) and Neutral-face ($M = 2.33$) conditions. Nonparametric analyses (Kruskal–Wallis and Mann–Whitney *U*s) yielded an identical pattern of results.

Because infants in the Anger-face condition were slow to touch the object, they may have had insufficient time remaining in the response period in which to perform the target action. In order to explore this possibility, we conducted a subsidiary analysis using only those trials in which infants had at least a 15 s window, from first touch of the object. Previous research (e.g., Meltzoff, 1985, 1988b) has shown that infants will typically imitate within this length of time. We then calculated the proportion of trials in which infants imitated within this time window. This type of proportion score has been used in previous multitrial studies of imitation (e.g., Meltzoff, 1988b). The proportion score was calculated as follows. If the infant was delayed in touching the target object for more than 5 s in a trial, that trial was dropped from the analysis because the time window for imitating the action was less than 15 s. In this case, the infant's imitation score would be the proportion of the two remaining trials in which the target behavior was produced. For example, if the infant produced the target behavior in one of the two trials, the score would be .50. Proportion scores were not used in Experiment 1 because only 75% of the trials in the Anger-present condition had this 15 s window. On the other hand, in Experiment 2, about 94% of the data set could be included in the analysis.

Consistent with the analysis based on the entire data set, the 3 (condition) × 2 (gender) ANOVA revealed a significant condition effect, $F(2, 65) = 5.60$, $\eta^2_p = .15$. As with the previous analysis, infants were significantly less likely to imitate in the Anger-face ($M = .54$, $SD = .37$) than in either the Neutral-face ($M = .74$, $SD = .34$) or the Anger-back conditions ($M = .85$, $SD = .22$). There was no significant difference between the latter two conditions.

Infant Looking During the Response Period—Preliminary analyses indicated that there were no trial effects for duration of infant looks to the Emoter, Experimenter, or Parent. Therefore the durations were averaged across the trials (see Table 2) and the three dependent measures were analyzed using a 3 (condition) × 2 (gender) MANOVA. There were significant multivariate effects for condition, $F(6, 128) = 9.30$, and for gender, $F(3, 64) = 3.69$.

A stepdown analysis was conducted to explore the condition effect and a Bonferroni corrected α level of .017 used to determine the significance of the three F values. Duration of looks to the Emoter was examined first because it yielded the highest F in a 3 (condition) × 2 (gender) ANOVA, $F(2, 71) = 22.93$, $\eta^2_p = .41$. Post hoc comparisons indicated that infants in the Anger-face condition spent significantly more time looking at the Emoter than did infants in either of the other conditions. In addition, infants in the Neutral-face condition looked longer at the Emoter than did those in the Anger-back condition. Duration of looks to the Parent was analyzed in the second step because it yielded the next highest univariate F value. A 3 (condition) × 2 (gender) ANC-OVA was conducted with looks to the Emoter entered as a covariate. There was a significant condition effect, $F(2, 65) = 5.39$, $\eta^2_p = .14$. Infants spent more time looking at their Parent in the Anger-face than the Neutral-face condition, but no other comparisons were significant. In the final step, duration of looks to the Experimenter was analyzed, with looks to the Emoter and Parent entered as covariates. The condition effect was not significant.

A second stepdown analysis was performed to explore the multivariate gender effect. This more detailed analysis indicated that the gender effect was only significant for looks to the Parent, $F(1, 66) = 10.30$, $\eta^2_p = .13$. Girls ($M = .63$, $SD = .97$) spent more time looking at their Parent during the response period than did boys ($M = .12$, $SD = .31$).

It was possible that, as a result of her angry outburst, the Emoter became an arousing stimulus, such that when she was facing infants in the response period, they were more interested in her than the test object. To explore this possibility, we compared the duration of infant looks to the Emoter and the Object using a 3 (condition) × 2 (gender) repeated measures ANOVA. Regardless of condition, infants spent significantly more time looking at the Object ($M = 13.34$ s, $SD = 3.38$) than the Emoter ($M = 2.38$ s, $SD = 2.55$) during the response period, $F(1, 66) = 404.50$, $\eta^2_p = .86$ (see Table 2). We also examined whether infants' looks toward the Object differed as a function of experimental condition. Looks to the Emoter and the Parent were entered as covariates because there were condition effects for these two variables (as noted above) and because these measures were correlated with looks to the Object. A 3 (condition) × 2 (gender) ANCOVA indicated that there were no significant differences across conditions in the amount of time that infants spent looking at the Object, $F(2, 64) = 1.06$. In summary, infants in the Anger-face condition spent the bulk of their time looking at the Object during the response period, and did so to the same extent as infants in the other conditions.

Infant Facial Expressions—Preliminary analyses indicated that there were no trial effects for infant affect during the emotional expression period (i.e., the emotional exchange between Emoter and Experimenter). We therefore collapsed across trials, and the mean positive and negative affect scores (see Table 2) were analyzed using a 3 (condition) × 2 (gender) MANOVA. There was a significant multivariate interaction effect, $F(4, 130) = 3.40$. In the stepdown analysis, this Condition × Gender interaction was only significant for the mean negative affect score, $F(2, 66) = 5.52$, $\eta^2_p = .14$. Simple effects analyses yielded a significant condition effect for the girls, $F(2, 33) = 4.11$, but not the boys. Girls expressed significantly more negative affect during the neutral than either of the angry emotional exchanges. There were no significant trial effects for infants' facial expressions during the response period. Infant affect during the response period (Table 2) was analyzed in a similar manner and there were no significant effects.

Discussion

Experiment 2 replicated and extended the findings obtained in the earlier experiment. When the Emoter faced infants during the response period, they were less likely to imitate if she had previously expressed anger than neutral affect toward the Experimenter. Once again, this indirect emotion effect was not limited to infants' imitative responses but was also evident in their general object-directed behavior. Infants in the Anger-face condition were initially hesitant to touch the object in comparison with infants in the Neutral-face condition. These indirect emotional cues during the expression period also influenced infants' subsequent looking behavior. Infants spent more time looking at the Emoter in the response period if she was facing them and had previously been angry than when she had previously been neutral. More importantly, the findings indicated that these effects were not simply due to: (a) the fact that the Emoter had been previously angry nor (b) the mere physical presence of that previously angry adult. Infants were only loathe to touch the object and imitate the action when the previously angry Emoter was facing them during the response period; when she showed anger but then turned away from infants, they eagerly played with the object. Infants in the Anger-back condition also spent less time looking at the Emoter than did infants in the other two conditions; thus infants seemed to behave as if she was no longer a source of emotional information now that her back was turned.

As we expected, there was no difference in the amount of imitation in the Neutral-face versus the Anger-back condition. This differed from the results in Experiment 1 and is likely due to the fact that in the response period for Experiment 2, the Emoter's facial expression was modified to give the impression that she was "interested" in what infants were doing. This modification appeared to decrease any concerns that infants might have had when the Emoter became silent and still in the response period. The fact that there was no difference between infants in the Neutral-face and the Anger-back condition with regard to their facial expressions and other behaviors (e.g., latency to touch) likewise suggests that infants did not view the Emoter's neutral silence as "odd" behavior.

One final point to note is that the indirect emotional signals did not appear to have an immediate impact on infants' own *affective* behavior, as might have been expected from a purely emotional contagion viewpoint. During the emotional expression period, infants in the two Anger conditions were no more negative in their facial expressions than were those in the Neutral condition. Indeed, in all three conditions, infants' affect scores indicated that they remained neutral as they watched the interaction between the Emoter and the Experimenter. As noted earlier, in previous social referencing studies there has been a tendency for infants to display more negative affect in response to another person's negative than happy or neutral displays. However, this affective difference has not been consistently reported (e.g., Hornik et al., 1987; Sorce, Emde, Campos, & Klinnert, 1985). It is unclear if this reflects methodological differences across studies, such as the identity of the emoting individual (e.g., experimenter, mother) or the type of negative emotion (e.g., fear, disgust). In the current experiments, it is perhaps not surprising that infants did not react negatively to the Emoter's angry outburst: After all, the Emoter's anger was relatively mild, short lived, and infants observed this display while seated safely in their parent's lap. In addition, the Emoter looked at the Experimenter as she delivered the emotional message, thereby suggesting that she was angry with this particular person or her activity, and not the infant. Thus, unlike other social referencing studies, the infant was a bystander, observing an emotional exchange between two other people.

General Discussion

This research advances our understanding of infants' ability to learn from observing the interactions of others—to profit from "socially guided" learning. These experiments are the first to demonstrate that infants can appropriately modify their actions in response to an emotional communication that does not directly involve them. The Emoter expressed anger toward the Experimenter in response to her actions on an object, and infants then used that information to regulate their own object-directed actions. This finding is in line with the recent work of Floor and Akhtar (2006) demonstrating that, at the same age, infants are also able to learn new words by listening to the conversations of others. Thus, early learning is not restricted to dyadic contexts in which relevant information is directly communicated to infants by their social partner; it can also occur when the infant overhears and sees two *other* people interact.

A lean interpretation of these results might be that infants simply reacted as if the Emoter was angry at them. However, during her angry outburst, there were no signs that infants were taking this personally. Infants were not visibly upset; instead, they watched and listened with great interest. Infants looked back and forth between the two adults as they closely followed the conversation, and they were no more negative in their affect than those infants exposed to a neutral exchange. Moreover, because the Emoter was looking at the Experimenter as she expressed her anger, this helped convey that it was not the infant who was being scolded. Various studies (e.g., Moses, Baldwin, Rosicky, & Tidball 2001; Repacholi, 1998) have shown that, by 12 – 14 months of age, infants can use gaze direction to identify which of two objects is the referent of an emotional expression. Thus, the 18-month-old infants in the current experiments should have had little difficulty determining that the target of the emotional communication was the Experimenter.

It appears that 18-month-old infants are responsive to emotional signals even when the message is intended for another person. Moreover, infants are adept at using this type of emotional information to guide their object-directed actions. This is an important ability because it will often enable infants to avoid negative outcomes that might arise were they to directly investigate the situation for themselves. On the other hand, it would be maladaptive if infants were compelled to respond to every emotional display that they overheard or saw. Infants need to be able to determine when these indirect emotional signals are relevant to their own situation and when they are not. In the current experiments, 18-month-old infants were highly selective. They regulated their actions if the previously angry adult's face was visible to them as they were presented with the test objects, but they discounted the Emoter's anger if she left the room or was present but no longer facing them. Thus, it is not simply the case that when a person has been angry, negative affect "lingers in the air." Instead, infants are discriminating users of indirect emotional information.

This research is also unique in that the emotional information was in reference to an action that had been performed on an object. In traditional social referencing studies, the test object is never touched by the emoting adult. In addition, these stimuli are usually designed to be ambiguous, so that before the delivery of the emotional message, infants are uncertain about whether to approach or avoid. It has been reported that as object ambiguity increases, infants become more receptive to the influence of direct emotional signals (Gunnar & Stone, 1984; Sorce et al., 1985). This is reminiscent of what has been observed in the classic social psychology literature on conformity. When adults are faced with uncertainty or ambiguity, they are also more susceptible to the influence of others' attitudes (Asch, 1955; Sherif, 1937). It is interesting, then, that regulatory effects were obtained in the current experiments. Infants not only saw the Experimenter touching a novel object, but she also demonstrated an action on that object—an action that resulted in an interesting outcome. Thus, before the Emoter's angry outburst, infants' appraisal of the object would have been very positive and they would have been eager to imitate. Indeed, infants' desire to interact with the object was readily apparent during the demonstration of the target act. They often vocalized, smiled, and/or reached for the object. Thus, the design of the "Emotion-Imitation" procedure is one that makes the task of behavioral regulation more difficult for infants than is usually the case in the standard social referencing study. Infants' had to inhibit their desire for the object and their proclivity to imitate what they had seen the adult repeatedly do with it. This is no small feat for an 18-month-old infant. Yet, in two separate experiments, evidence was obtained that infants can do just that.

One question that immediately arises from this research is whether infants were linking the Emoter's anger with the target act or the object. Is the Emoter angry that the Experimenter is pulling apart the dumbbell (i.e., performing a forbidden act), or angry about the object itself? Our working hypothesis is that infants interpret the Emoter's anger to be about what the Experimenter is doing with the object (i.e., the target act). Consistent with this assumption, infants rarely refused to touch the object after the Emoter had expressed anger toward the Experimenter (they did so in only 19 of 96 Anger-present trials in Experiment 1 and 6 of 72 Anger-face trials in Experiment 2). This remains an unanswered question, however.

We recognize that, in both experiments, it was not simply that infants performed fewer of the "forbidden" target acts, but they also took longer to initially touch the object than did infants exposed to Neutral affect. This could mean, contrary to our working hypothesis, that infants had linked the Emoter's anger to the object (e.g., "It's a bad object"). It could then be argued that these infants had lower imitation scores only because there was not enough time left in the response period for them to perform the target act. This seems unlikely for two reasons. First, Meltzoff (1985) reported that when 14-month-old infants imitated the target act on the dumbbell object used here, 79% did so within 5 s of touching it. Across the two experiments reported here, the average delay to touch an object was about 4 s; thus, infants had ample time remaining in the response period in which to produce the target act. Second, in Experiment 2, we were able to recalculate infants' imitation score so that it included only those trials in which infants had a 15-s response window following their first touch of the object. Even when they had a lengthy period of time in which to imitate, infants in the Anger-face condition were *still* less likely to do so than infants in each of the other conditions. Thus, we favor the idea that infants interpret the target act as "prohibited" or "bad," and this leads to dampened imitation. Indeed, the prohibition on the action may in turn have created some hesitancy to touch the object (e.g., "If I can't do *that* action, then maybe there are other things that I shouldn't be doing with the object").

Having analyzed 18-month-old infants' regulation of their actions in response to indirect emotional information, we now need to consider the underlying mechanism a little more closely. The most obvious possibility is some form of emotional contagion. On the contagion account, infants' affective state automatically became negative in response to the Emoter's anger and, as a consequence, they were now less motivated to interact with the object. However, contagion by itself is an implausible mechanism in the current experiments, given infants' behavior when the Emoter left the room or remained physically present with her back turned.

If infants had simply caught the adult's negative mood, then they should have been delayed in touching the object and/or hesitant to imitate, regardless of whether the Emoter was absent or turned her back. In addition, the affect data in both experiments are inconsistent with contagion. Infants in the Anger conditions did not exhibit more negative affect during the emotional expression period than those infants in the Neutral conditions. Until now, it has been impossible to discount contagion as the mechanism underlying the regulatory effects in the standard social referencing paradigm. However, the current research provides a more definitive test and the findings presented here are not reducible to contagion alone.

If it is not contagion, then maybe simple associative learning processes can explain the pattern of results. For instance, in each trial, the emotional expressions immediately followed the completion of the target act. Thus, the temporal contiguity between these two events might have enabled infants to connect the Emoter's anger to the action and/or its outcome, so that they now viewed it negatively. Or, based on past experience, infants might have learned to associate anger displays with negative outcomes. Consequently, when exposed to the angry adult, infants may have anticipated that something bad was going to happen and became behaviorally inhibited. However, these approaches seem insufficient by themselves to explain why infants were so very willing to touch the object and perform the target acts in the Anger-absent (Experiment 1) and Anger-back (Experiment 2) conditions.

There is one further lean interpretation of the findings that needs to be considered. By virtue of her prior anger, the Emoter's face may have become an interesting or arousing stimulus—more so than the test object itself. This would not only explain why infants spent more time looking at the previously angry Emoter when her face was visible, but would also account for their lower rates of imitation. On the other hand, the majority of these infants touched the object and, in Experiment 2, they spent similar amounts of time touching it compared with infants in the Neutral-face and Anger-back conditions. Both of these findings suggest that infants retained an interest in the object, despite the Emoter's prior anger and the visibility of her face in the response period. Indeed, in Experiment 2, infants in all three conditions spent more time looking at the object than the Emoter during the response period. Moreover, infants in the Anger-face condition spent just as much time looking at the object as did infants in the other conditions. Thus, although the face of the previously angry Emoter may have been arousing, it is unlikely that it captured infants' attention to such an extent that they lost interest in the test object.

We favor an interpretation more solidly rooted in infants' developing social cognition whereby infants grasped the "aboutness" of the adult's emotion and searched for a cause of the Emoter's anger. For instance, infants might understand something about how actions are linked to people's emotions, which would allow them to make predictions about the other person's likely affective state. After watching the Emoter express anger in response to the Experimenter's actions, infants might have expected her to become angry if they themselves were to perform the target act. But how do we then explain infants' eagerness to play with the object when the previously angry adult left the room or stayed present and turned her back? Maybe infants were simply responding to the Emoter's physical orientation. For example, the Emoter's visible face could have signaled to infants that she was "available" as a social partner and might then engage in an angry interaction with them if they performed the action, just as she had done with the Experimenter. On the other hand, infants may have been sensitive to whether the Emoter had *visual access* to their actions. When facing infants in Experiment 2, the Emoter's eyes, head and body were directed toward them, and these cues might have indicated to infants that the Emoter was looking at what they were doing with the object. Likewise, in Experiment 1, although the Emoter did not look directly at infants, it was obvious that they were within her visual field. Consequently, in both experiments, infants might have expected that the Emoter would become angry, but only if she could *see* them performing the target action. The key notion here is that the Emoter is also a Perceiver.

This builds a potential link between our current data and the joint visual attention literature. Several converging lines of evidence suggest that, in the second year of life, infants begin to understand “seeing” and “perception” in a new and richer way. For instance, at around 12 months of age, infants will turn to look in the same direction as an adult who can see an object but not when that person is unable to see the target by virtue of having closed eyes (Brooks & Meltzoff, 2002). Nine-month-olds, on the other hand, look to where the adult is turning even if the adult’s eyes are closed (Brooks & Meltzoff, 2005). Moreover, Moll and Tomasello (2004) reported that 12-month-olds actively follow another’s gaze to an object hidden behind a barrier, rather than to the barrier itself, suggesting that infants are trying to identify what another person is seeing. Finally, at this age, infants also begin to produce gestures like pointing and showing, and use these to direct another person’s attention to a specific event (Brooks & Meltzoff, 2002; Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004). Ultimately, however, further studies using the “Emotion-Imitation” procedure will need to be conducted to determine whether infants are able to predict another person’s emotional responses by taking into account their visual experiences.

The findings are also significant with respect to the child clinical literature on family emotional climate. For instance, children from families in which there are high levels of interparental anger are at risk for behavior problems (see Hudson, 2005 for a review). In line with this, Cummings and colleagues (Cummings, 1987; Cummings, Iannotti, & Zahn-Waxler, 1985) reported that when young children are exposed to adult (verbal) conflict in the laboratory, this influences their social behaviors (e.g., peer-directed aggression) in the period immediately after the conflict episode. To date, however, the research on family background anger has not included infants, nor has it explored its potential impact on learning mechanisms such as imitation. If a brief and relatively mild anger display can temporarily inhibit infant imitation, as it did in the current experiments, it is possible that the effects are more pervasive when infants are exposed to frequent episodes of intense interparental anger. Also, the question then arises as to whether chronic inhibition of infants’ imitative performances might ultimately have some impact on their proclivity to engage in observational learning itself or dampen specific skills that are learned by observing others.

Finally, the issue of individual differences in infants’ responses to anger and other emotional signals requires systematic investigation. As in most social referencing studies, there was some variability in the current experiments in the degree to which individual infants were affected by the Emoter’s negative emotional display. For instance, a small number of infants not only failed to imitate but also refused to touch the test object in one or more trials. Likewise, some individuals imitated *on every trial*, despite the visibility of the previously angry Emoter’s face. Thus, further research is required to identify whether these individual differences are related to specific infant (e.g., executive function) or family variables (e.g., interparental anger).

In summary, these findings constitute the first evidence that infants are able to regulate their actions in response to indirect emotional cues, what we call “emotional eavesdropping.” By 18 months of age, infants do not have to wait for emotional information to be directly communicated to them in the course of their social interactions. Rather, infants can take advantage of the information that is available when other people are engaged in an emotional exchange. Infants can use this indirect source of emotional information to guide their own actions. Moreover, infants are apparently selective in their use of this information. Rather than responding to every emotional expression that they see and/or hear, infants have some capacity to determine whether the information is personally relevant. Thus, by 18 months of age, infants are becoming discriminating users of emotional information.

This research also makes a contribution to the long-standing debate about the mechanism underlying infant social referencing. In the current experiments, emotion contagion was not an adequate explanation of the indirect emotion effect. Instead, it was argued that infants understood something about the meaning of the emotional display and used that information to reappraise the situation (e.g., this is a “forbidden” action). Finally, this research adds to the growing body of evidence that toddlers possess embryonic social-cognitive skills that may pave the way for the later emergence of a more adult-like theory of mind (e.g., Meltzoff, 2007). Specifically, the findings suggest that 18-month-old infants understand the primitive “aboutness” of other people’s emotions. At this age, infants apparently understand how actions on objects can impact another person’s emotions and are then able to make predictions about that person’s future emotions if the self were to act likewise. As such, the “Emotion-Imitation” procedure promises to become a useful tool for investigating developmental changes in infants’ social cognition.

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Appendix

Complete Set of Anger Scripts

Emoter: "That's aggravating! That's so annoying!"

Experimenter: "Oh, I thought it was really interesting."

Emoter: “Well, that’s just your opinion! Its aggravating!”

Emoter: “That’s infuriating! That’s so irritating!”

Experimenter: “Oh, I’m sorry you feel that way about it.”

Emoter: “Well, you should be sorry! It’s infuriating!”

Emoter: “That’s so frustrating! That’s really distracting!”

Experimenter: “Oh, I didn’t realize you’d care so much.”

Emoter: “Well, you’re wrong about that! It’s very frustrating!”

Complete Set of Neutral Scripts

Emoter: “That’s entertaining. That’s so enticing.”

Experimenter: “Oh, I thought it might have been too distracting.”

Emoter: “Well, you could be right. But it is entertaining.”

Emoter: “That’s encouraging. That’s so engaging.”

Experimenter: “Oh, I had no idea you’d feel that way.”

Emoter: “I do feel that way. But it is encouraging.”

Emoter: “That’s stimulating. That’s very striking.”

Experimenter: “Oh, I didn’t think you’d really notice it.”

Emoter: “Well, not to worry. But it is stimulating.”

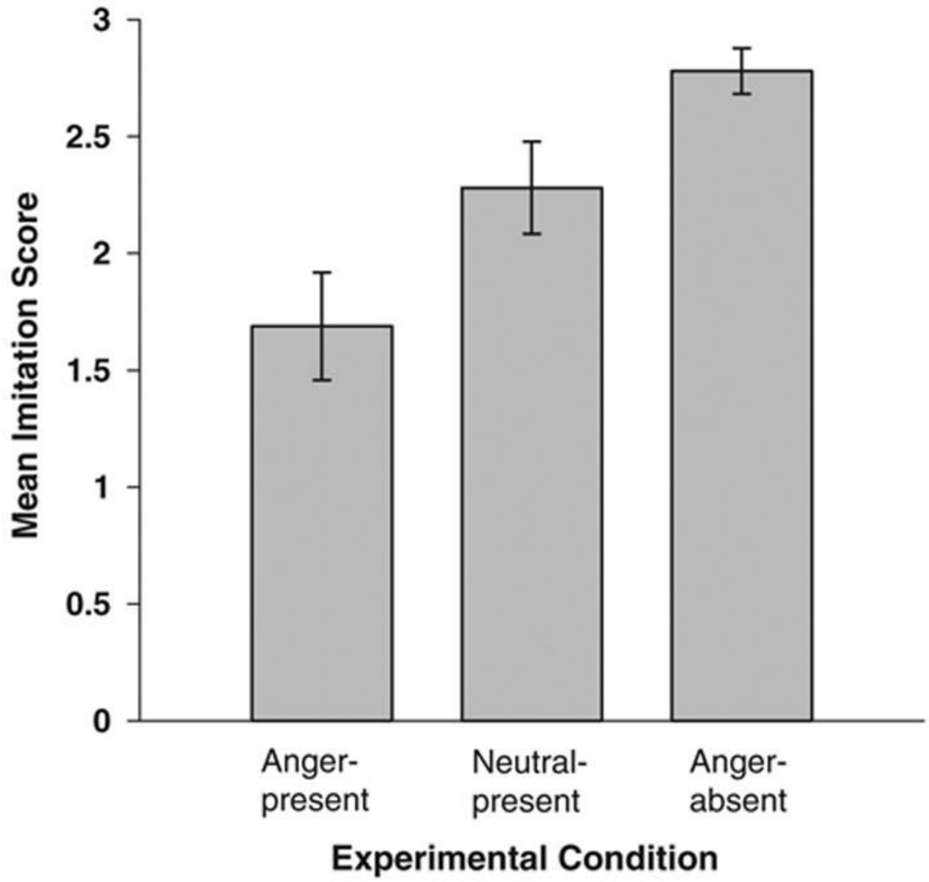

Figure 1.
Mean total imitation score as a function of experimental condition (with vertical lines depicting standard errors) for Experiment 1 (n = 32).

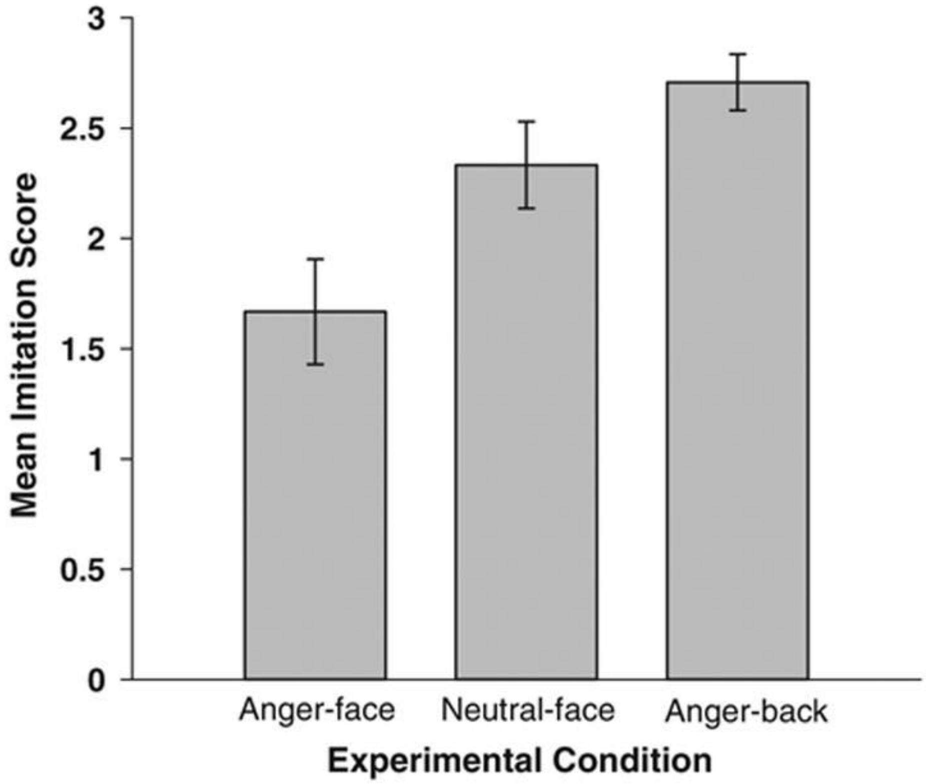

Figure 2.
Mean total imitation score as a function of experimental condition (with vertical lines depicting standard errors) for Experiment 2 (n = 24).

Table 1

Experiment 1: Mean (and SD) Infant Instrumental and Affective Behavior as a Function of Experimental Condition

	Experimental condition					
	Anger-present		Neutral-present		Anger-absent	
	M	*SD*	*M*	*SD*	*M*	*SD*
Latency to touch object	4.93 s	7.15	0.65 s	1.21	0.43 s	0.38
Duration of object touch	14.54 s[a]	6.30[a]	18.71 s	1.97	19.07 s	1.85
Duration of looks to Emoter	3.67 s	2.78	1.71 s	1.44	Not applicable	
Duration of looks to Experimenter	4.20 s	2.00	3.65 s	1.74	3.13 s	1.87
Duration of looks to Parent	0.21 s	0.73	0.18 s	0.42	0.33 s	0.58
Positive affect in expression period [b]	0.05	0.11	0.17	0.25	0.11	0.23
Negative affect in expression period [b]	0.05	0.17	0.02	0.07	0.05	0.18
Positive affect in response period [b]	0.20	0.28	0.50	0.42	0.47	0.37
Negative affect in response period [b]	0.02	0.06	0.01	0.03	0.04	0.12

Note. n = 32 except where otherwise noted.

[a] *n* = 30, two infants did not touch the object in any of the trials.

[b] Ratings based on a scale from 0 to 2.

Table 2

Experiment 2: Mean (and SD) Infant Instrumental and Affective Behavior as a Function of Experimental Condition

	Experimental condition					
	Anger-face		**Neutral-face**		**Anger-back**	
	M	***SD***	**M**	***SD***	**M**	***SD***
Latency to touch object	2.95 s	4.81	0.78 s	1.92	0.63 s	0.40
Duration of object touch	16.61 s	3.85	18.91 s	1.91	18.84 s	1.16
Duration of looks to Emoter	4.24 s	2.67	2.59 s	2.13	0.29 s	0.43
Duration of looks to Experimenter	2.55 s	1.04	2.63 s	1.31	3.00 s	1.67
Duration of looks to Parent	0.60 s	1.00	0.03 s	0.10	0.50 s	0.71
Duration of looks to Object	11.00 s	3.45	14.02 s	2.82	15.01 s	2.50
Positive affect in expression period[a]	0.16	0.28	0.13	0.26	0.15	0.24
Negative affect in expression period[a]	0.03	0.08	0.12	0.26	0.06	0.07
Positive affect in response period[a]	0.35	0.48	0.33	0.30	0.40	0.43
Negative affect in response period[a]	0.04	0.08	0.07	0.16	0.07	0.13

Note. $n = 24$.

[a]Ratings on a scale from 0 to 2.