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Infant, Control Thyself: Infants' Integration of Multiple Social Cues to Regulate Their Imitative Behavior

Betty M. Repacholi, **Andrew N. Meltzoff**, **Hillary Rowe**, and **Tamara Spiewak Toub**

Department of Psychology and the Institute for Learning & Brain Sciences

Abstract

This study investigated 15-month-old infants' (N = 150) ability to self-regulate based on observing a social interaction between two adults. Infants were bystanders to a social exchange in which an Experimenter performed actions on objects and an Emoter expressed anger, as if they were forbidden acts. Next, the Emoter became neutral and her visual access to the infant was experimentally manipulated. The Emoter either: (a) left the room, (b) turned her back, (c) faced the infant but looked down at a magazine, or (d) faced and looked toward the infant. Infants were then presented with the test objects. When the previously angry Emoter was facing them, infants were hesitant to imitate the demonstrated acts in comparison to the other conditions. We hypothesize that infants integrated the emotional and visual-perceptual cues to determine whether the Emoter would get angry at them, and then regulated their behavior accordingly. Temperament was related to infants' self-regulation –infants with higher impulsivity scores were more likely to perform the forbidden acts. Taken together, these findings provide insight into the roots of executive functions in late infancy.

Keywords

Emotion; imitation; executive function; gaze following; social referencing

Establishing self-control is a fundamental and challenging developmental task. The developmental emergence of basic self-regulatory skills relies on a diverse set of processes, including neurological, attentional, cognitive, and experiential ones. When the developmental course is disrupted, a child may be put at risk for behavioral disorders such as ADHD. How children develop self-control is a central question in the emerging fields of affective cognition and affective neuroscience.

In the first months of life, parents are primarily responsible for regulating infants' behavior and affect. Parents might control an infant's exposure to certain events in order to avoid over-stimulation, or attempt to calm a crying infant with rocking and singing. With age,

Correspondence concerning this article should be addressed to Betty Repacholi, Institute for Learning & Brain Sciences, Box 357988, University of Washington, Seattle, WA, 98195-7988. bettyr@u.washington.edu.

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infants become increasingly able to self-regulate. The first signs appear around 4 months of age when infants systematically use gaze aversion to reduce their distress in arousing or uncertain situations. Advances in motor development likewise provide new ways for infants to control their exposure to environmental stimuli. Crawling and walking enable infants to regulate their feelings by approaching or retreating. In the second year, infants become increasingly able to restrain themselves to comply with parental "do's" and "don'ts." These increases in self-regulation are partly due to neurological maturation, especially in frontal brain regions. Advances in social cognition, however, are also crucial to the self-control process in late infancy, although this link has not always been clearly articulated.

Infants become increasingly adept at using social cues to govern their own actions in the second year of life. This advance is reflected in a cluster of developments in social cognition – notably gaze following, social referencing, and "emotional eavesdropping." The gaze-following literature suggests that during this time infants become more sophisticated in their use of attentional cues to regulate their own looking behavior. For instance, they *selectively* follow an adult's head turn toward an object only when the adult can see that object (e.g., when their eyes are open but not closed; Brooks & Meltzoff, 2002). Social referencing also emerges. In situations of uncertainty, infants will use other people's emotional cues (e.g., facial expression, tone of voice) to guide their own behavior (Sorce, Emde, Campos, & Klinnert, 1985). Twelve- to 18-month-old infants typically avoid a novel object when it is the target of their social partner's negative affective display but will approach that object if the person expresses positive or neutral affect.

A third aspect of infant social cognition integral to the development of self-control functions is infants' beginning to regulate their imitative behavior based on emotional cues gleaned from observing two people socially interacting with each other (Repacholi & Meltzoff, 2007; Repacholi, Meltzoff, & Olsen, 2008). In these "emotional eavesdropping" studies, 18-month-olds were simply bystanders who observed one adult (an "Emoter") expressing anger toward an Experimenter, in response to her actions on an object. Unlike classic social referencing studies, the emotional communication was directed toward someone else, not the infant. Infants were observers, eavesdropping on the social exchange. After the Emoter responded to the Experimenter's actions, she assumed a neutral demeanor and looked toward the infant. Infants were then given an opportunity to play with the object. Infants in the anger condition were hesitant to imitate the Experimenter's actions, compared to infants in a control condition in which no anger had been displayed.

Infants live in a complex social world and it is rarely the case that only one type of social cue is available. Thus, it would be advantageous for infants to integrate multiple pieces of social information, for example gaze and emotions, to make inferences about other people and to regulate their own behavior. There is some evidence that infants might begin to engage in this coordination of social cues in the second year of life. For instance, some social referencing studies suggest that infants as young as 12–14 months of age consider not only how another person is feeling but also where that person is looking (Hertenstein & Campos, 2004; Moses, Baldwin, Rosicky, & Tidball, 2001; Repacholi, 1998). In these studies, infants were able to use gaze direction to identify what another person was emoting about.

While these integrative abilities are evident by 12 months of age in the context of social referencing, at least one report suggests that these abilities do not yet support infants' *predictions* about another person's impending actions. Vaish and Woodward (2010) familiarized 14-month-old infants with an adult who looked inside one of two cups and expressed either happiness or disgust in response to its contents. The other cup was ignored. In test trials, the adult reached into either the previously ignored cup or the cup that had been the target of her emotional display. Overall, infants in both the happy and the disgust conditions spent more time looking at the adult when she reached into the cup that had previously been ignored. Thus, infants relied on attentional but not emotional cues, to predict the adult's behavior: If there was a mismatch between attentional cue and subsequent behavior, infants increased their looking, but if there was a mismatch between emotional cue and subsequent behavior, they did not. Infants expected the adult to reach into the cup that had been the focus of her prior attention, regardless of her prior affect.

By 18 months, infants have the capacity to integrate emotional and attentional cues to predict another person's behavior (Repacholi & Meltzoff, 2007; Repacholi, et al., 2008). In "emotional eavesdropping" studies, infants did not imitate if the Emoter had previously expressed anger *and* she was currently looking in their direction. If the previously angry adult left the room, turned her back on the infant, or read a magazine, infants eagerly played with the object and imitated the adult's acts. They also did so if the adult had not become angry and was currently looking at them. Thus, infants did not simply respond to the Emoter's prior emotion alone or direction of gaze alone. Instead, infants' were able to take into account the Emoter's current looking behavior and her prior emotion and used this dual information to predict how the Emoter would respond if they themselves were to play with the object. Infants then regulated their own behavior accordingly.

The primary goal of the present study was to explore whether infants younger than 18 months of age can successfully integrate two different and temporally distinct pieces of social information – an adult's prior emotion and current attention – and use this information to regulate their own imitative behavior. Despite being able to use gaze or emotion cues for self-regulatory purposes at 12 months of age, infants might require more proficiency in their use of each of these cues, along with extensive social experience, before being able to use them conjointly to make complex predictions about other people's affective behavior and to regulate their own actions. Here we tested 15-month-old infants to begin exploring the developmental roots of this integrative capacity.

Another reason to test infants older than 12 months of age is that emotional eavesdropping places greater demands on infants' self-control than does the classic social referencing paradigm. This is so due to a fundamental difference between the social referencing and emotional eavesdropping test procedures. The standard social referencing paradigm employs ambiguous stimuli (e.g., mechanical toy, visual cliff), so that at the outset, infants are uncertain about whether to approach or avoid. It is assumed that infants use the emotional information (directly provided to them by their social partner) to re-appraise the target stimulus and then regulate their behavior accordingly (Feinman, Roberts, Hsieh, Sawyer, & Swanson, 1992; Klinnert, Campos, Sorce, Emde, & Svejda, 1983). In the eavesdropping procedure, there is not the initial uncertainty. However, once they observe that the Emoter is

angered by the Experimenter's performing target acts, infants need to inhibit their imitation of that behavior. In essence, they need to suppress a dominant or pre-potent response. The inhibitory control demands placed on the infant are far less (or non-existent) in a typical social referencing context. Thus, it was unclear whether even 15-month-olds would be able to inhibit the urge to imitate (i.e., regulate their motor responses) based simply on observing an emotional interchange between two adults.

In the present study we also examined individual variability. In previous eavesdropping studies with 18-month-olds, some infants performed the forbidden act in every trial. In the standard social referencing paradigm, there is likewise considerable variation in infants' responses. Yet few studies have explored the source of these differences. We reasoned that infants' temperament may influence the extent to which they can use social cues for self-regulatory purposes. Some social referencing studies (Feinman & Lewis, 1983) report that infants with "difficult" temperaments are less likely to regulate their own actions in response to their social partner's emotional cues, but others have failed to detect such links (Bradshaw, Goldsmith, & Campos, 1987). It has also been reported that temperamental fearfulness (de Rosnay, Cooper, Tsigaras, & Murray, 2006) and behavioral inhibition (Aktar, Majdandzic, de Venter, & Bögels, 2013) predict greater avoidance of strangers or ambiguous objects when infants are exposed to maternal displays of anxiety. Here, we explored the relation between infants' temperament and instrumental behavior in the emotional eavesdropping paradigm.

1. Method

1.1. Participants

Participants were 150 (75 boys) 15-month-old infants, highly restricted in age (M = 15.01 months, SD = 5.44 days, range = 14.66 – 15.35 months). The tight age grouping within a 21-day age window was by design because we were interested in possible differences between this sample and 18-month-olds in previous emotional eavesdropping studies. All infants were recruited from a university infant database. According to parental report, children were 77% Caucasian, 1% Asian, 20% mixed race, and 2% unknown. Infants were from middle- to upper-class families. Additional infants were tested and excluded due to experimenter error (n = 3), fussiness/inattentiveness (n = 11), or parent interference (n = 5).

1.2. Design

Equal numbers of boys and girls were randomly assigned to five groups (n = 30 per group): Anger-attentive, Anger-distracted, Anger-back, Anger-absent, and Control. Each infant completed three trials, each with a different test object. The six possible orders for the three test objects were counterbalanced within groups.

1.3. Materials

1.3.1. Test objects—The test objects were modeled after ones used by Hanna and Meltzoff (1993). One was a buzzer box with a wooden stick presented by its side. The target act was to use the stick to press a recessed button on top of the box, activating the buzzer. The second was a dumbbell-shaped object made of two wooden cubes with plastic tubing

attached; one tube fit inside the other. The target act was to pull outward so that the object came apart, producing a popping sound. The third was a plastic cup with a strand of beads. The target act was to pick up the beads and drop them into the cup, producing a rattling sound as they hit the bottom.

1.3.2. Emotional stimuli—The Emoter (an unfamiliar female adult) engaged in an emotional interchange with the Experimenter (a familiarized female adult). The Experimenter's facial and vocal expressions were always neutral.

In the four Anger groups, the Emoter's angry facial expression followed that used by Ekman and Friesen (1975). Her tone of voice was angry and her words were congruent, but the emotion words were intentionally selected to be too difficult for 15-month-olds to understand (Fenson et al., 1993); thus the assumption was that infants would use prosody as the relevant vocal cue for anger. An example of an Anger interchange between the Emoter and Experimenter is as follows: (a) Emoter (angry tone of voice) – "That's aggravating! That's so annoying!" (b) Experimenter (neutral voice) –"Oh, I thought it was really interesting." (c) Emoter (angry voice) – "Well, that's just your opinion. It's aggravating!"

In the Control group, the Emoter displayed a relatively neutral expression instead of an angry one (or any other emotions). The Emoters's mouth was relaxed, her forehead was smooth, there was minimal facial movement, and she spoke in a matter-of-fact fashion. The structure of the Control interchange was similar to the Anger one in terms of number of syllables and the overall flow of events, but the affect was not angry but rather neutral-attentive, e.g., (a) Emoter (neutral voice) –"That's entertaining. That's so enticing." (b) Experimenter (neutral voice) – "Oh, I thought it might have been too distracting." (c) Emoter (neutral voice) – "Well, you could be right. But it is entertaining."[1] (See Repacholi and Meltzoff, 2007, for the complete scripts for both Anger and Control interchanges.

1.3.3. Temperament—Infant temperament was assessed using the 210-item Early Childhood Behavior Questionnaire (ECBQ; Putnam, Garstein, & Rothbart, 2006). Each item requires parents to report infant responses to specific events using a 7-point Likert scale (ranging from "never" to "always"). The ECBQ consists of 18 scales and generates three factors based on an average of a subset of the scales. Parents completed the ECBQ in the week prior to testing. One family did not complete the questionnaire.

1.4. Procedure

Infants were individually tested, seated on their parent's lap at a table, with the Experimenter seated on the opposite side. Parents were instructed to remain silent and neutral, look away if their infant tried to make eye contact or otherwise engage with them, and avoid any form of interaction with their infant (e.g., comforting touches). If parents did not comply with these instructions, the infant was excluded from the study.

[1]It was difficult to find a set of neutral words that mapped onto the structure of the emotion words from the angry scripts, and therefore words with a more positive meaning were used. Crucially, however, the emotion words in the Control group scripts were also selected to be beyond the comprehension of a typical 15-month-old infant. Thus we think the children did not understand the word meanings and were responding to the neutral-attentive facial and vocal demeanor of the Emoter in this group.

1.4.1. Stimulus-presentation period—Each of the three trials involved a different test object and target act, along with a different verbal script. In each trial, the Experimenter demonstrated the target act twice. The Emoter then entered the room and sat to the Experimenter's left. The Experimenter demonstrated the act a third time and the Emoter responded by expressing either anger or neutral affect toward the Experimenter (depending on condition). After the interchange, the Emoter became affectively neutral in all groups (passive, pleasant facial expression with no vocalizations). Her visual attention to the infant was systematically manipulated in accordance with the experimental design, as depicted in Table 1.

1.4.2. Response period—The response periods were identical for all groups. The Experimenter placed the object in front of the infant and said, "Here," in a neutral tone of voice. A 20-s response period was timed from when the object was placed on the table. In all groups, the Experimenter looked down at her lap and maintained a neutral facial expression throughout. The Experimenter retrieved the object after 20 s, and the Emoter then exited the room. The next two trials followed an identical procedure.

1.5. Scoring

All scoring was based on videotape records of the testing sessions. Coders were uninformed regarding an infant's test condition.

1.5.1. Manipulation check of Emoter's affective displays—In order to check that the adult emotional displays were administered correctly, coders (blind to experimental group and study procedures) used a 5-point scale (−2: very negative to +2: very positive) to assign an overall rating for the hedonic tone of the Emoter's facial expression during both the stimulus-presentation and the response periods. These facial ratings were performed without sound. The coders also indicated which discrete facial emotion was predominant: happiness, interest, neutral, surprise, sadness, anger, disgust, or fear. Two other naïve coders, also blind to condition and study details, rated (from −2 to +2) the Emoter's vocalizations for their hedonic tone during the stimulus-presentation period. For this coding, the audio files were low-pass filtered at 475 Hz, rendering them verbally unintelligible but maintaining their hedonic tone.

1.5.2. Primary dependent measures: Infants' object-directed behaviors—Three aspects of infants' instrumental behavior were scored from the videotapes. *Latency to touch* was defined as the time (in seconds) from placement of the object on the table to the infant first touching it. If infants never touched, latency was recorded as the maximum duration of the response period, 20 s. *Duration of touch* was defined as the total time (in seconds) infants spent touching the object. If infants never touched, no duration score was recorded. *Imitation score* was defined as number of target acts the infant performed. Each response period was scored to assess whether or not infants performed each target act, using a dichotomous (yes/no) measure (following Hanna & Meltzoff's, 1993, criteria). Scores ranged from 0–3.

1.5.3. Duration of infant looks—Infant looking to the Emoter was scored during each of the 20-s response periods, using the close-up video records. Scores were number of seconds looking at the Emoter (range = 0–20). (In the Anger-absent group, the Emoter was not present during the response period and so this measure could not be obtained.)

1.5.4. Infant hedonic tone—Infant affect was measured using two separate three-point scales (modified from Hertenstein & Campos, 2004) to rate maximum positive and negative affect displayed by the infant in the stimulus-presentation period (i.e., during the emotional interchange between Emoter and Experimenter). Infant affect was also coded in each of the three response periods, using the close-up video record of the infant's face and without sound. For the positive affect scale: 0 = absence of positive affect; 1 = slight smile (slightly upturned mouth, no cheek elevation); and 2 = a broad smile (usually with mouth open and/or cheeks elevated) or a laughing face. For the negative affect scale: 0 = absence of negative affect; 1 = either a frown/brow furrowing or any of the following facial movements – corners of the mouth pulled back in a grimace, disgust-like nose wrinkle, pout, sneer; and 2 = (a) a frown/furrowed brow accompanied by any of the other facial movements that qualified for a score of 1, or (b) the infant actively avoided the Emoter by leaning away from her or leaning back into the parent plus one of the facial movements that met the criteria for a score of 1, or (c) a crying face.

1.5.5. Scoring agreement—All coders were blind to infants' group assignment and different pairs of coders were used for each dependent measure. Inter-coder agreement, based on 33% of the sample, was excellent; for all measures, the kappa and correlation coefficients exceeded .80.

2. Results

All results reported as significant are $p < .05$. All post-hoc comparisons used Fisher's least significant difference (LSD) procedure.

2.1. Manipulation check

The manipulation check confirmed that the Emoter's expressions met the procedural requirements. The Emoter's facial and vocal expressions during the stimulus-presentation period (her interchange with the Experimenter) were equally "negative" across Anger groups: the predominant facial expression was consistently identified as "anger," and the face ratings were significantly more negative in the Anger groups ($M = -1.99$, $SD = .5$) than in the Control group ($M = .15$, $SD = .35$). Likewise, the Emoter's vocalizations in the Anger groups were significantly more negative ($M = -1.00$, $SD = .03$) than those in the Control group ($M = .97$, $SD = .18$). Also, for all groups, the Emoter's facial hedonic tone was rated as 0 and the predominant emotion was identified as "neutral."

2.2. Differences in Infants' Instrumental Behavior as a Function of Adult Emotion

Latency to touch the object was analyzed using a 5 (groups) × 3 (trials) repeated measures analysis of variance (ANOVA). There was a significant group effect, $F(4, 145) = 4.47$, $\eta^2_p = .11$ (see Table 2). Post-hoc comparisons showed that infants in the Anger-attentive and

Anger-distracted groups took significantly longer to touch the objects than did those in the Anger-back and Control groups, and infants in Anger-attentive group took significantly longer to touch than did those in the Anger-absent group.

Duration of touch scores were converted to proportions based on the amount of time in the response period following infants' first touch.[2] A mean duration proportion score (Table 2) was calculated so that infants who did not touch the test object on all trials did not have to be excluded from the analysis. This analysis showed no group effect.

Imitation scores (Table 2) revealed a significant group effect, $F(4, 145) = 5.63$, $\eta^2_p = .13$. Infants in the Anger-attentive group were less likely to imitate than were infants in the Anger-back, Anger-absent, and Control groups. Infants in the Anger-distracted group had lower imitation scores than did those in the Anger-absent and Control groups. The same overall pattern of results was also obtained using non-parametric analyses (Kruskal-Wallis and Mann-Whitney *U* tests). Moreover, the same pattern was obtained in a fine-grained subsidiary analysis using imitation proportion scores (Table 2) based on those trials in which infants had at least a 15 s window from first touch of the object. On virtually all trials, infants touched the test object within 5 s of it being presented; therefore 94% of the trials could be included. As expected, this analysis yielded a similar pattern of results as the main imitation analysis. There was a significant group effect, $F(4, 144) = 4.54$, $\eta^2_p = .11$. Infants in the Anger-attentive group had significantly lower imitation scores than infants in all other groups with the exception of Anger-distracted. Infants in this latter group had lower scores than those in the Anger-absent group.

2.3. Infants' Visual Attention During the Response Period

Durations of infant looks to the Emoter during the response periods (Table 2) were analyzed using a 4 (groups) × 3 (trials) repeated measures ANOVA. (The Anger-absent group was not included because the Emoter did not remain in the room during the response period.) There was a group effect, $F(3,116) = 7.83$, $\eta^2_p = .17$ and a group × trial interaction, $F(6, 232) = 2.14$, $p = .05$, $\eta^2_p = .05$. In each of the three trials, infants in the Anger-back group spent less time looking at the Emoter than did those in the Anger-attentive group. In Trials 1 and 2, Anger-back infants looked less at the Emoter than did those infants in the Neutral-attentive group. In Trials 2 and 3, infants in the Anger-back group spent less time looking at the Emoter than did infants in the Anger-distracted group. Finally, in Trial 1, infants in Anger-attentive spent more time looking at the Emoter than did those in the Anger-distracted group.

2.4. Infant Affect

In the stimulus-presentation periods, there were no trial effects, and thus we could analyze infants' mean positive and negative affect scores (Table 2) using multivariate analysis of variance (MANOVA). There were no group effects. In the response periods there were also no trial effects, and the MANOVA using infants' mean positive and negative affect scores yielded a significant multivariate group effect, $F(8, 288) = 3.82$, $\eta^2_p = .10$. This group effect

[2]In preliminary analyses a repeated measures ANOVA was conducted with the subset of infants who touched the objects on all three trials ($n = 132$). There were no significant trial effects and therefore the main text reports means across the trials.

was examined in more detail using a Roy-Bargmann Stepdown analysis (Tabachnick & Fidell, 2001), to take into account the correlation between the two affect scores. Mean negative affect was examined first because this variable yielded the highest univariate *F* value, $F(4, 145) = 5.22$, $\eta^2_p = .13$. Infants in the Anger-distracted group displayed more negative affect than did those in the Control and the other three Anger groups. Positive affect scores were then analyzed using a one-way analysis of covariance (ANCOVA), with mean negative affect entered as a covariate. There was an effect of group, $F(4, 144) = 2.51$, $\eta^2_p = .07$. Infants in the Anger-absent group displayed more positive affect than did those in the Anger- attentive and Anger-distracted groups.

2.5. Infant temperament

The relation between infants' temperament and instrumental behavior (latency and duration of touch and imitation score) was initially analyzed for the entire sample. Any significant effects were followed up with further analyses within each experimental group. Infant Impulsivity scores were significantly correlated with imitation scores for the entire sample, $r(148) = .18$, $p = .025$. Impulsivity is defined in the ECBQ as "speed of response initiation." A sample item from this scale is: "When offered a choice of activities, how often did your child stop and think before deciding?" The relation between impulsivity and imitation was significant within the Anger-attentive group, $r(29) = .38$, $p = .04$, but not significant within the other groups. The group effect for the imitation scores remained significant when impulsivity was taken into account using ANCOVA, $F(4,143) = 5.24$, $\eta^2_p = .13$, and the pattern of results was identical to that obtained in the ANOVA.

The Positive Anticipation scale (defined as "Excitement about expected pleasurable activities") was negatively correlated with mean latency to touch, $r(148) = -.19$, $p = .017$, for the entire sample. A sample item is: "Before an exciting event (such as receiving a new toy), how often did your child get very excited about getting it?" This correlation did not vary significantly across experimental groups. When infants' positive anticipation scores were used as a covariate, the group effect for latency to touch remained significant, $F(4, 143) = 4.31$, $\eta^2_p = .11$.

3. Discussion

The findings reported here are relevant to social-developmental theory in three ways. First, this study demonstrates that 15-month-old infants appropriately inhibit their imitative behavior (a pre-potent response), based on emotional information gathered simply from observing a social interaction between two other individuals. Second, the results suggest that, at this age, infants can integrate multiple pieces of social information – another person's prior emotion and current gaze direction/body-orientation – and use it to govern their imitative behavior. Third, a link was found between infants' temperament and the extent to which they were able to control their imitative responses.

3.1. Emotional eavesdropping

Infants in the Anger-attentive group were delayed in touching the test object and were hesitant to imitate the Experimenter's acts, compared to infants in the Control group. During

the response period for both groups, the Emoter looked toward the infant with a pleasant, neutral facial expression. The only difference between these groups was with regard to the Emoter's *prior* reaction to the other adult's acts. Thus, by 15 months of age, emotional information does not need to be perceptually present or directed at infants in order for it to affect their self-regulatory responses. Consistent with claims about the power of social-observational learning in infancy (Meltzoff, Kuhl, Movellan, & Sejnowski, 2009), the present findings reveal that infants rapidly learn based on observation alone.

One might wonder whether the Emoter's anger induced a state of wariness in infants, resulting in behavioral inhibition. In this case, the results would best be accounted for by some simple form of emotion contagion. However, there were no significant differences between the Control and Anger-attentive groups in the degree to which infants displayed negative (or positive) affect during either the stimulus-presentation or the response periods. Alternatively, perhaps associative processes led infants to connect the Emoter's anger with the object – it was tainted and viewed as "something to be avoided." However, infants' behavior in the Anger-absent group provides a good control for this lean interpretation and is inconsistent with it: When the Emoter was angry and then left the room, infants eagerly picked up the object and performed the target acts. Evidently, the object in and of itself was not tainted.

A final lean interpretation is that infants were scared of the angry Emoter and her *continued presence* maintained their fear, resulting in behavioral inhibition. However, this is inconsistent with the fact that when the previously angry person was also physically present, but had her back turned, infants were not hesitant to pick up the object and imitate the target acts.

3.2. Integrating multiple cues (perception + emotion)

Why, then, did infants so eagerly touch and imitate with the test objects when the previously angry Emoter left the room or turned her back, but not when the previously angry person was looking in their direction? We believe that infants take into account the Emoter's line of regard in conjunction with her previous emotional reaction. The gaze-following literature suggests that 15-month-olds are adept at identifying the specific target of another person's gaze. For example, they look at specific visual targets instead of simply turning to the appropriate side (Butterworth & Jarrett, 1991), follow another's gaze to an object behind a barrier (Moll & Tomasello, 2004), and selectively follow a person who turns with open rather than closed eyes (Brooks & Meltzoff, 2002). Thus, in the response period, infants may have determined that they themselves were the focus of the Emoter's gaze. This visual-perceptual information, in concert with the Emoter's prior affect, may have driven infants' behavior. They may have expected the Emoter to become angry, but only if she could see what they were doing during the response period. Consistent with this interpretation is the growing evidence that infants deepen their understanding of others' seeing (the contents of their visual perceptions) in the second year of life (Meltzoff & Brooks, 2008). Infants start to use pointing to direct another person's attention to a specific target (Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004) and they point selectively only when the adult can see this gesture (Brooks & Meltzoff, 2002).

3.3. Developmental changes

Unlike 18-month-olds (Repacholi et al., 2008), 15-month-olds were also hesitant when the previously angry adult was facing them but not specifically directing her gaze at the infant's behavior (because she was looking down and reading a magazine). Infants in this Anger-distracted group were as delayed in touching the object and as hesitant to imitate as were those in the Anger-attentive group. Thus, in the special case that the Emoter was facing infants, it did not seem to matter whether she looked down at a magazine or looked ahead toward the infants; however, it mattered greatly to 18-month-olds in the Repacholi et al. (2008) study. Why?

The literature is replete with findings of developmental shifts between 15 and 18 months of age. For example, Piaget (1954) reported significant changes in infants' causal reasoning and understanding of objects in this time window. Others have found rapid changes in infants' self-awareness (mirror self-recognition; Bertenthal & Fischer, 1978), pretend play (McCune-Nicolich, 1981), categorization (Gopnik & Meltzoff, 1987; Sugarman, 1983), and language (Bloom, 1973) during this interval. Thus, the 15- to 18-month-old period has been documented as a time of particularly rapid psychological change, but none of these studies has examined potential changes in affective cognition and self-regulation.

We propose two candidate explanations, not mutually exclusive, for the developmental changes between 15 and 18 months of age in infants' performance in the emotional eavesdropping paradigm. First, the 15-month-olds may have merely used the Emoter's body orientation – i.e., whether she was facing them or not – to determine if they were likely to be the target of her anger. Early on, infants might think that a forward-facing orientation signals a person's "social availability." Consequently, in the Anger-attentive and Anger-distracted groups, infants might have expected the Emoter to interact with them during the response period and, based on her prior emotional behavior, they predicted that this interaction would be marked by anger. However, when the Emoter's back was turned (Anger-back) or she was out of the room (Anger-absent), infants may have registered that the Emoter was "socially unavailable" – that there would be no interaction, angry or otherwise.

An alternative is that 15-month-olds are still developing an understanding of the Emoter's "visual-perceptual field." Infants in the Anger-distracted group may have appreciated that the Emoter's gaze was directed down toward a magazine, yet were confused as to whether she could only see the magazine or whether she could *also* see what they were doing with the target object. Consistent with this interpretation, infants in the Anger-distracted group showed more frowns and furrowed brows (scored as "negative affect" than did infants in all the other groups, including the Anger-attentive group (in which it was very clearly the case that the Emoter could see them). It is also noteworthy that infants in the Anger-distracted group spent more time looking at the Emoter in the response period than did those in the Anger-back group, and that their looking times were similar to the Anger-attentive and Control groups in which the Emoter was directly watching them. One interpretation of this pattern is that when the previously angry adult was facing the infant and looking down at a magazine, infants were concerned that the Emoter was able to see them (that the infant fell within the adult's field of view). We hypothesize that infants' understanding of a person's field of perception is still relatively immature at this point. Future studies of infants'

understanding of perception and perspective-taking might usefully undertake a microgenetic analysis of the changes in infants' understanding of other people's "field of visual perception" between 15 and 18 months of age.

Regardless of which explanation ultimately obtains, both accounts suggest that 15-month-old infants are able to integrate multiple social cues. As demonstrated in the comparison between the Anger-attentive and Control groups, infants' tracked the Emoter's prior affective response to the Experimenter's actions and used this information to regulate their imitative behavior. Moreover, comparisons between the different Anger groups indicate that infants integrated this emotional information with the Emoter's visual-perceptual cues during the response period. That is, in the Anger-back and Anger-absent groups, in which the Emoter clearly could not see them, infants eagerly imitated the target acts, whereas infants in the Anger-attentive and Anger-distracted groups were more likely to inhibit touching the object and imitating. Thus, it was not only the emotional history of the person that guided infants' imitative behavior.

We speculate that infants combine the tracking of the Emoter's prior emotional history with the Emoter's current visual-perceptual information to predict how the Emoter will respond if they (the infant) reproduce the target act. Infants do not automatically imitate nor do they respond in a rigid manner and inhibit their imitative responses whenever the Emoter expresses anger. Instead, infants are able to integrate different pieces of social information to determine when they themselves might be the target of another person's anger and then regulate their imitative behavior accordingly.

This is a useful aspect of social cognition, with substantial ecological validity. For example, infants often observe an older sibling being scolded for an act, such as poking an electric socket. It is useful for the infant to learn simply from observing the emotional reactions directed toward someone else who performs them. This regulation of imitation is a key component of the human infant's imitative capacity and is often overlooked in the debate about neural mirroring systems and compulsory copying (Marshall & Meltzoff, 2014).

3.4. Linking temperament and infants' behavioral regulation

In the Anger-attentive group, in which infants were clearly the target of the Emoter's gaze, infants' impulsivity scores were positively correlated with their imitation scores. This finding suggests that infants who performed the forbidden actions in this group did so because they could not inhibit their pre-potent response (imitating the adult). Infant impulsivity was not, however, related to infants' imitative behavior in the Anger-distracted group. Thus, infants who were hesitant to imitate when the Emoter was facing them and reading a magazine, were not necessarily less impulsive than those who imitated the acts. Instead, we speculate that these infants did not fully understand the scope of the Emoter's visual-perceptual field (i.e., whether she could see them or not).

The variability in infants' imitative behavior in the Anger-attentive group was striking. Ten infants in that group performed the target act on every trial, despite the watchful gaze of the previously angry Emoter. An in-depth review of their videotapes revealed that: (a) all of these individual infants had been attentive to the Emoter's anger and (b) all had taken note of

where she was looking (by checking her face) before they touched the object. These observations, along with the correlation between impulsivity and imitation (which was specific to the Anger-attentive group), suggest that infants in this group were not unaware of the social information provided by the Emoter; instead, they may not have engaged in reflection on the available social cues.

Such individual variation may have predictive value. If particular infants fail to regulate their behavior in response to an external source of control, they may experience difficulties later on with the internal regulation of their conduct. During the preschool period and beyond, they may be less likely to comply with adult prohibitions in the absence of continued external monitoring. Being responsive to external social signals, such as other people's gaze and emotions, during infancy may be a foundation for later internalization of parental/societal values and moral development (Kochanska, 1994). We are currently testing this speculation in a follow-up study with 5-year-olds who participated in our eavesdropping paradigm at 15 months of age.

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Highlights

- Infants regulated their imitation based on observing social interactions between two adults
- Infants integrated emotional and visual-perceptual cues in order to self-regulate
- Infants' temperament scores (Impulsivity) predicted their imitation regulation
- The findings provide new insight into the roots of executive functions in infancy

Table 1

Emoter's Behavior as a Function of Experimental Groups

Groups	Emotion toward Experimenter during stimulus-presentation period	Emotion during response period	Gaze during response period
1. Anger-attentive	Anger	Silent/neutral face	Facing infant. Looking toward infant.
2. Anger-distracted	Anger	Silent/neutral face	Facing infant. Looking down at magazine.
3. Anger-back	Anger	Silent/neutral face	Facing away from infant. Looking down at magazine.
4. Anger-absent	Anger	N/A	Not in the room.
5. Control	Neutral	Silent/neutral face	Facing infant. Looking toward infant.

Table 2

Mean (and SD) Infant Behavior and Affect as a Function of Experimental Group

	Experimental Group				
Variable	**Anger attentive**	**Anger distracted**	**Anger back**	**Anger absent**	**Control**
Infant Behavior in Response Period					
Latency to Touch (in seconds)	4.26 (5.94)	3.48 (4.82)	.72 (.51)	1.54 (2.26)	1.47 (3.37)
Duration of Touch (Proportion)	.90 (.19)	.85 (.18)	.92 (.07)	.91 (.08)	.94 (.07)
Imitation Score (Range 0–3)	1.53 (1.22)	1.83 (1.18)	2.20 (.92)	2.57 (.63)	2.47 (.94)
Imitation Proportion	.54 (.40)	.67 (.39)	.73 (.31)	.87 (.21)	.82 (.31)
Duration of Attention to Emoter (in seconds)	3.56 (2.63)	2.19 (2.26)	.97 (1.22)	N/A	2.54 (1.98)
Infant Affect in Stimulus- Presentation Period [a]					
Positive affect	.08 (.27)	.11 (.25)	.20 (.47)	.23 (.52)	.27 (.51)
Negative affect	.23 (.34)	.19 (.29)	.11 (.20)	.16 (.26)	.19 (.30)
Infant Affect in Response Period [a]					
Positive affect	.51 (.67)	.42 (.62)	.86 (.75)	1.03 (.76)	.78 (.74)
Negative affect	.23 (.32)	.40 (.46)	.09 (.15)	.11 (.20)	.17 (.27)

[a]Ratings based on a scale from 0–2