Title: Infants expect friends, but not rivals, to be happy for each other when they succeed

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Abstract: Emotions arise not just from people's own circumstances, but also from the experiences of friends and rivals. Here we asked if human infants have expectations about vicarious emotions, and if they expect those emotions to be guided by social relationships. Ten- and 11-month-old infants (*N*=154) expected an observer to be happy rather than sad when the observer watched a friend successfully jump over a wall. In contrast, infants did not expect the observer to be happy when the friend failed, nor when a different, rival jumper succeeded. Infants are thus able to integrate information about desires and outcomes with knowledge of social relationships to infer others' vicarious emotional responses. Biased concern for friends but not adversaries is not just a descriptive feature of human relationships, but an expectation about the social world present from early in development.

Introduction

Humans are capable of remarkable empathy toward others, but we apply this capacity selectively [1]. Friends celebrate one another's good news and mourn each other's losses. In contrast, empathy for strangers is often weaker or absent [2–4]. When it comes to enemies, we can even be delighted by their pain or saddened by their success [5]. These vicarious emotions (i.e. emotional responses to others' experiences) can motivate acts of altruism, violence, and other social behaviors [6–8].

Like other emotions, vicarious emotions are a valuable source of information [9,10]. Understanding them is thus an important ingredient of emotional competence. Knowing that empathy motivates others to help, and knowing who is most likely to empathize, can guide effective help seeking [11,12]. Observing empathic or counter-empathic responses in others can support inferences about the empathizers' dispositions and relationships, and moral or social evaluations based on those inferences [13–15]. Recipients of empathy use it to assess the strength of their relationships or identify good candidates for new relationships [3,16]. Finally, a second-order understanding that others will interpret empathy as evidence of friendship or support may motivate expressions of vicarious emotions, helping the expresser to strengthen her social relationships [17,18]. For example, people are more likely to wince in response to another's pain if the affected individual can see them, and observers of these expressions interpret them as evidence of care [19]. Emotional competence plays an important role in healthy socioemotional development from early ages [17,20], but little research has investigated the typical development of understanding vicarious emotions. Here we ask if even infants can reason about vicarious emotions and their dependence on social relationships.

Infants experience emotional contagion and empathy. Newborns exhibit signs of distress when they hear another baby cry, though this may simply reflect a typical response to an aversive stimulus [21,22]. Older infants show concern for individuals in distress and attempt to help and comfort them [23–28]. These expressions of concern are motivated by others' circumstances and are not dependent on their emotional expressions [26,29,30], suggesting they are more akin to adult empathic concern than the emotional contagion observed in newborns.

This research does not tell us, however, if infants understand vicarious emotions or how such an understanding might develop. In their first year of life infants do make predictions about others' emotional responses to a variety of experiences, including both the outcomes of goal-directed actions and positive or negative social interactions [31–36]. However, in each of these cases researchers have tested infants' understanding of how someone will respond to the outcomes of their own goal-directed actions and their own social interactions. Here we sought to test if infants also have expectations about emotional responses to *other's* experiences.

One possibility is that infants' own experience with emotional contagion leads them to expect emotion matching between others. This would be in line with the theory that infants learn about others' minds from expecting them to be "like me" [37,38]. In this case, infants would primarily expect an observer to express emotions that match those of a target, e.g., to laugh when the target laughs or cry when the target cries. Expectations of emotion matching could be affected by knowledge of the social relationship between an observer and target, as infants show some expectations that affiliated individuals will be more similar [39,40]. However, infants could also simply extend an emotion matching heuristic to any observer.

Alternatively, infants may flexibly reason about vicarious emotions by basing emotion inferences on representations of desires, beliefs, and relationships, reflecting the use of an

intuitive theory of psychology. Intuitive theories specify causal relationships between related concepts, allowing observers to use partial information to make inferences and predictions that can guide behavior [41–44]. Intuitive psychology is an intuitive theory that supports reasoning about other people through connections between concepts of internal mental states (e.g. beliefs, desires emotions), stable but abstract social characteristics (e.g. relationships, temperament), and behavior [43]. When reasoning using intuitive psychology, an actor's actions can be taken as evidence of desires that would plausibly motivate them [45,46]. The success or failure of those actions is expected to impact the actor's appraisal of the world state relative to their desires, prompting an emotional response [47,48]. Friends (i.e. positively-affiliated individuals) are assumed to want one another's desires to be fulfilled, so a person's appraisals and emotions should be impacted by a friend's successes or failures, in addition to their own [8,49]. In contrast, rivals do not adopt one another's goals, and thus an adversarial observer should not share an actor's positive appraisal and emotions following successful outcomes.

If infants use intuitive psychology to reason about others' vicarious emotions, we can make several predictions. First, their expectations of empathy should not depend on emotion matching. If an actor experiences a good outcome, infants with the intuitive theory described above could predict that a friendly observer will appraise the outcome positively and be happy for the actor even if the actor does not outwardly emote. Second, infants' expectations of empathy should be affected by information about the social relationship between an actor and an observer, given existing evidence that infants expect social relationships to be accompanied by concern for others' welfare [49–52]. In particular, infants should not expect an observer to respond positively toward a rival's success, as the observer should not find this outcome rewarding.

In three preregistered experiments, we tested if infants have expectations about vicarious emotions that are consistent with the intuitive psychology approach. Our experiments built on studies showing that infants expect an actor to be happy about their own success[35]. In these studies, 10-month-old infants saw an animated character repeatedly attempting to jump over a wall, and the infants expected the jumper to be happy after it succeeded; they looked longer at the display if the jumper instead expressed sadness after succeeding. In contrast, infants had no clear expectations about the jumper's sadness (or happiness) when the jumper failed [35]. We modified these studies by introducing an observer who watched the jumper's attempts, and then was the one to respond emotionally to their outcomes. In addition, we added introductory scenes that used either matching and synchronized behaviors [40,53,54] or physical conflict [55,56] to convey either a positive or negative relationship, respectively, between the jumper and the observer. We hypothesized that 10- and 11-month-old infants will expect a positively affiliated observer to be happy when the actor succeeds, just as Skerry and Spelke found that infants expected the jumper itself to be happy following success. In contrast, we hypothesize that infants will not expect happiness from the observer either when a positively affiliated jumper fails or when a negatively affiliated jumper succeeds.

Results

In all experiments 10- and 11-month-old infants watched 3D animated displays featuring geometric shape characters with faces [35,40,56–60]. In Experiment 1 (N=30), we first sought to examine infants' understanding of vicarious emotions in positively affiliated individuals. All infants saw two blocks of events, a completed goal block and a failed goal block, each featuring a pair of identical characters (either purple spheres or red cones, see Fig.1A) acting in four phases. First, in a two-event "emotion familiarization" phase, one of the characters, alone

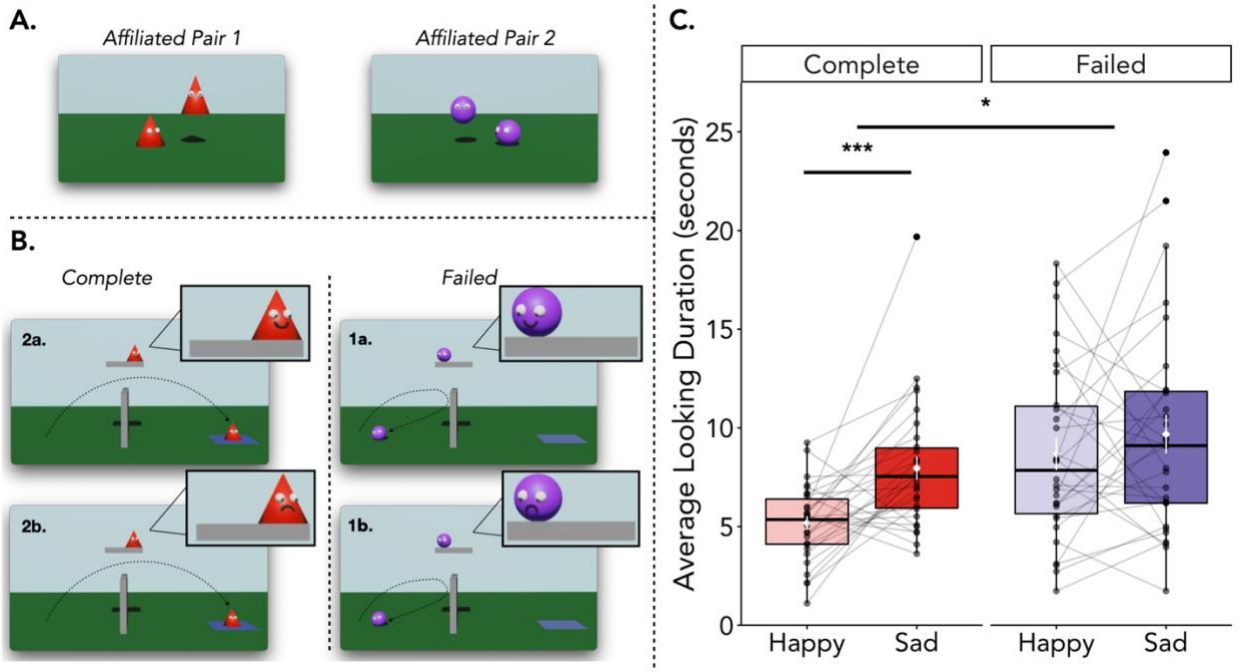

Fig.1. Stimuli and results of Experiment 1. (**A**) Images from affiliated social induction in Experiment 1 (left and right). (**B**) Happy (top) and sad (bottom) trials in the complete (left) and failed (right) blocks. (**C**) Infants' looking time plotted in seconds (statistical tests were performed on log-transformed data). Connected black dots represent an individual infant's average looking to the two trial types within each block. The means and standard errors are plotted in white. **p*<0.05, ****p*<0.001.

onscreen, displayed a happy emotion (i.e. a laughing vocalization accompanied by a smile) and then a sad emotion (i.e. a crying vocalization accompanied by a frown). Next, in a "social induction" phase, the second character joined the first one, and the two characters engaged in repetitive matching and synchronous movements (Fig.1A). This type of interaction leads infants to infer social affiliation [40,53]. Third, in a "goal familiarization" phase, one member of this friendly pair (the "jumper") repeatedly moved across the bottom of the display toward a goal location (see Methods and Movie S1 for additional detail), attempting to jump over a wall if present, while the second character (the "observer") observed these attempts from a platform in the center of the upper half of the display (see Methods for additional detail).

The fourth and final phase of each block was the test phase. In each test trial of the failed goal block, the jumper failed to get over the wall, bouncing back to its starting position. The jumper did not react to the outcome. However, across trials, the observer alternately reacted with either a happy or sad emotional expression (the same expressions introduced in the emotion familiarization phase), followed by a pause to measure the duration of infants' voluntary looking time to the display (Fig.1B). In each test trial of the completed goal block, the jumper succeeded in getting over the wall to the goal location, again followed by alternating happy or sad responses from the observer.

When the jumper succeeded, infants expected the observer to be happy. They looked longer—indicating relative surprise—following events in which a successful jump was followed by a sad expression from the observer than they did at events in which success was followed by a

happy expression ($F(1,28)=17.655$, $p<.001$, $\eta^2=0.236$; Fig.1C; see Table 1 for looking times). When the jumper failed, infants' looking to the observer's happy versus sad responses did not differ reliably ($F(1,28)=1.127$, $p=.297$, $\eta^2=0.012$). Expectations for vicarious emotions in both conditions matched prior work on infants' expectations for the jumper's emotional responses to their own successes and failures [35]. There was a statistically significant interaction reflecting a reliable difference in looking patterns to happy vs. sad trials across the completed goal and failed goal blocks ($F(1,28)=5.813$, $p=.023$, $\eta^2=0.028$).

Experiment 1 found that infants expect the same emotional reactions from an affiliated observer as they expect from the actor directly achieving positive or negative outcomes. This suggests that infants expected the observer to share the jumper's appraisal of its outcome. Infants did not simply expect the observer to emote positively toward a friend, as their expectations were modulated by the outcome of the friend's goal. Their inferences also cannot be described as an expectation of direct emotional contagion [61]; the jumper in our displays did not emote in response to its own success or failure, and thus expressed no overt emotion the observer could share. However, the results of Experiment 1 may reflect a simple expectation for positive emotional responses to follow any successful outcome. A more complete understanding of vicarious emotions would involve reasoning about their dependence on underlying social relationships.

In Experiment 2, we tested the role of social relationships in infants' vicarious emotion expectations by manipulating the relationship between the jumper and observer. Infants (N=60) viewed two blocks of events, an affiliated block and a non-affiliated block, both similar to the completed goal block of Experiment 1. In the social induction phase there were still two identical characters (purple spheres) who interacted in a friendly, synchronized manner (Movie *S2*). However, there was also a red, conical character positioned apart from and behind the two friends (Fig.2A). It acted similarly to the two purple characters, but only after a delay and

Experiment	**Block Type**	**Trial Type**	
		Happy ***M (SD)***	**Sad** ***M (SD)***
Experiment 1	**Complete**	**5.19s (1.90s)**	**7.96s (3.23s)**
	Failed	**8.68s (4.48s)**	**9.68s (5.35s)**
Experiment 2	**Affiliated**	**7.83s (3.41s)**	**10.71s (4.20s)**
	Non-Affiliated	**7.75s (3.32s)**	**9.17s (4.41s)**
Experiment 3	**Affiliated**	**7.57s (3.71s)**	**9.82s (4.85s)**
	Anti-Affiliated	**9.72s (5.02s)**	**9.59s (5.12s)**

Table 1. Infants' mean looking times. *M* indicates mean. *SD* indicates standard deviation.

without any engagement from them. In the goal familiarization and test trials of the non-affiliated block the red cone acted as the jumper, while one of the purple spheres observed. In the affiliated block, one purple sphere acted as the jumper, while the other purple sphere again observed. Across test trials in both blocks the observer responded alternately with happiness and sadness to each jumper's success (Fig.2B).

When the observer watched its friend jump successfully, infants expected the observer to be happy and looked longer following a sad response, replicating Experiment 1 ($F(1,56)=22.140$, $p<.001$, $\eta^2=0.116$; Fig.2C). When the observer watched a non-affiliated jumper succeed, infants also expected happiness, looking longer at the sad response ($F(1,56)=5.88$, $p=.019$, $\eta^2=0.032$). The size of the effect of trial type was somewhat smaller in the non-affiliated jumper block than the affiliated jumper block, but there was not a reliable interaction between the effects of trial type (happy vs. sad) and block type (affiliated vs. non-affiliated) on looking ($F(1,56)=2.881$, $p=.095$, $\eta^2=0.008$).

Experiment 2 did not provide strong evidence that social relationship information modulates infants' expectations for vicarious emotions. This could be because infants expect positive responses to follow positive outcomes regardless of social context. Alternatively, it could be that our relationship manipulation was insufficient: infants may not have understood the intended difference between the affiliated and non-affiliated relationship pairs, or they may require a more salient, negative relationship to adjust their emotion expectations.

In Experiment 3, we investigated infants' emotion expectations in the context of antagonistic relationships. In the affiliated block, as in Experiments 1 and 2, we introduced infants ($N=64$) to a pair of characters who moved together in a friendly manner. In the antagonistic block we introduced them to a second pair, who bumped into one another

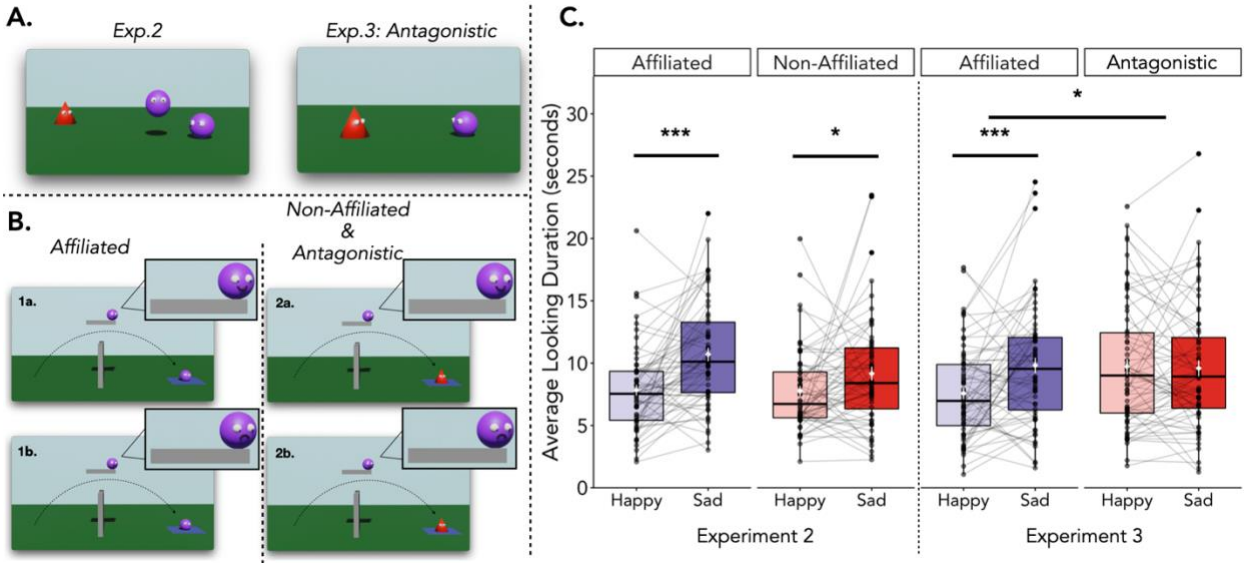

Fig.2. Stimuli and results of Experiments 2 and 3. (**A**) Images from the social induction in Experiment 2 (left) and the antagonistic social induction in Experiment 3 (right). (**B**) Happy (top) and sad (bottom) test trials in the affiliated (left) and antagonistic (right) blocks. (**C**) Infants' looking time is plotted in seconds (statistical tests were performed on log-transformed data). Connected black dots represent an individual infant's average looking to the two trial types within each block. The means and standard errors are plotted in white. *$p<0.05$, ***$p<0.001$.

aggressively while trying to move across the screen in opposing directions. This sort of conflict has been used in prior studies investigating infants' understanding of dominance [55,56], though in this case the contest was not resolved and both characters turned and exited the screen on the side they entered from. In the goal familiarization and test trials of each block, one member of the relevant pair observed the other member successfully jump over the wall. In test trials, the observer alternated between responding happily or sadly to the jumper's success.

In the affiliated block, we found for the third time that infants expected the observer to be happy following a friend's success ($F(1,60)=11.724$, $p=.001$, $\eta^2=0.054$). In the antagonistic block, when the observer watched the antagonistically-related jumper, infants' looking times did not differ reliably, providing no evidence for an expectation of vicarious happiness ($F(1,60)=0.004$, $p=.953$, $\eta^2=0.000$; Bayesian analyses provided strong evidence in favor of the null hypothesis, $BF_{01} = 19.39$, see SM). Across blocks, there was a significant interaction between trial type (happy vs sad) and block type (affiliated vs. antagonistic), indicating that infants' vicarious emotion expectations were affected by the social relationship context ($F(1,60)=7.101$, $p=.010$, $\eta^2=0.015$). Thus, in this final experiment, information about social relationships did reliably impact infants' expectations about vicarious emotions.

Discussion

In three experiments, we found that infants expect others to be happy when their friends succeed. In contrast, infants did not hold the same expectations for an observer's emotions when a friend failed or when an adversary succeeded. This supports the conclusion that, in the context of positive outcomes, infants understand a central social phenomenon: Our emotions are impacted not just by our own experiences but by those of others, in accordance with our relationships to them.

These data are consistent with infants' possession of a rich intuitive theory of psychology. In the same way that people use concepts about objects and their properties to make predictions about physical outcomes (e.g., that an object pushed off a supportive surface will fall), infants use knowledge of actors' goals and relationships to make predictions about their emotional states (e.g., that friends may be happy for each other's success). Infants in our experiments did not expect the observers to always match the actor's own outward emotional response, regardless of their relationship to the actor. Instead, infants considered the strength and valence of individuals' relationships while appraising an outcome. This pattern of findings is best explained by theory-like psychological inferences [46,62], rather than heuristic expectations of emotional contagion [61,63]. In sum, the present findings suggest that human infants reason about the social world using a framework that integrates an understanding of individual mental states with concepts of social relationships between agents.

Although we take no position on whether this intuitive theory accurately captures the psychological processes that give rise to vicarious emotions, it is aligned with accounts of selective or motivated empathy in which the degree of empathy one person feels for another will be moderated by their relationship and their appraisal of the other's circumstances [2,4 6,8,64]. The results are also consistent with other research on the development of ingroup favoritism [65–67]. Infants and children expect others to help, share with, and defend those they are affiliated with over those they are not [51,68–71]; the current research extends evidence for this expectation of social bias into the realm of emotions. These expectations may be normative as well as

descriptive. There is some evidence that young children value loyalty and find it permissible to harm outgroup individuals [72–74]. Future research should investigate if infants and young children negatively evaluate an observer who does not empathize with a friend, but refrain from judging one who does not empathize with an outgroup member. Further, under this intuitive theory, individuals may also be able to reason about relationships by observing others' vicarious emotions and make more complex inferences such as predicting how an affiliate feels when they possess information their friend or rival does not.

Our findings also raise several additional questions. First, research with other populations is necessary to test if these results generalize beyond middle class infants from the United States. Second, what explains infants' expectation of vicarious happiness for a non-affiliated actor (Expt.2)? Infants may have a default expectation of prosocial concern, only abandoned in clearly negative relationships. Third, infants did not expect the observer to be sad when an antagonist succeeded. Does this reflect a lack of expectations for the sorts of counter-empathic emotions observed in adults (i.e. schadenfreude, gluckschmerz)[1,2,5,67]? Or does it reflect a broader uncertainty about negative emotions, also found in the failure block of Experiment 1? Infants may also have expected a different negative emotion, such as anger or frustration, to follow failure, rather than sadness. However, infants' lack of clear vicarious emotion expectations following failure is in line with their inconsistent expectations about emotional responses to direct negative experiences [34,35]. This contrast with their relatively well-developed expectations about positive emotional responses begs explanation [35,36]. Finally, future work should explore the development of understanding social sources of mixed emotions. Friends' goals can conflict with our own, and it remains unclear how children reason about emotions in such cases.

These findings also have implications for the way infants and young children learn from and participate in social interactions. Infants use caregivers' expressed emotions to guide their behaviors in new and potentially dangerous situations [75,76]. Such social referencing suggests that infants, like older children and adults, use emotions as a vital source of information about the world [10]. The current results expand the circumstances under which infants are likely to learn from emotions. On one hand, if infants are aware of the relationship between an actor and observer (e.g. their sibling and parent) they may use the observer's responses to the actor's experiences to infer which outcomes or objects are good or bad. Alternatively, if infants do not know the relationship between two people, they may be able to use vicarious emotional responses as a basis for inference. When participating in social interactions, the knowledge that social affiliates tend to celebrate one another's success may support children's own expressions of vicarious happiness toward friends and family; this shared positive affect plays an important role in maintaining close relationships throughout the lifespan [17,77].

In sum, these experiments add to a growing field on early emotional development and how it supports infants' and children's ability to engage in and learn from social interactions [10,17,78]. In addition, testing infants' ability to integrate information about goals and relationships to predict emotions gives insight into the nature of the basic social cognitive capacities that infants use to reason about their social world [79].

Methods

Stimuli for all experiments were created using Blender, a 3D animation program [80]. Participants were tested remotely over Zoom. Stimulus videos were presented using slides.com, an online slideshow hosting website, according to a protocol developed and tested by Smith-Flores and colleagues [81]. Participants were required to participate using a computer with a

webcam. Recruitment and study protocol was approved by the university review board. Caregivers were provided informed consent and a $5 Amazon giftcard was sent for their participation.

An online coder measured infants' looking throughout each experiment. All videos were recoded offline, and these looking times were analyzed; 20% of sessions in each experiment were double-coded to assess reliability. All coders used PyHab [82]. Study sessions began with an animated video of bouncing fish that attracted their attention to the center and sides of the screen to calibrate coders' judgments of infants' gaze. All infant-controlled pauses (e.g., after familiarization events and test trials) ended when the infant looked away from the screen for two consecutive seconds or when 60s had elapsed since coding began. Raw looking time data for all experiments were log-transformed to mitigate issues of skewed distributions[83] and then averaged across the log-transformed trials within each block and trial type. Analyses were performed on these averaged values.

Experiment 1: Complete vs. Failed Goal

The sample size, study design, hypotheses, exclusion criteria, and data analysis plan were preregistered (https://osf.io/5cf3x).

Participants. Thirty 10- to 11-month-old middle-class, U.S. infants participated (M_{age}=10.77 months; *SD*=0.51 months; 16 girls). Data from 3 additional infants were excluded for fussiness. Eighteen infants were identified by their caregiver as White, 4 as Asian, 1 as American Indian/Alaskan Native, 6 were identified as belonging to two or more races, and 1 caregiver declined to answer. Eight infants were identified by their caregiver as Hispanic/Latinx. Twenty-six infants came from families where at least one caregiver indicated having a college degree or higher. The modal screen size across participants was 13 inches (range=11-29 inches). Infants were seated in a highchair (*n*=18) or on their caregiver's lap (*n*=12) for the duration of the study.

Procedure. The study events were arranged in two blocks of trials, each with four phases. The failed goal block was always presented first (see *SM* for justification). All stimulus materials are available at https://osf.io/vrqzp. An example condition of this experiment can be seen in Movie S1.

Emotion familiarization. At the beginning of the first block, infants saw an animated purple ball with eyes, alone on the screen, bounce up and down twice, and then smile while the sound of a child laughing played (Movie S1). Next, infants saw the same purple agent bounce up and down twice, and then frown while the sound of a child crying played. There was an infant-controlled pause after each event; coding began at the onset of the vocal emotion sounds. Infants saw a similar video before the second block that featured a red cone with eyes.

Social induction. Next, a social scene introduced the pair of affiliated agents featured in that block. Two identical agents (purple balls in the first block, red cones in the second) entered from the right side of the screen and looked at each other. One agent wiggled and bounced while the other agent watched (Fig.1A, Movie S1). The other agent copied these movements, and then the agents repeated them in unison. The agents performed this full cycle of movements a second time. Finally, they both looked towards the front before turning to the right and exiting the screen together. The online coder measured infants' looking from the agents' appearance until their exit, but there were no infant-controlled pauses.

Goal familiarization. Infants next saw three events featuring the same two agents. Throughout all events, the "observer" watched the events from a platform in the center of the upper half of the screen (Fig.1B, Movie S1). The "jumper" started each event in the lower left

corner of the screen. In the first event, the jumper bounced twice before moving along the ground to the mat in the lower right corner, i.e. the agent's goal. In the second event there was a low wall between the agent and the goal mat, and the agent jumped over the wall to reach the mat. The third event differed depending on block type. In the "Failed" block, the jumper attempted to jump over a tall wall to reach the mat, but failed and bounced back to its starting position. In the "Complete" block, the jumper successfully made it over the tall wall and reached the mat. There was an infant-controlled pause after each event. The online coder began coding at the sound of an audio cue, signaling that the jumper had completed their action.

Test Trials. Each block ended with two happy and two sad test trials per block. Trials were presented in ABAB order, and whether infants saw the happy or sad emotion test trial first was counterbalanced across participants but held constant across blocks. As in the goal familiarization, test trials began with the jumper in the lower left corner and the observer on the center platform. The outcomes of the test trials were the same as the third goal familiarization: In Failed block trials, the jumper did not make it over the wall, and bounced back to its starting position, while in the Complete block trials, the jumper made it over the wall and reached the mat. Critically, once the jumper completed their action, the observer bounced twice on the platform and then portrayed either a happy or sad emotion via a vocalization and facial expression (Fig.1B, Movie S1). The emotion expressions were the same as those in the Emotion Familiarization. The online coder began coding at the onset of the emotion vocalization. Each test trial ended once when the infant looked away for two consecutive seconds or 60s elapsed since coding began.

Coding. Naive offline coding was not feasible (i.e., block order was fixed, and the failed goal block had a different coding sound than the complete goal block). Intercoder reliability was high, as determined by intraclass coder coefficient (ICC)=0.99, $p<0.001$, 95% CI [0.997, 0.999].

Experiment 2: Affiliated vs. Non-affiliated

The sample size, study design, hypotheses, exclusion criteria, and data analysis plan were preregistered (https://osf.io/5yze3).

Participants. Sixty 10- to 11-month-old middle-class, U.S. infants (M=11.09 months; SD=0.56 months; 32 girls) were included in the sample. Seventeen additional infants were excluded: parent interference (8), low video quality (5), fussiness (3), and preregistered outlier criterion (1). Forty-five infants were identified by their caregiver as White, 7 as Asian, and 8 were identified as belonging to two or more races. Thirteen infants were identified by their caregiver as Hispanic/Latinx. Fifty-eight infants came from families where at least one caregiver indicated having a college degree or higher. The modal screen size across participants was 13 inches (range=11 - 27 inches). Infants were seated in a highchair (43) or on their caregiver's lap (17) for the duration of the study.

Procedure. The procedure matched that of Experiment 1 except where described below. There were once again two blocks of trials, one "Affiliated" block and one "Non-affiliated" block (order counterbalanced), both of which began with the Emotion Familiarization as described above. An example condition of this experiment can be seen in Movie S2.

Social Induction. The social induction video was changed to include three agents: one pair of affiliated purple agents and a lone red agent (Fig.2A, Movie S2). First, the purple agents performed the same affiliative "dance" as in the Experiment 1 social induction. After a several second pause, the red agent then performed the same dancing movements on its own, without looking to the purple agents. Then the affiliated purple agents looked at each other and exited to

the right, away from the red agent. Finally, the red agent exited to the left. This same social induction was played in each block.

Goal Familiarization. Goal familiarization in both blocks matched that of Experiment 1's complete block. The observer was always one of the two purple agents. In the Affiliated block the jumper was the second purple agent, while in the Non-affiliated block the jumper was the red agent.

Test Trials. Test trials proceeded as in Experiment 1's complete block (Fig.2B, Movie S2), with the observer responding to the jumper's successful jumps with a happy or sad expression, alternating across trials.

Coding

Offline coders were naïve to block type. Intercoder reliability was high, ICC=0.93, $p<0.001$, 95% CI [0.88, 0.96].

Experiment 3: Affiliated vs. Antagonistic

The sample size, study design, hypotheses, exclusion criteria, and data analysis plan were preregistered (https://osf.io/qf4nh).

Participants. Sixty-four 10- to 11-month-old middle-class, U.S. infants participated (M_{age}: 10.92 months; SD=0.52 months; 29 girls). Data from 15 additional infants were excluded for interference (7), technology errors (3), video quality (3), fussiness (1), and using an incompatible testing device (1). Forty-four infants were identified by their caregiver as White, 7 as Asian, 1 as Black, 11 were identified as belonging to two or more races, and 1 declined to answer. Thirteen infants were identified by their caregiver as Hispanic/Latinx. Fifty-nine infants came from families where at least one caregiver indicated having a college degree or higher. The modal screen size across participants was 13 inches (range=12 - 27 inches). Infants were seated in a highchair (52) or on their caregiver's lap (12) for the duration of the study.

Procedure. All aspects of Experiment 3 matched Experiment 2 except for the Social Induction. Two different social induction scenes in the two blocks resulted in an Affiliated block and an Antagonistic block (order counterbalanced). An example condition of this experiment can be seen in Movie S3.

Social Induction. In the social induction from the Affiliated block, infants saw the same social induction featured in Experiment 1, with two purple ball characters performing a matching, synchronized dance. In the social induction from the Antagonistic block, a purple ball agent entered the screen from the right side and paused (Fig.2A, Movie S3). Then a red cone agent entered from the left side and paused. The two agents approached each other and collided four times, accompanied by a thudding sound effect, before turning away from each other and exiting the screen from the sides they entered.

In the Affiliated block, the two purple characters went on to play the roles of the observer and jumper in goal familiarization and test trials. In the Antagonistic block, the purple character went on as the observer, and the red character was the jumper. All jumps were successful, and in test trials the observer reacted with alternating happy and sad responses.

Coding

Intercoder reliability was high, ICC=0.95, $p<0.001$, 95% CI [0.93, 0.97].

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Data and materials availability: All data, code, and materials used in the analysis are available on OSF: https://osf.io/vrqzp.

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Supplementary Material

Experiment 1

Procedure

The order of trial types in the test phase of each block (happy or sad first) was counterbalanced across participants, but the order of blocks was not: the failed goal block always came first. This choice was motivated by data from Experiment 2 (which was conducted prior to Experiment 1), which showed a stronger expectation of observer happiness in the first block of test trials than the second block (see below). To maximize our chances of finding that infants simply expected observers to emote positively toward friends, falsifying our hypothesis of vicarious emotions based on the friend's goal outcome, we thus opted to test all infants in a failed block-complete block order.

Cross-Block Analyses

As reported in the main text, we used repeated measures ANOVA to compare infants' looking to the happy and sad responses in both the completed and failed blocks with test order (happy or sad first) as a between-subjects factor (Fig.1C, see Table 1 for looking times), which yielded a significant interaction between trial type and block type, $F(1,28)=5.813$, $p=.023$, $\eta^2=0.028$. (There was also a main effect of trial type, $F(1,28)=10.351$, $p=.003$, $\eta^2=0.081$ – infants looked longer at the sad response, overall). Follow up post-hoc paired-samples *t*-tests with Bonferroni adjustments found that infants looked longer at the sad response than the happy response in the complete block, $t(29)=4.269$, $p<.001$, 95% CI [0.099, 0.281], $d=0.779$, but did not do so in the failed block, $t(29)=1.071$, $p=.293$, 95% CI [-0.048, 0.152], $d=0.196$. There was also a main effect of block type, $F(1,28)=8.938$, $p=.006$, $\eta^2=0.077$ – looking was greater in the failed block, which came first – and test order, $F(1,28)=5.263$, $p=.029$, $\eta^2=0.064$ – looking was greater when the negative response was presented first. There were no other interactions, all $Fs<1.153$, $ps>.292$.

Individual Block Analyses

Complete Goal. We conducted a preregistered repeated measures ANOVA using only average, log-transformed looking times from the complete block and test order as a between-subjects factor. As reported in the main text, there was a main effect of trial type, $F(1,28)=17.655$, $p<.001$, $\eta^2=.236$ – looking was greater during the sad response. There were no other main effects or interactions, all $Fs<1.962$, $ps>.172$.

Failed Goal. We conducted a preregistered repeated measures ANOVA using only average, log-transformed looking times from the failed block and test order as a between-subjects factor. As reported in the main text, there was no main effect of trial type. There were also no other significant main effects or interactions, all $Fs<4.170$, $ps>.051$.

Experiment 2

Procedure

Block order (affiliated or non-affiliated first) and test order (happy or sad first) were orthogonally counterbalanced across participants.

Cross-Block Analyses

We compared infants' looking to the happy and sad responses in both the affiliated and non-affiliated blocks using repeated measures ANOVA with block order and test order as

between-subjects factors (Fig.2C). There was a main effect of trial type, $F(1,56)=24.732$, $p<.001$, $\eta^2=0.069$ – overall, infants looked longer at the sad response – and a main effect of block type, $F(1,56)=5.020$, $p=.029$, $\eta^2=0.017$ – infants looked longer during the affiliated block than the non-affiliated block (even though order was counterbalanced). There was also an interaction between block order and block type, $F(1,56)=33.017$, $p<.001$, $\eta^2=0.101$ – infants looked longer overall at the block type that they saw presented first. The interaction between trial type and block type was not statistically significant, $F(1,56)=2.881$, $p=.095$, $\eta^2=0.008$.

First Block Only Analyses

This was chronologically the first experiment run, and because we were initially unsure whether infants would provide reliable data across two blocks of trials, we preregistered main confirmatory analyses on the first block only. For the first block of trials, infants assigned to the affiliated block looked at the happy response for 9.07s (*SD*=3.98s) and the sad response for 11.50s (*SD*=3.81s) on average, while infants assigned to the non-affiliated block looked at the happy response for 8.77s (*SD*=3.92s) and the sad response for 10.64s (*SD*=4.77s).

Affiliated First Block. We ran a preregistered repeated measures ANOVA on infants' log-transformed looking times to happy and sad test trials during the affiliated block for infants assigned to view the affiliated block first, with test order (happy first vs. second) as a between-subjects factor. As predicted, there was a significant main effect of trial type, F (1,28)=11.987, $p=.002$, $\eta^2=.101$, such that infants looked significantly longer at the sad response. There was no effect of test order nor an interaction between test order and trial type, Fs<0.335 and all ps>.568.

Affiliated and Non-Affiliated First Block. To test whether infants' emotion expectations differed by observer-jumper affiliation, we ran another preregistered repeated measures ANOVA including first-block data from both block types, with block type (affiliated vs. non-affiliated) as an additional between-subjects factor. There was a significant main effect of trial type, $F(1,56)=15.856$, $p<.001$, $\eta^2=.087$ – infants looked longer at sad responses compared to happy ones. The trial type x block type interaction did not reach statistical significance $F(1,56)=.159$, $p=.692$, $\eta^2=.001$. No other main effects or interactions were observed, all Fs<3.839, ps>.056.

Second Block Only Analyses

When examining data from each infant's first block only, we noticed that looking times across block types were even more similar than in the aggregate data. This prompted an exploratory analysis of data from the second block only. A repeated measures ANOVA on data from the affiliated block when administered second, with test order as a between-subjects factor, again showed a main effect of trial type ($F(1,28)=10.725$, $p=.003$, $\eta^2=.130$) – infants looked longer at sad responses compared to happy ones. The same analysis on data from the non-affiliated block when administered second did not show a main effect of trial type ($F(1,28)=1.048$, $p=.315$, $\eta^2=.009$) . When entered into a joint repeated measures ANOVA, there was a main effect of trial type ($F(1,56)=10.221$, $p=.002$, $\eta^2=.054$) and a marginal interaction between block type and trial type ($F(1,56)=3.681$, $p=.060$, $\eta^2=.020$).

Affiliated Block Only Analysis

An additional repeated measures ANOVA on infants' looking to the happy and sad responses during the affiliated block as a within-subjects factor with test order and block order as between-subjects factors was conducted to determine if infants' expectations of affiliated characters' responses diminish during a multiblock experiment. There was a main effect of trial

type, $F(1,56)=22.140$, $p<.001$, $\eta^2=0.116$ – infants looked longer at the sad response. There was also a main effect of block order, $F(1,56)=7.378$, $p=.009$, $\eta^2=0.081$ – infants looked longer at the affiliated block when it was presented first. There were no other main effects or interactions, all $Fs<1.1399$, $ps>0.242$.

Experiment 3

Procedure

Block order (affiliated or antagonistic first) and test order (happy or sad first) were orthogonally counterbalanced across participants.

Cross-Block Analyses

We compared infants' looking to the happy and sad responses in both blocks using repeated measures ANOVA with block order and test order as between-subjects factors. As reported in the main text, there was a significant interaction between trial type and block type, $F(1,60)=7.101$, $p=.010$, $\eta^2=0.015$. (There was also a main effect of trial type, $F(1,60)=6.793$, $p=0.012$, $\eta^2=0.014$). Follow-up post-hoc paired-samples *t*-tests with Bonferroni adjustments found that infants looked longer at the sad response than the happy response in the affiliated block, $t(63)=3.479$, $p<.001$, 95% CI [0.048, 0.176], $d=0.435$, but did not do so in the antagonistic block, $t(63)=-0.060$, $p=.953$, 95% CI [-0.056, 0.052], $d=0.007$. Infants also looked longer at the happy outcome in the antagonistic block compared to the affiliated block, $t(63)=2.796$, $p=.007$, 95% CI [0.029, 0.172], $d=.350$, but looking to the sad outcome was not different across the two block types, $t(63)=-0.324$, $p=.747$, 95% CI [-0.094, 0.068], $d=0.041$.

There was also an interaction between block order and block type, $F(1,60)=36.150$, $p<.001$, $\eta^2=0.102$ – infants looked longer overall at the block type that they saw presented first. There were no other main effects or interactions, all $Fs<2.853$, $ps>.096$.

Affiliated Block Only Analysis

An additional repeated measures ANOVA on infants' looking to the happy and sad responses during the affiliated block as a within-subjects factor with test order and block order as between-subjects factors was conducted to determine if we replicated our findings from the previous two experiments. As reported in the main text, there was a main effect of trial type, $F(1,60)=11.724$, $p=.001$, $\eta^2=0.054$ – infants again looked longer at the sad response compared to the happy response. There was also a main effect of block order, $F(1,60)=7.501$, $p=.008$, $\eta^2=0.081$ – infants looked longer overall when the affiliated block was presented first. There were no other main effects or interactions, all $Fs<0.843$, $ps>.362$. These results replicate our findings from the previous two experiments' affiliated blocks.

Antagonistic Block Only Analysis

An additional repeated measures ANOVA on infants' looking to the happy and sad responses during the antagonistic block as a within-subjects factor with test order and block order as between-subjects factors was conducted to explore infants' reasoning about antagonistic relationships. The was a main effect of block order, $F(1,60)=11.011$, $p=.002$, $\eta^2=0.126$ – infants looked longer at the antagonistic block when it was presented first. As reported in the main text, there was no main effect of trial type, $F(1,60)=0.004$, $p=.953$, $\eta^2=0.000$ – infants' looking times did not distinguish between the happy and sad responses in the antagonistic block. There were no other main effects or interactions, all $Fs<2.394$, $ps>.127$. These results suggest that infants did

not have clear expectations about how observers will respond to the goal completion of anti-affiliated others.

To provide support for the null hypothesis in the antagonistic block (i.e. no difference in looking to happy vs. sad responses), we conducted a Bayesian one-sample t-test on proportional difference scores (i.e. looking to the sad outcome – looking to the happy outcome/total looking). Based on data from the affiliated conditions, we defined the alternative hypothesis with an effect size of d = 0.6 and a scale of .707. The outcome, BF_{01} = 19.39, provided strong support for the conclusion that our data reflected a true lack of difference in looking to the two trial types.

Emotion Familiarization: All Experiments

One factor that could have motivated increased looking to sad responses compared to happy responses is that infants may attend more to sad responses because they perceive sad vocalizations as more salient or containing more information about the world. If this is true, then infants during each experiment's emotion familiarization should have looked longer at the sad familiarization compared to the happy familiarization. However this was not true for Experiment 1 ($t(29)=-1.686$, $p=.103$, 95% CI [-0.134, 0.013], $d=0.308$), Experiment 2 ($t(59)=0.678$, $p=.500$, 95% CI [-0.065, 0.131], $d=0.088$), or Experiment 3 ($t(63)=-1.106$, $p=.102$, 95% CI [-0.106, 0.010], $d=0.207$) – there was no evidence that infants in any of the three experiments looked longer at sad responses in the emotion familiarization events, when they were presented without the context of a completed goal.