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RESEARCH ARTICLE

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

Alexis S. Smith-Flores | Isabel A. Herrera-Guevara | Lindsey J. Powell

Department of Psychology, University of California, San Diego, 9500 Gilman Dr., La Jolla, California, USA

Correspondence
Alexis S. Smith-Flores, Department of Psychology, University of California, San Diego, 9500 Gilman Dr., La Jolla, CA 92093, USA.v
Email: alexis-smith@ucsd.edu

Abstract

A friend telling you good news earns them a smile while witnessing a rival win an award may make you wrinkle your nose. Emotions arise not just from people's own circumstances, but also from the experiences of friends and rivals. Across three moderated, online looking time studies, we asked if human infants hold expectations about others' 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; infants looked longer at the sad response compared to the happy response. In contrast, infants did not expect the observer to be happy when the friend failed, nor when a different, rival jumper succeeded; infants' looking times to the two emotion responses in these conditions were not reliably different. These results suggest that infants are able to integrate knowledge across social contexts to guide expectations about vicarious emotional responses. Here infants connected an understanding of agents' goals and their outcomes with knowledge of social relationships to infer an emotion response. 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. Further, the successful integration of these information types welcomes the possibility that infants can jointly reason about goals, emotions, and social relationships under an intuitive theory of psychology.

KEYWORDS
infants, social affiliation, vicarious emotions

RESEARCH HIGHLIGHTS

- 11-month-old infants use knowledge of relationships to make inferences about others' vicarious emotions.
- In Experiment 1 infants expected an observer to respond happily to a friend's success but not their failure.

- Experiments 2 and 3 varied the relationship between the observer and actor and found that infants' expectation of vicarious happiness is strongest for positive relationships and absent for negative relationships.
- The results may reflect an intuitive psychology in which infants expect friends to adopt concern for one another's goals and to thus experience one another's successes as rewarding.

1 | INTRODUCTION

Humans are capable of remarkable empathy toward others, but we apply this capacity selectively. Friends celebrate one another's good news and mourn one another's losses. In contrast, empathy for strangers is often weaker or absent (Bloom, 2017; Zaki, 2014). When it comes to enemies, we can even be delighted by their pain or saddened by their success (Cikara et al., 2011; Smith et al., 2009). These vicarious emotions (i.e., emotional responses to others' experiences) motivate a spectrum of social behaviors from altruism to violence (Batson, 2011; Bruneau et al., 2017).

These features of vicarious emotions make them a potential source of valuable social information (Van Kleef et al., 2004; Wu et al., 2021). Vicarious emotions could be used to infer the existence and strength of social relationships, or to predict prosocial and antisocial actions. Relationships and actions could, in turn, be used to infer likely vicarious emotions. Do people incorporate vicarious emotions into systematic social cognitive inference? If so, how? Some evidence suggests that adults do reason about vicarious emotions. Adults judge those who empathize with others' struggles as kinder and more worthy of respect than those who do not, unless they are empathizing with morally suspect targets (Hareli & Hess, 2010; Wang & Todd, 2021). People use emotional empathy to assess the strength of their own relationships (Gable et al., 2012; Morelli et al., 2015). And expectations of empathy in others are correlated with the likelihood of help seeking (Bohns & Flynn, 2021).

There are several gaps in what we know about people's understanding of vicarious emotions, however. First, there is little work on the developmental trajectory of reasoning about vicarious emotions. Second, there is no account of what kind of concepts or representations people use to reason about vicarious emotions at any age. Here we suggest that systematic reasoning about vicarious emotion could be accomplished by an intuitive theory of psychology that integrates concepts of affiliation, reward, and emotions, and we test if such an intuitive psychology already supports reasoning about vicarious emotions by human infants.

Intuitive theories specify causal relationships between related concepts, allowing observers to use partial information to make inferences and predictions that can guide behavior (Gerstenberg & Tenenbaum, 2017; Wellman & Gelman, 1992). Intuitive psychology is an intuitive theory that supports reasoning about other people through connections between concepts of dynamic, internal mental states (e.g. beliefs, desires emotions), stable but abstract social characteristics (e.g. relationships, temperament), and behavior (Gopnik & Wellman, 1992; Jara-Ettinger et al., 2016).

When reasoning using intuitive psychology, an observer expects an agent's own experiences to cause emotional responses (Ong et al., 2015; Wu et al., 2021). Exactly what emotional response the observer expects is based on an understanding of how the agent will appraise their experiences relative to their beliefs and desires (Ong et al., 2019; Saxe & Houlihan, 2017). Observers expect desired outcomes (i.e., "rewards") that meet or exceed expectations to lead to positive emotions, whereas outcomes that deliver losses or less reward than expected are thought to lead to negative emotions (Ong et al., 2015).

Intuitive psychology also encompasses concepts of relationships or affiliation between agents. Here we refer to the general class of positively affiliated individuals as "friends" (though see the Discussion for consideration of more specific relationship types). Concepts of prosocial relationships entail that friends adopt concern for one another's goals and welfare (Afshordi & Liberman, 2021; Powell, 2022; Rhodes, 2013). In other words, if two agents are friends, each one is expected to desire that the other experiences rewarding outcomes rather than failure or harm. Given these vicariously adopted desires, observers may infer that each agent's appraisals and emotions should be impacted by their friend's successes or failures, in addition to their own (Smith-Flores & Powell, 2023; Wondra & Ellsworth, 2015). In contrast, rivals do not adopt one another's goals, and thus one rival should not be expected to share another's positive appraisal and emotions following successful outcomes.

This intuitive psychology is one of several alternative possibilities for how infants and young children may develop an understanding of vicarious emotions. Research on early social cognition finds that infants have both concepts of relationships that involve expectations of adopted concern for others' goals, and concepts of emotions that relate emotions to the events and appraisals that cause them. For example, in their first two years of life infants expect individuals who share goals or preferences to affiliate (Liberman et al., 2018; Powell & Spelke, 2018), and expect positively affiliated individuals to promote one another's interests (Bian et al., 2018; Pun et al., 2021). Infants around this age also hold expectations regarding people's emotional responses to their own positive and negative experiences (Chiarella & Poulin-Dubois, 2013; Ruba et al., 2019; Skerry & Spelke, 2014; Wu et al., 2017). In sum, infants seem to possess concepts of affiliative relationships and of emotions that could be integrated via reference

to a common concept of desire or reward, but whether or not these concepts are integrated is an open empirical question.

Alternatively, infants' understanding of vicarious emotion could be based on their own experience. Newborns demonstrate emotional contagion, exhibiting signs of distress when they hear another baby cry, though this may reflect a typical response to an aversive stimulus (Sagi & Hoffman, 1976). Older infants show concern for individuals in distress and attempt to help and comfort them (Davidov et al., 2021; Roth-Hanania et al., 2011; Svetlova et al., 2010; Zahn-Waxler et al., 1992). By 18 months of age, these expressions of concern are motivated by others' circumstances and are not restricted to people who are overtly sad (Hepach et al., 2013; Vaish et al., 2009). However, sad expressions do elicit substantially more concern from toddlers, and infants under 18 months are less likely to express concern based on circumstance alone (Chiarella & Poulin-Dubois, 2013; Vaish, 2016). On balance, these data suggest that if infants nearing their first birthday were to use their own vicarious emotions to predict others', then they may only expect concern in response to another's overt sadness, and it is not clear how knowledge of social relationships could affect these expectations.

One final possibility is that infants may expect emotion matching between others, especially friends. This expectation could be based on the belief that positively affiliated individuals share behaviors and preferences (Liberman et al., 2014; Powell & Spelke, 2013). In this case, infants would primarily expect a positively affiliated observer to express emotions that match those of a target (e.g., to laugh when the target laughs or cry when the target cries).

1.1 | Current studies

If infants use intuitive psychology to reason about others' vicarious emotions, we can make several predictions that contrast with the two alternative accounts laid out above. First, infants should expect agents to have emotional responses to others' outcomes, but these expectations should not depend on expression 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, 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 (Johnson et al., 2007; Powell, 2022; Pun et al., 2021). 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.

We tested these predictions in three preregistered experiments with 10- and 11-month-old infants. Our experiments adapted an experimental protocol for showing that infants expect an actor to be happy about their own success (Skerry & Spelke, 2014). These studies showed infants an animated character repeatedly attempting to jump over a wall. In separate blocks of test trials, the jumper either succeeded or failed; within blocks and across test trials, the jumper reacted with either happiness or sadness to the outcome. In the original studies, in blocks of successful outcomes infants expected the jumper to be happy and looked longer when the jumper expressed sadness instead. In blocks of failed outcomes, infants' looking did not indicate a clear expectation of sadness or happiness.

We modified these studies by introducing an observer who watched the jumper's attempts, and then was the one to respond emotionally to the jumper's outcomes. The jumper did not display a reaction to any outcome, though infants could readily infer its goal from its repeated jumping attempts (Csibra et al., 2003; Liu et al., 2017). In addition, we added introductory scenes at the beginning of the experiment that used either matching and synchronized behaviors (Liberman et al., 2018; Powell & Spelke, 2013) or physical conflict (Thomas & Sarnecka, 2019; Thomsen et al., 2011) to convey either a positive or negative relationship, respectively, between the jumper and the observer. Based on Skerry and Spelke's previous findings and the intuitive psychology proposed above, we hypothesized that infants would expect an observer to be happy following the success of a friend, but not following the friend's failure nor following the success of a rival.

2 | EXPERIMENT 1: COMPLETE VS. FAILED GOAL

In Experiment 1 ($N = 30$), we sought to examine infants' understanding of vicarious emotions in the context of positive relationships. 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 Figure1A) acting in four phases.

2.1 | Methods

2.1.1 | 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 three additional infants were excluded for fussiness. Eighteen infants were identified by their caregiver as White, four as Asian, one as American Indian/Alaskan Native, six were identified as belonging to two or more races, and one 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. For this and all subsequent experiments recruitment and study protocol was approved by the university review board. Caregivers provided informed consent and a $5 Amazon gift card was sent for their participation.

2.1.2 | Materials

In all of our experiments, 10- and 11-month-old infants watched 3D animated displays featuring geometric shape characters with faces

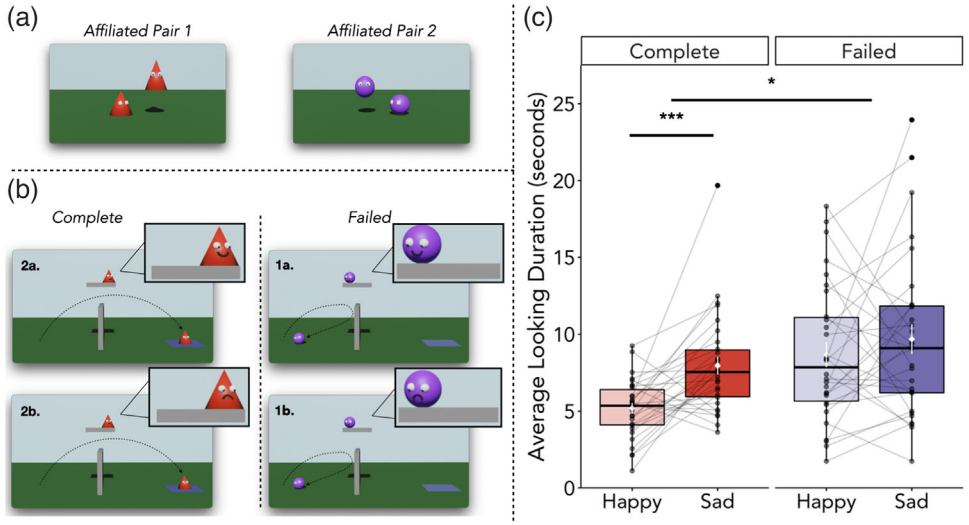

FIGURE 1 Stimuli and results of Experiment 1. (A) Images from affiliated social induction in Experiment 1 (left and right). (B) Happy (top) and sad (bottom) trials in the complete (left) and failed (right) blocks. (C) Infants' looking time plotted in seconds (statistical tests were performed on log-transformed 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. $^{*}p < 0.05$, $^{***}p < 0.001$.

(Kominsky et al., 2022). Stimuli for all experiments were created using Blender, a 3D animation program. 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 et al. (2022). Participants were required to participate using a computer with a webcam.

2.1.3 | Procedure

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. The subsequent events were arranged in two blocks of trials, each with four phases, for a total of 20 trials presented to each infant. The failed goal block was always presented first because previously collected data suggested that trial type effects might be strongest in the first block, and we wanted to maximize the chances of disconfirming our hypothesis (see SM for additional details). An example condition of this experiment can be seen in Movie S1. 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.

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 similar events at the beginning of the second block, featuring 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 (Figure 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 (Figure 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 (Figure 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.

We preregistered exclusion criteria in all experiments. We dropped trials prior to any analysis during coding for technology problems (i.e., apparent video lag), interference by a parent, sibling, or pet, fussiness, or inattention to the stimuli (i.e., failure to meet the preregistered minimum looking time) (see SM and Table S1 for additional information). Once data was coded and cleaned, we ran a preregistered outlier analysis to remove any individual trials that were 2.5 standard deviations above or below the mean of their same type (i.e., affiliated happy trials in the first block, etc.).

2.1.4 | Coding

All coders used PyHab (Kominsky, 2019). An online coder measured infants' looking throughout the experiment. All videos were recoded offline, and these looking times were analyzed; 20% of sessions in each experiment were double-coded to assess reliability. Intercoder reliability was high, as determined by intraclass coder coefficient (ICC) = 0.99, $p < 0.001$, 95% CI [0.997, 0.999]. 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). Fewer than 4% of test trials were excluded, all based on the preregistered criteria (see SM).

2.1.5 | Data analysis

Raw looking time data for all experiments were log-transformed to mitigate issues of skewed distributions (Csibra et al., 2016) and then averaged across the log-transformed trials within each block and trial type. Analyses were performed on these averaged values. Following our preregistered plans, we conducted separate repeated measures ANOVAs on each of the two blocks, with test trial order as a between–subjects factor in each, as well as a repeated measures ANOVA combining data from both blocks (again with trial order as a between–subjects factor) in order to test for an interaction between test trial type and block type (see https://osf.io/vrqzp for data and code used in data analysis).

We also conducted non-preregistered analyses on the data from both blocks using nested comparisons of mixed-effect linear regression models to test if any observed findings were robust when accounting for participant-level variance in looking time (random intercepts) or effect sizes (random slopes for trial type and block type; see SM). We did the same for subsequent experiments. In all cases, the results of these analyses provide the same or more support for our preregistered hypotheses, relative to the ANOVA results reported below. The results of these exploratory analyses are reported in the supplementary materials.

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

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)
	Antagonistic	9.72s (5.02s)	9.59s (5.12s)

2.2 | Results

In the completed goal block infants 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 ($F(1,28) = 17.655$, $p < 0.001$, $\eta^2 = 0.236$; Figure 1C; see Table 1 for looking times). In the failed goal block infants' looking to the observer's happy versus sad responses did not differ reliably ($F(1,28) = 1.127$, $p = 0.297$, $\eta^2 = 0.012$). There was a statistically significant test trial type x block type interaction, reflecting a reliable difference in looking patterns to happy vs. sad trials across the completed goal and failed goal blocks ($F(1,28) = 5.813$, $p = 0.023$, $\eta^2 = 0.028$).

2.3 | Discussion

Experiment 1 found that infants expect an observer to have a happy reaction to their friend's success, but do not have clear expectations of either observer happiness or sadness following the friend's failure. These expectations for vicarious emotions in both blocks matched prior work on infants' expectations for the jumper's emotional responses to their own successes and failures (Skerry & Spelke, 2014). 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 (Dezecache et al., 2015; Sagi & Hoffman, 1976); 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. These initial results are thus consistent with our proposal of an intuitive psychology that integrates concepts of affiliation and emotion.

3 | EXPERIMENT 2: AFFILIATED VS. NON-AFFILIATED

Though the results of Experiment 1 are consistent with our proposed intuitive psychology, they may reflect a simple expectation for positive emotional responses following 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.

3.1 | Methods

3.1.1 | 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, seven as Asian, and eight 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.

3.1.2 | Materials and procedure

The materials and procedure matched those 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). In this experiment we only showed infants one pair of Emotion Familiarization events, for a total of 18 trials presented to each infant. 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 (Figure 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 (Figure 2B, Movie S2), with the observer responding to the jumper's successful jumps with a happy or sad expression, alternating across trials. Trial exclusion criteria were the same as Experiment 1.

3.1.3 | Coding

Offline coders were naïve to block type. Intercoder reliability was high, ICC = 0.93, $p < 0.001$, 95% CI [0.88, 0.96]. Fewer than 1% of test trials were excluded, all based on the preregistered criteria (see SM).

3.1.4 | Data analysis

As in Experiment 1, raw looking times were log transformed and averaged across trials of a given trial type before data analysis. Following our preregistered analysis plan, we compared infants' looking to the happy and sad responses using three repeated measures ANOVAs (affiliated block only, non-affiliated block only, and combined blocks) with block order and test order as between-subjects factors (see https://osf.io/vrqzp for data and code used in data analysis).

3.2 | Results

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 ($F(1,56) = 22.140$, $p < 0.001$, $\eta^2 = 0.116$; Figure 2C). When the observer watched a non-affiliated jumper succeed, infants also expected happiness, looking longer at the sad response ($F(1,56) = 5.88$, $p = 0.019$, $\eta^2 = 0.032$). The size of the effect of trial type was somewhat smaller in the non-affiliated jumper block than in the affiliated jumper block, but there was not a statistically significant interaction between the effects of trial type (happy vs. sad) and block type (affiliated vs. non-affiliated) on looking ($F(1,56) = 2.881$, $p = 0.095$, $\eta^2 = 0.008$).

3.3 | Discussion

Experiment 2 did not provide strong evidence that social relationship information modulates infants' expectations for vicarious emotions.

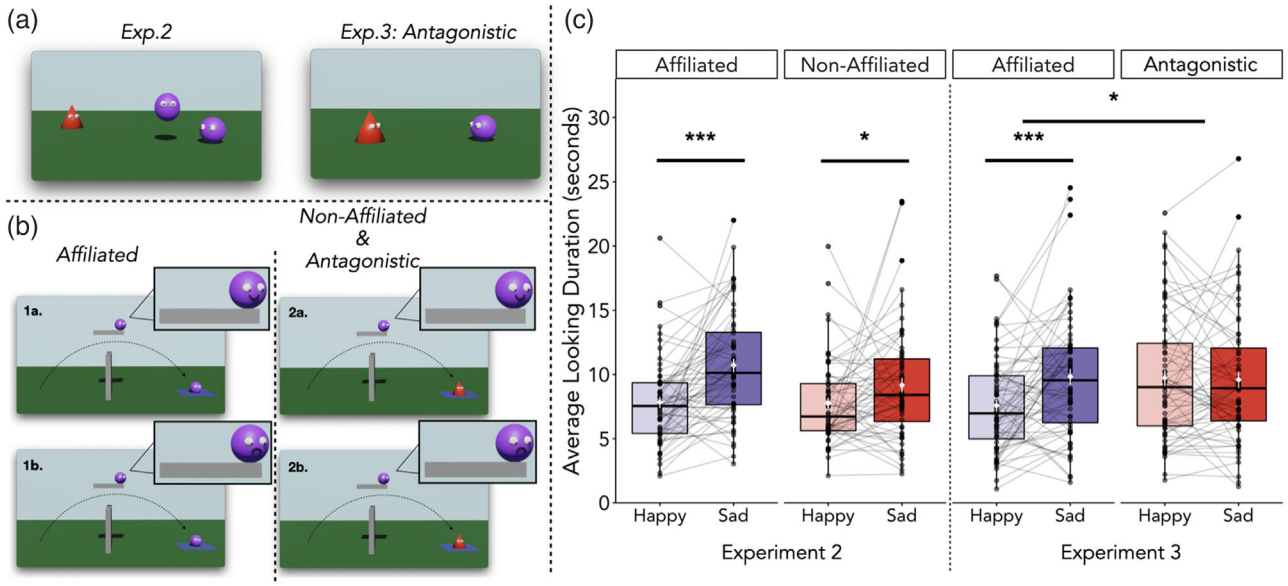

FIGURE 2 Stimuli and results of Experiments 2 and 3. (A) Images from the social induction in Experiment 2 (left) and the antagonistic social induction in Experiment 3 (right). (B) Happy (top) and sad (bottom) test trials in the affiliated (left) and antagonistic (right) blocks. (C) Infants' looking time 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. $^{*}p < 0.05$, $^{***}p < 0.001$.

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.

4 | EXPERIMENT 3: AFFILIATED VS. ANTAGONISTIC

In Experiment 3, we investigated infants' emotion expectations in the context of antagonistic relationships. Previous research on early understanding and evaluation of social dominance has demonstrated that infants can understand conflicts over competing goals (Thomas & Sarnecka, 2019; Thomsen et al., 2011). We employed events similar to those used in dominance studies to convey rivalry between two agents, but we left the conflict unresolved so that infants would not prefer one agent to the other nor have the impression that one individual and their goals were dominant.

4.1 | Methods

4.1.1 | 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, seven as Asian, one as Black, 11 were identified as belonging to two or more races, and one 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.

4.1.2 | Materials and 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) with a total of 20 trials presented to each infant. An example condition of this experiment can be seen in Movie S3.

Social induction

In 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 (Figure 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.

4.1.3 | Coding

Intercoder reliability was high, ICC = 0.95, $p < 0.001$, 95% CI [0.93, 0.97]. Fewer than 3% of test trials were excluded, all based on the preregistered criteria (see SM).

4.1.4 | Data analysis

As in Experiments 1 and 2, raw looking times were log transformed and averaged across trials of a given trial type before data analysis. Following our preregistered analysis plan, we compared infants' looking to the happy and sad responses using three repeated measures ANOVAs (affiliated block only, antagonistic block only, and combined blocks) with block order and test order as between-subjects factors (see https://osf.io/vrqzp for data and code used in data analysis). We additionally ran a non-preregistered post-hoc Bayesian analysis to provide support additional support for our findings.

4.2 | Results

In the affiliated block, we found for the third time that infants expected the observer to be happy following a friend's success ($F(1,60) = 11.724$, $p = 0.001$, $\eta^2 = 0.054$). In the antagonistic block, when the observer watched the antagonistically-related jumper, infants' looking times to the observer's happy and sad responses did not differ reliably, providing no evidence for an expectation of vicarious happiness ($F(1,60) = 0.004$, $p = 0.953$, $\eta^2 = 0.000$; 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 ($F(1,60) = 7.101$, $p = 0.010$, $\eta^2 = 0.015$).

4.3 | Discussion

In this final experiment, information about social relationships did reliably impact infants' expectations about vicarious emotions. Infants' expectations of vicarious happiness in the completed goal/affiliated blocks across all three experiments thus cannot be explained by a general expectation that the valence of outcomes and emotions in a situation will always match. Instead, these results point to an intuitive psychology in which infants use relationships to understand what individuals want (i.e., rewards for friends but not rivals), and use these vicarious desires to inform expectations about vicarious emotions.

5 | GENERAL DISCUSSION

In three experiments, we repeatedly 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 (Baker et al., 2017; Jara-Ettinger et al., 2016), rather than heuristic expectations of emotional contagion (Dezecache et al., 2015; Sagi & Hoffman, 1976). While we have labeled the positively affiliated individuals as "friends" throughout, it is important to note that infants likely are not relying on a concept of friendship that would differentiate it from other positive relationships. Future research should characterize the set of properties infants do believe positive relationships have, and how differentiation into culturally specific relationship types proceeds over the course of development. These relationship types may be associated with more subtly varying strengths or patterns of interpersonal care and vicarious emotion. 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 a basic concept 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 both by their relationship and their appraisal of the other's circumstances (Batson, 2011; Cikara et al., 2011; Wondra & Ellsworth, 2015; Zaki, 2014). The results are also consistent with other research on the development of ingroup favoritism. Infants and children expect others to help, share with, and defend those they are affiliated with over those they are not (Bian et al., 2018; Jin & Baillargeon, 2017; Liberman & Shaw, 2017; Olson & Spelke, 2008; Pun et al., 2021); 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 (Hamlin et al., 2013; Misch et al., 2014; Rhodes & Chalik, 2013). Future research

should investigate if 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.

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 a rival succeeded. Does this reflect a lack of expectations for the sorts of counter-empathic emotions observed in adults (i.e., schadenfreude, gluckschmerz) (Bloom, 2017; Cikara et al., 2011; Smith et al., 2009)? 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 (Ruba et al., 2019; Skerry & Spelke, 2014). This contrasts with their relatively well-developed expectations about positive emotional responses (Skerry & Spelke, 2014; Wu et al., 2017). The differences in expectations following negative outcomes and positive outcomes for rivals also made it difficult to observe a full-crossover interaction in our data, which would have been the clearest evidence in support of our hypotheses. A more thorough exploration and understanding of infants' reasoning about outcomes that are intuitively followed by negative responses is critical to this line of research. 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 (Boccia & Campos, 1989; Sorce et al., 1985). Such social referencing suggests that infants, like older children and adults, use emotions as a vital source of information about the world (Wu et al., 2021). 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 (Denham et al., 2003; Gable et al., 2012).

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 (Denham et al., 2003; Ruba & Pollak, 2020; Wu et al., 2021). 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 (Spelke & Kinzler, 2007).

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

ETHICS STATEMENT

This study was conducted with approval from the UC San Diego Institutional Review Board (Approval #201677, "Infants' and children's understanding of their social and physical world").

DATA AVAILABILITY STATEMENT

All studies were preregistered before data collection began. All research plans (including initial hypotheses and the analysis plan), materials and stimuli, data, and code used in the analysis are available on OSF: https://osf.io/vrqzp/os

ORCID

Alexis S. Smith-Flores https://orcid.org/0000-0002-6755-4986
Lindsey J. Powell https://orcid.org/0000-0001-5142-5998

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