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Infants use attention but not emotions to predict others' actions

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ABSTRACT

Phillips et al. (2002) suggest that by 12–14 months, infants can use a person's emotional and attentional cues to predict that person's actions. However, this work was conducted using only positive emotions, which is problematic because attention and positive emotions lead to the same prediction about a person's actions, thus leaving unclear whether infants made predictions based upon attention and emotion or attention alone. To get around this problem, we used both positive and negative emotions in a looking-time paradigm to investigate whether 14-month-old infants can use emotional cues to predict a person's actions. The findings suggest that infants used attentional but not emotional cues as predictors. We argue that while 14-month-olds can use another person's emotion cues to modify their own behavior (as in social referencing situations), they do not yet use them robustly to predict the other's behavior.

Adults construe others' behaviors in terms of internal states such as beliefs, emotions, and intentions. Although this "folk psychology" takes years to fully mature, its development begins early in childhood. In the present study, we assessed the early manifestation of this folk psychology. In particular, we examined infants' ability to construe another's behaviors based upon their emotions.

There are at least two distinct ways in which infants can use others' emotions about a referent. First, infants can use them to learn about their environment, as in social referencing situations wherein an informant provides emotional information about a novel referent and infants use this information to guide their own future behavior toward the referent. There is sufficient work to show that infants robustly use emotions in this way by 12 months of age (Hornik, Risenhoover, & Gunnar, 1987; Mumme, Fernald, & Herrera, 1996; Vaish & Striano, 2004). Second, infants can use others' emotions to learn about the emoter and to thereby make predictions about the emoter's future behavior toward the referent. This basic level of folk psychology was the focus of the current paper. Although several recent studies have touched on the development of this ability, none have yet provided convincing evidence that infants younger than 18 months of age use emotional cues to reason and make predictions about the emoter.

Past work has shown that by around 2 or 3 years, children can use others' emotions (and relatedly, desires) to guide their interpretations of and predictions about others' actions (Stein & Levine, 1989; Wellman & Woolley, 1990). In a study with younger children (Repacholi & Gopnik, 1997), 14- and 18-month-olds were first asked which of two foods they themselves preferred. Participants were then shown an experimenter expressing disgust as she tasted one of the foods and happiness as she tasted the other food, and were subsequently asked to give the experimenter some food. While 14-month-olds gave the experimenter whichever food they themselves preferred, 18-month-olds handed over the food that the experimenter preferred, even if they themselves preferred the other food. The authors concluded that 18-month-olds, but not 14-month-

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olds, possess a basic folk psychology based upon others' emotions. One problem with this study, however, is that in order to respond appropriately, infants needed to inhibit the urge to pick up the food that they themselves liked. It is possible that 14-month-olds' inability to inhibit their own preferences resulted in their inability to respond appropriately to the experimenter's request.

A more effective paradigm might be a looking-time paradigm in which infants need not inhibit their own preferences. Phillips, Wellman, and Spelke (2002) used this kind of design. These authors examined whether infants can use a person's gaze and positive emotions to predict how that person will subsequently behave. Infants saw an actress looking with interest and joy at, and vocalizing positively about object A, and then subsequently holding object A (consistent event) or object B (inconsistent event). Phillips et al. (2002) found that 14-month-olds, and less robustly, 12-month-olds, looked longer to the inconsistent than to the consistent test events, and argued that by the end of the first year, infants use the combined information about a person's direction of gaze and emotional expression to predict that person's actions. These results have been replicated and extended to other referential cues such as reaching and pointing (Sodian & Thoermer, 2004).

Although interesting, these studies do not unequivocally demonstrate infants' use of emotions as predictors of actions, as they leave unclear whether the combination of emotional and attentional cues, or attentional cues alone, lead infants to make correct predictions about a person's actions. Presumably, if a person emotes positively while attending to A, infants predict that the person will approach A. It is also possible, however, that if a person pays attention to A without emoting positively about it, infants still expect the actor to pick up A. Indeed, 12-month-old infants show a novelty preference when an actor who has gazed (without emotions) at A subsequently gazes at B (Woodward, 2003). It seems quite plausible, then, that infants in the studies by Phillips et al. (2002) and by Sodian and Thoermer (2004) showed a novelty preference in the inconsistent test events based primarily on the use of attentional cues. Whether the person's positive emotions enhanced or were even necessary to make the correct predictions remains to be investigated.

The present study was designed to provide clearer evidence concerning infants' ability to use emotions to predict others' actions. To address this issue, we adapted the paradigm developed by Phillips et al. (2002), changing the format slightly and adding a condition with a negative emotion. When a person displays negative emotions (such as fear or disgust) about an object, one predicts that she will *not* hold that object. Thus, a negative emotion might help to tease apart the effects of attentional versus emotional cues.

We familiarized 14-month-olds to an actress looking inside a cup and emoting positively (happily) or negatively (with disgust) about it while ignoring another cup. We then tested whether these infants looked longer when the actress reached into the same cup that she had emoted about or into the other cup. Prior work on social referencing has shown that 12- to 14-month-old infants understand disgust cues. For instance, Hornik et al. (1987) found that 12-month-old infants avoided an ambiguous toy that their mother had displayed disgust about, and Moses, Baldwin, Rosicky, and Tidball (2001) found that 12-month-olds responded appropriately to an experimenter's disgust cues. Hertenstein and Campos (2004) similarly showed that 11- and 14-month-old infants avoided an object that an adult had shown disgust toward, and furthermore, that 14-month-olds avoided this object even an hour after the disgust cues were provided. Thus, in past work on social referencing, 12- to 14-month-old infants have displayed a robust ability to use disgust cues for themselves.

We used cups in our procedure so that the actress could touch the stimulus that she was emoting about in order to make absolutely clear to infants which stimulus she was referring to; since the actress would be emoting about what was inside the cups rather than about the cups themselves, she could believably touch not only the cup whose contents she was happy about but also the cup whose contents she was disgusted by. Infants' understanding of containment was not of concern because prior work has shown that even very young infants have a basic understanding of this phenomenon (Caron, Caron, & Antell, 1988; Hespos & Baillargeon, 2001). Moreover, in a study by Repacholi (1998), when an actor displayed happiness while looking into one container and disgust while looking into a different container, 14-month-old infants subsequently touched the two containers equally but preferred to search for the object inside the happy box rather than inside the disgust box. That is, infants associated the actor's emotional cues with the contents of the container and not with the container itself. Thus, in social referencing situations, 14-month-old infants appropriately use not only emotional cues displayed toward visible objects but also those displayed toward objects inside containers.

Our working hypothesis was that if 14-month-olds truly understand the predictive value that emotions carry, then infants in the happy condition would show a novelty preference for the test events in which the actress emoted positively about one cup but then reached into the other (unattended) cup, and infants in the disgust condition would show a novelty preference for the test events in which the actress emoted negatively about one cup and then reached into the same (attended) cup.

1. Method

1.1. Participants

A total of 59 14-month-old infants were tested. The infants' parents had been contacted by advertisements or mailings, and were offered $10 as travel reimbursement. Eleven of the 59 infants were excluded because they were fussy or distracted

(7), there was an experimenter error (2) or an equipment failure (1), or because the infant was an outlier[1] (1). The final participants were thus 48 full-term infants (22 girls) between the ages of 13 months, 15 days and 14 months, 18 days (M = 13 months, 28 days; SD = 8.82 days). Half of the infants (12 girls) were randomly assigned to the happy condition, and half (10 girls) to the disgust condition. The final sample of 48 infants was ethnically diverse: 22 parents identified their child's ethnicity as Caucasian, 13 as African-American, 6 as Hispanic/Latino, 3 as Asian, 2 as bi-racial (Caucasian and African-American), 1 as Native American, and 1 as Hawaiian/Pacific Islander.

1.2. Setting

Infants sat on their parents' lap during the experimental events. Parents were instructed to look down at their infant rather than at the experimental events. Infants faced a small stage that held a red and a green plastic cup, one on the left and one on the right side of the stage. The actress sat behind the stage so that only her upper body and face were visible. A white cloth screen hid the stage and the actress from view at the start of the experiment and between trials. A video camera was placed just above the actress' head and was focused on the infant's face. During the experiment, one experimenter (E1) watched the image from this video camera, and coded infants' looking times on-line (refer to Woodward, 2003, for details on how observers were trained). A second video camera was placed behind infants and was focused on the actress. A second experimenter (E2), who was out of the child's view, monitored the event, instructed parents, and raised and lowered the screen between trials. The minimum inter-trial interval was set at 1 s, but most trials were separated by intervals of 2–3 s. The maximum trial length was set at 150 s, but no infant reached the maximum trial length on any event.

1.3. Procedure

There were two parts to the experiment: familiarization and test.

1.3.1. Familiarization

During familiarization trials, E2 lowered the screen so that the actress was visible to the infant. The actress smiled at the infant, said "Hi!" and then turned to one of the cups (cup positions and which cup the actress emoted to first were counterbalanced across infants). Without lifting the cup off the table, the actress tilted it toward herself using both hands, looked in, and emoted according to the condition. In the happy condition, the actress smiled, gasped audibly, protruded her neck toward the cup, and said in a happy, excited voice, "Ooh, wow!" In the disgust condition, she lowered and drew her brows together, pulled up her upper lip and pulled down and protruded her lower lip, gasped audibly, retracted her neck, and said in a disgusted tone of voice, "Eww, yucky!" The facial expressions were based upon descriptions in Ekman and Friesen (1975), and the prosody was based upon descriptions in Scherer (1986). During each trial, the actress only said the emotional phrase once, but then continued to hold the facial expression until the infant had looked away for a consecutive 2 s. Thus, these trials were infant-controlled. Infants were shown four familiarization trials, after which the test trials began.

1.3.2. Test

Infants were shown six test events, alternating between attended and unattended (order counterbalanced across infants). In both types of test events, the actress emoted in the same way and about the same cup as in familiarization, then put the cup down and moved her hands to the center of the table while still looking at the cup and holding the emotional expression. In the attended events, she then assumed a neutral face, tilted the same cup toward herself using the hand closer to the cup, and reached into it with the other hand. In the unattended event, she acted the same way but upon the other cup (which had thus far been ignored). In each event, she maintained the reach until the infant had looked away for a consecutive 2 s.

Based on prior findings (Phillips et al., 2002; Sodian & Thoermer, 2004), in the happy condition, infants should show a stronger novelty preference for the unattended than the attended test events. That is, infants should look for a longer duration when the actress looks joyfully into one cup but then reaches into the other cup (unattended) than when she reaches into the same cup (attended). The predictions for the disgust condition were less obvious. If infants predict actions using emotional and attentional cues, they should show a stronger novelty preference for the attended than the unattended test events, i.e., they should look for a longer duration when the actress looks disgustedly into one cup and then reaches into that same cup (attended). However, if infants use attentional but not emotional cues, they should look for a longer duration when the actress looks disgustedly into one cup and then reaches into the other cup (unattended).

1.4. Coding and reliability

Infants' looking times to the familiarization and test events were coded on-line by E1. For each infant, average looking-time scores were calculated for the familiarization, and attended and unattended test events. A second observer, who was

[1] This infant's average duration of looks to attended and unattended events was 6.28 SD and 5.18 SD from the mean, respectively, both of which are unusually far from the mean (Tabachnick & Fidell, 2001). No other infants' looks were more than 2 SD from the mean. This infant was thus excluded from analyses, and an additional infant tested as a replacement.

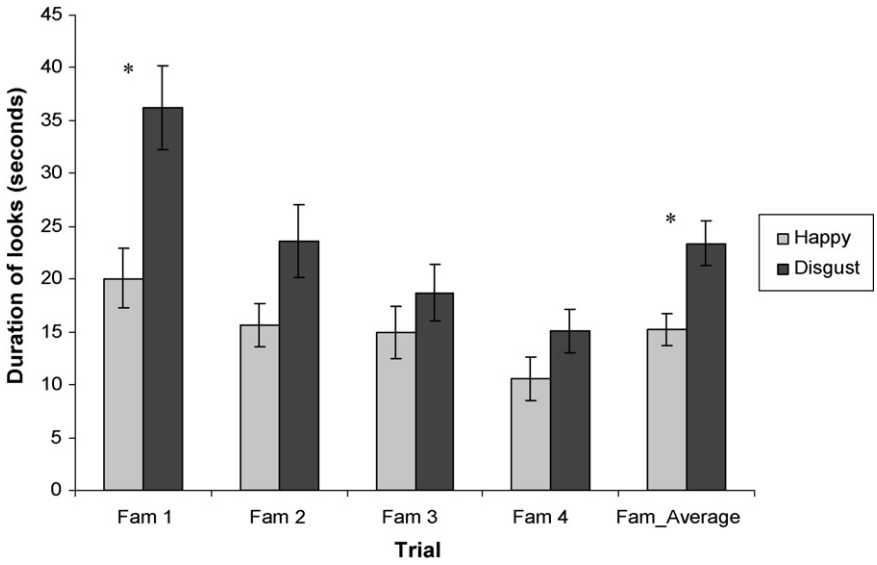

Fig. 1. Duration of looks to the four happy versus the four disgust familiarization events as well as the average duration of looks to all four familiarization events. $^{*}p < .05$.

unaware of the trial type, coded each infants' session from videotape. The primary and secondary observers were counted as agreeing if they identified the same look away as ending the trial. The observers agreed on 93% of the test trials in the happy condition and 92% of the test trials in the disgust condition. To ensure that disagreements did not occur systematically in favor of the hypotheses, the disagreements were categorized into two groups: those that would have contributed to the hypothesized pattern of findings (i.e., longer looking to unattended events in the happy condition, and shorter looking to unattended events in the disgust condition), and those that would have worked against the hypothesized pattern of findings if the on-line observer's data were used. In both emotion conditions, the disagreements were randomly distributed among these categories, Fisher's one-sided exact $p = .548$ for happy and .667 for disgust conditions.

2. Results

2.1. Familiarization

To assess infants' looking to the happy versus disgust emotions during familiarization events, we conducted a repeated-measures ANOVA with duration of looks as the dependent measure, trial as a within-subjects factor (with 4 levels: familiarization trials 1, 2, 3, and 4), and condition as a between-subjects factor (with 2 levels: happy and disgust). This analysis revealed a main effect of condition, $F(1,46) = 9.839$, $p = .003$: infants' looking times during disgust familiarization events ($M = 23.39$ s, $SD = 10.27$) were significantly greater than their looking times during happy familiarization events ($M = 15.29$ s, $SD = 7.39$).

A significant trial $\times$ condition interaction also emerged, $F(3,138) = 2.797$, $p = .043$. Independent-samples t-tests revealed that infants looked significantly longer to the first disgust familiarization event ($M = 36.22$ s, $SD = 19.38$) than to the first happy familiarization event ($M = 20.03$ s, $SD = 13.78$, $t(46) = 3.334$, $p = .002$). The means of the other trial pairs also followed this pattern although the differences were not significant (see Fig. 1).

2.2. Test events

A repeated-measures analysis of variance was conducted with average duration of looks as a dependent measure and trial type as a within-subjects factor (2 levels: attended and unattended). The three between-subjects factors were condition (2 levels: happy and disgust), trial order (2 levels: attended first and unattended first), and gender. To reduce positive skew, the data were subjected to a log transformation before this analysis was conducted. We also included the average duration of looks during familiarization trials as a covariate in both analyses, given that this measure differed significantly across emotion conditions. We had predicted that if infants use emotional and attentional cues to predict others' actions, we should find a significant interaction between trial type and emotion such that infants look longer to unattended events in the happy but to attended events in the disgust condition. However, this interaction was not significant, $F(1,39) = .312$, $p = .580$, $p\eta^2 = .008$. Instead, there was a trial type $\times$ trial order interaction, $F(1,39) = 9.91$, $p = .003$, $p\eta^2 = .203$ (see Fig. 2). A separate analysis of each trial order group revealed that those 24 infants who saw the unattended event first looked, on average, significantly longer to the unattended events ($M = 11.97$ s, $SD = 5.64$) than to the attended events ($M = 8.63$ s,

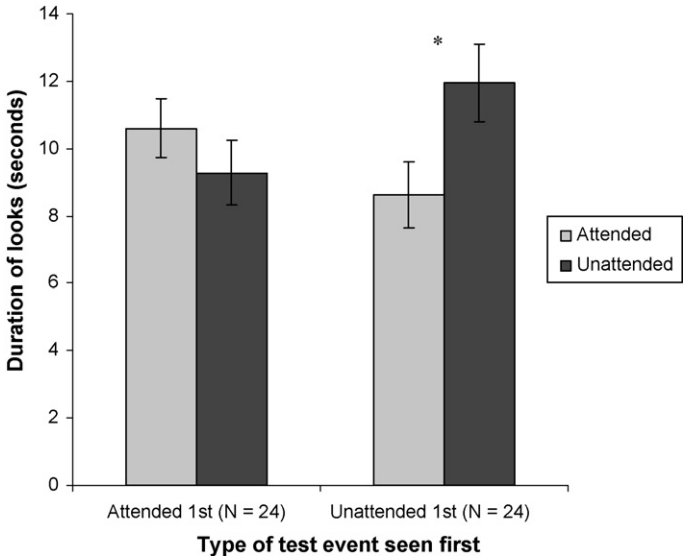

Fig. 2. Average duration of looks to attended versus unattended test events by infants who saw an attended event first versus infants who saw an unattended event first. $^{*}p < .05$.

$SD = 4.84$, $t(23) = 2.55$, $p = .018$). Importantly, those 24 infants who saw the attended event first did not look significantly longer to either kind of event (unattended events: $M = 9.26$ s, $SD = 4.71$; attended events: $M = 10.59$ s, $SD = 4.29$; $t(23) = 1.37$, $p = .184$).

Although there was no significant trial type × emotion interaction, we nevertheless examined the two emotion conditions separately since a comparison of these conditions was the main focus of the study. Thus, for each emotion condition, we conducted a repeated-measures ANOVA with trial type as a within-subjects factor and trial order as a between-subjects factor. Again, the data were subjected to a log transformation to reduce positive skew, and the average duration of looks during familiarization trials was included as a covariate in both analyses. Both ANOVAs revealed similar trial type × trial order interactions as the overall ANOVA had (happy condition: $F(1,21) = 7.76$, $p = .011$, $p\eta^2 = .27$; disgust condition: $F(1,21) = 4.38$, $p = .049$, $p\eta^2 = .173$). The significant interaction in the overall ANOVA was thus not driven by an interaction in only one emotion condition; rather, similar interactions emerged in both emotion conditions.

The order effects that we found are quite common in looking-time studies (Schöner & Thelen, 2006), and were also reported by Sodian and Thoermer (2004). These effects suggest that any effects of trial type might be limited to the first test trial that infants saw. To assess this, we conducted a univariate ANOVA with (log transformed) durations of infants' looks to the very first test trial as the dependent measure, whether the first test trial was attended or unattended as a between-subjects factor, and the average duration of looks during familiarization trials as a covariate. As expected, this analysis showed that infants looked longer during the first test trial when this trial was unattended ($M = 18.91$ s, $SD = 12.05$) than when it was attended ($M = 15.71$ s, $SD = 8.90$), which was a marginally significant effect, $F(1,45) = 3.13$, $p = .083$, $p\eta^2 = .07$.

A second way to address the order effects was to analyze the recovery in infants' looking from familiarization to test trials. That is, perhaps those infants who first saw an unattended test trial showed significant recovery (i.e., an increase) in their looking from the last familiarization trial to the first test trial, and their looking then declined to a plateau on subsequent test trials (due to fatigue or boredom, or because, having viewed this unexpected event, infants' predictions about the actress' subsequent behavior changed). On the other hand, perhaps those infants who first saw an attended test trial did not show a similar recovery to the first test trial, and their looking also declined to a plateau on subsequent test trials. This would explain why only infants who first saw an unattended test trial showed greater looking to unattended than to attended test trials, whereas infants who saw an attended test trial first did not show this difference.

We thus analyzed recovery to the first test trial. We first analyzed recovery by which type of event infants saw first (attended or unattended). In support of the findings from the test events, paired-samples t-tests revealed that those 24 infants who saw the unattended event first showed significant recovery from the last familiarization trial ($M = 11.46$ s, $SD = 9.3$) to the first test trial ($M = 18.91$ s, $SD = 12.05$, $t(23) = 2.790$, $p = .010$). However, those 24 infants who saw the attended event first did not show a similar recovery, $p = .511$. Note that this difference was not a result of a difference in the two groups' mean looking times during the fourth familiarization trial, $p = .301$.

We next examined recovery of looking as a function of condition. First, we simply analyzed the happy and disgust conditions separately. Paired-samples t-tests revealed that the 24 infants in the happy condition recovered significantly from the last familiarization event ($M = 10.55$, $SD = 10.17$) to the first test event ($M = 16.49$, $SD = 9.88$, $t(23) = 2.500$, $p = .020$). Moreover, in support of the findings from the test events, the 12 infants who saw the unattended event first recovered their looking significantly from the last familiarization event ($M = 8.30$ s, $SD = 7.2934$) to the unattended test event ($M = 18.38$ s,

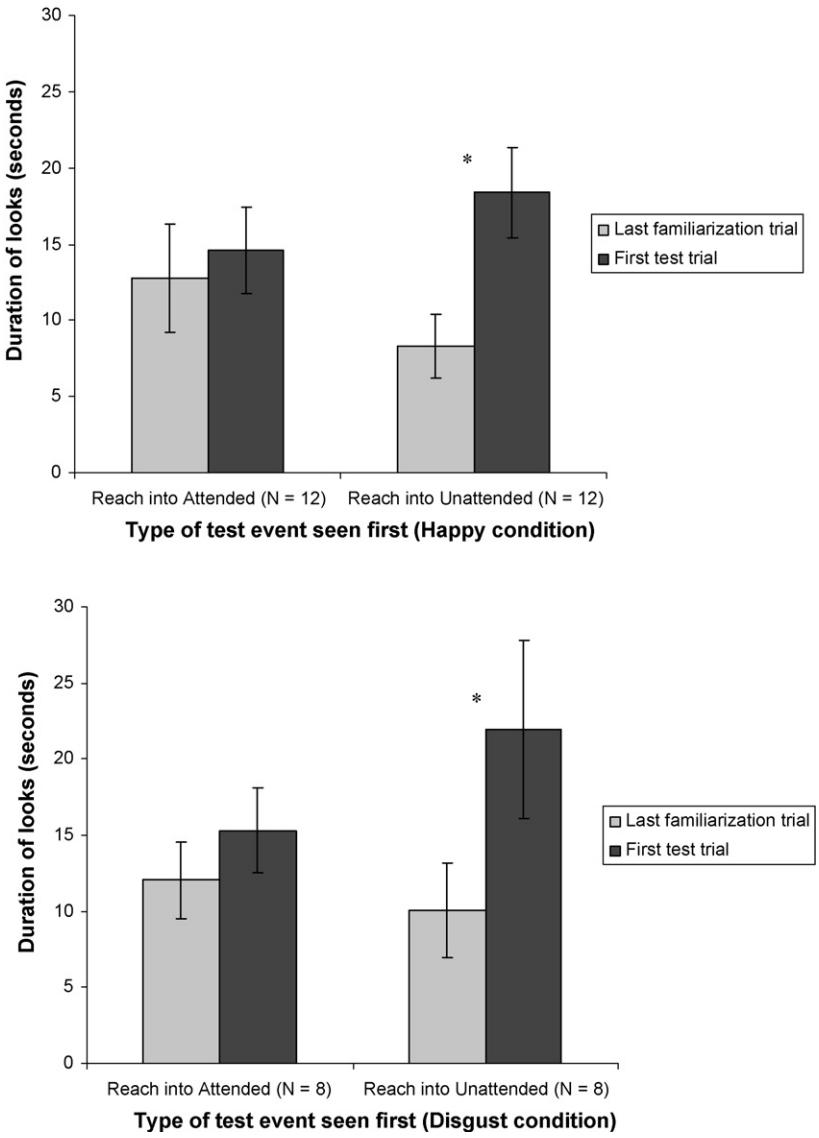

Fig. 3. Recovery in infants' looking from the last familiarization to the first attended versus unattended trial, in the happy condition (top) and disgust condition (bottom). Note that only infants who habituated are included in the graph of the disgust condition. $^{*}p < .05$.

SD = 10.12, $t(11) = 2.790$, $p = .018$). However, infants who saw the attended event first did not show a similar recovery, $p = .523$ (see top graph of Fig. 3).

Interestingly, the 24 infants in the disgust condition did not show significant recovery from the last familiarization event to the first test event, $p = .273$. Recall, however, that infants' looks during the disgust familiarization events were, on average, far longer than were infants' looks during the happy familiarization events. We were therefore concerned that perhaps infants in the disgust condition simply did not reduce their looking enough during the familiarization events to show significant recovery to either kind of test event. To assess only those infants who reduced their looking substantially, we divided infants in the disgust condition into those infants who "habituated," i.e., reduced their looking by 50% or more from the first to the last familiarization events, and those who did not. Of the 24 infants in the disgust condition, 16 met this "habituation" criterion. As expected, these 16 infants showed significant recovery from the last familiarization ($M = 11.04$ s, $SD = 7.80$) to the first test trial ($M = 18.63$ s, $SD = 12.93$, $p = .021$). Of these 16, eight infants saw the attended and eight saw the unattended event first. Analyses revealed that those eight infants who habituated and then saw an unattended event first recovered significantly from the last familiarization event ($M = 10.06$ s, $SD = 8.84$) to the first test event ($M = 21.94$ s, $SD = 16.49$, $t(7) = 3.175$, $p = .016$), whereas those eight infants who habituated and then saw an attended event first did not show significant recovery from the last familiarization ($M = 12.03$ s, $SD = 7.08$) to the first test event ($M = 15.32$, $SD = 7.82$, $p = .458$; see bottom graph of Fig. 3).

Finally, infants who did not habituate according to our 50% criterion did not show significant recovery regardless of whether they saw an attended or unattended test event first; indeed, both groups of infants' mean looking times *decreased* from the last familiarization event to the first test event, indicating that as a group, they may not have fully processed the familiarization events. On the whole, then, infants looked for extremely long durations to the disgust familiarization events, which made it difficult to assess the pattern of infants' recovery to the test events. However, those infants who did process these events enough to substantially reduce their looking to them then showed the same pattern as did infants in the happy condition: those who saw an unattended event showed a recovery in their looking times whereas those who saw an attended event did not.

3. Discussion

Infants saw an actress looking either happily or disgustedly into a cup while ignoring a different cup. If infants can use emotions to reason and make predictions about others' actions, they should show greater novelty preference when the actress behaves in a manner inconsistent with her emotional displays. That is, they should look longer not only when the actress has looked happily into one cup and then reaches into the other cup but also when the actress has looked disgustedly into one cup and then reaches into that same cup. In contrast, the 14-month-old infants in our study showed greater novelty preference when the actress reached into the ignored (unattended) cup regardless of the emotion she had previously shown toward the other cup. These findings suggest that infants were relying not on attentional plus emotional cues but on attentional cues alone to reason about the actress' actions.

Our results were tempered by an effect of trial order such that only those infants who saw the unattended event first displayed longer looking to unattended events; those infants who saw the attended event first did not display any differences in looking times. Similar order effects were also reported across multiple studies by Sodian and Thoermer (2004). Whether such order effects indicate that infants possess only a weak understanding of the phenomenon being tested or whether they are an artifact of the experimental procedure is an open question (see Schöner & Thelen, 2006, for a discussion). Nevertheless, infants who saw the unattended event first looked longer overall to unattended events and recovered their looking from the last familiarization event, whereas infants who saw the attended event first did not look longer overall to attended events and did not recover their looking from the last familiarization event. Thus, infants did not simply look longer at whichever test event they saw first and then reduce their looking times to each subsequent test event, but rather made sense of the attended versus unattended test events and showed a novelty preference for the unattended test events.

Our results contribute to the growing literature on the development of folk psychology in the first few years of life. In order to develop a folk psychology, young infants must learn to read others' attentional and intentional cues correctly and must be able to use such cues to make inferences and predictions about those people. One step along the way to this ability is the understanding of others' emotional cues as being informative about the emoter's future actions. Phillips et al. (2002) argued that 12- and 14-month-old infants can use others' emotions to predict their actions. However, because Phillips et al. (2002) used only a positive emotion, perhaps infants in their study used the actress' attentional cues alone. Similar problems arise with studies that have replicated and extended Phillips et al.'s results (Sodian & Thoermer, 2004). We attempted to tease apart the effects of attentional versus emotional cues by using both positive and negative emotions, and found that 14-month-olds did not use emotional but rather attentional cues to predict an actress' actions. These findings suggest that the positive emotions displayed in Phillips et al.'s (2002) and Sodian and Thoermer's (2004) studies may not have contributed to infants' longer looking at the inconsistent events; rather, the experimenter's attention to the objects may alone have caused the significant difference.

Our findings are in keeping with work by Repacholi and Gopnik (1997), in which 14- and 18-month-olds were shown that an adult feels disgust toward one food but likes another food. Fourteen-month-olds were unsuccessful at giving the adult her preferred food if they themselves preferred a different food. However, infants in that study were required to inhibit their own preferences, which might have been challenging for such young infants. We employed a looking-time paradigm that did not require infants to inhibit their own preferences, but still found no evidence that 14-month-olds understand that people's emotions are predictive of their actions. This suggests that their failure in Repacholi and Gopnik's study was due not to task demands but to a true lack of a robust understanding of the emotion–action connection.

Two questions arise from our findings. First, when does a robust understanding emerge? Considering Repacholi and Gopnik's (1997) finding that 18-month-olds were successful in their task, it seems that later in the second year, infants do understand the connection between a person's emotions and behavior, and, at a basic level, are aware that a person's emotions represent the person's internal states and are causally linked to the person's behaviors (see also Wellman, 1993). However, it remains unclear whether this understanding is in place before 18 months. Perhaps 14-month-olds are at the cusp of this understanding but our paradigm was too challenging for them to display this knowledge. Alternatively, perhaps 14-month-olds do not yet conceptualize emotions and desires as internal subjective states that predict the person's future behaviors, with the implication that a mentalistic understanding of emotions and desires will only emerge with more time and experience.

A second interesting question is what do 14-month-olds know about others' emotions? We know from work on social referencing that 12- to 14-month-olds appropriately use a person's emotional cues (including disgust) toward objects to modify their own behaviors toward those objects (e.g., Hertenstein & Campos, 2004; Hornik et al., 1987; Mumme et al., 1996; Repacholi, 1998). Although social referencing is an essential and sophisticated way for infants to learn about their

environment, it does not provide evidence for the mentalistic understanding required for the eventual development of folk psychology (Gergely, Egyed, & Király, 2007; Perner, 1991; Phillips et al., 2002). That is, infants' ability to social reference is often taken as evidence that they read and understand the meanings of emotions. At one level, this is certainly true: when social referencing, infants do read others' emotional cues and apply them toward their own understanding of the world. However, at another level, 12- to 14-month-olds seem unable to grasp that the emotion represents an internal state of the actor and thus unable to draw a causal link between the actor's emotion and her future intentional, object-directed actions (see also Gergely et al.). It is thus important to be cautious when attributing "emotional understanding" to infants, as the various pieces of this understanding may emerge at various points in development rather than all at the same time.

Relatedly, perhaps even mentalistic emotion–action understanding emerges in stages. For instance, an alternative interpretation of our results is that 14-month-olds do use attentional and emotional cues to construe others' actions, but not when these cues point to conflicting actions. In other words, when attention and emotions point to the same action, as with positive emotions, then perhaps infants can use both to predict the person's behavior, but when the two point to conflicting actions, as with negative emotions, then infants place more weight on attentional cues. Thus, our findings do not rule out the possibility that infants can use positive but not negative emotions in a predictive manner.

Indeed, positive emotions might be easier to use in a predictive way than negative emotions because when a person displays happiness or excitement toward an object, she also pays attention toward that object, and thus also draws the infant's attention to that object. The infant only needs one further mental step to predict that the person will act upon that object in the future. When a person displays disgust or fear toward an object, she again draws the infant's attention to that object, but the infant must now delink the emotional and attentional cues, and must make the negative prediction that the person will *not* act upon that object. This latter is clearly more complicated than the former, and might well emerge later.

Interestingly, infants in our study looked significantly longer to disgust than to happy events. This is consistent with the *negativity bias*, or the idea that humans, even infants, attend more and are more responsive to negative than to positive information (Cacioppo, Gardner, & Berntson, 1997; Vaish, Grossmann, & Woodward, 2008). In our study, this enhanced attention seemed to account for the lack of recovery in infants' looking from negative familiarization to test events. Importantly, infants who "habituated" to the disgust familiarization events did show the same pattern as infants in the positive condition: significant recovery to the first unattended (but not the first attended) test event. Thus, perhaps future work that uses negative emotions should use a habituation paradigm in which test events begin only once infants' looking times to the negative emotion have decreased by a pre-determined amount (e.g., 50%).

Another caveat regarding our study is that we only used one negative emotion (disgust), making it difficult to generalize our findings to all negative emotions. Future work could therefore use our paradigm to explore infants' responses to and understanding of other negative emotions, and might indeed reveal an earlier understanding and use of negative emotions other than disgust.

In conclusion, the current study shows that at 14 months, infants are not yet able to robustly predict a person's actions using both attentional and emotional cues. Rather, when predicting a person's actions, 14-month-olds seem to rely primarily on the former. As the development of this emotion–action causal understanding likely influences important aspects of social-cognitive development, such as the development of a mature folk psychology, it is crucial for future work to explore circumstances under which even 14-month-olds might display this understanding as well as to explore when this understanding robustly emerges.

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