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Vicarious emotion predictions integrate information about relationship strength

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Abstract

It is well-established that people feel empathic and counter-empathic emotions in response to others' experiences. The abilities to predict, interpret, and elicit these emotions help people successfully navigate social interactions. However, we know little about how people understand these vicarious emotions. Here we test the hypothesis that observers use a third-party appraisal approach, much like the one they use for direct emotion inference, to predict vicarious emotions. Critically, though, this reasoning must include information about relationship strength to capture the relevance of one person's experiences for an onlooker's emotional appraisals. We find support for this hypothesis from an experiment in which participants predicted emotions for both the player of a gambling game and an onlooker, whose social closeness to the player varied across trials. A model that integrated closeness information into an appraisal process better explained the data than an alternative model based on expectations of emotional contagion. These results offer initial insights into human reasoning about vicarious emotions.

Keywords: emotions; empathy; counter-empathy; relationships; affective cognition

Introduction

If you think about the last time you were happy, it may have been the result of something good that happened to you. There is also a decent chance, however, that the emotion was caused by witnessing or hearing about something good that happened to a person you care about. Vicarious emotions – emotions that people feel as a result of others' experiences – are ubiquitous. A large body of research investigates when and why people feel vicarious emotions, including both “empathic” emotions that are generally congruent with the experiences and emotions of the person whose experience inspires them and also “counter-empathic” emotions that are generally incongruent with the experiences and emotions of their target (Batson et al., 2002; Cikara, Bruneau, Van Bavel, & Saxe, 2014; Depow, Francis, & Inzlicht, 2021; Preston & De Waal, 2002; Hudson, Cikara, & Sidanius, 2019; Zaki, 2014). Here, we focus on how people *reason about* vicarious emotions. Feelings of empathy and counter-empathy are powerful forces in social life, and understanding when and how they arise is likely an important component of human social competence.

We hypothesize that a key factor observers use to predict vicarious emotions is the relationship between the person experiencing an outcome (a role we will refer to as the “target”) and the person witnessing that outcome (“onlooker”).

We suggest that when those two people have a close relationship, observers understand that the onlooker cares about the target's rewards and welfare, and is thus likely to have an emotional response similar to the target's own response (Smith-Flores & Powell, 2023). When someone earns a promotion at work, it is obvious both that they will be happy about it and that their friends will be happy for them. However, when a target and onlooker are not close, observers will not expect the onlooker to care about the target's welfare nor to feel empathic emotions in response to their experience.

These hypothesized effects are based on a synthesis of existing theories about emotion inference and representations of social relationships. Building on a belief-desire approach to emotion inference, recent work provides substantial evidence that people use a process of third-party appraisal to infer how others will feel in a given situation (Ong, Zaki, & Goodman, 2019; Doan, Ong, & Wu, 2025; Saxe & Houlihan, 2017). Appraisals are evaluations of a situation along motivationally-relevant dimensions, and they have long been hypothesized as the basis for first-person experiences of emotion (e.g., Ellsworth & Scherer, 2003). To engage in third-party appraisal, an observer considers how an event is relevant to the motivational landscape of a target individual and infers the emotions the target is thus likely to be feeling (Ong, Zaki, & Goodman, 2015; Houlihan, Kleiman-Weiner, Hewitt, Tenenbaum, & Saxe, 2023). For example, a parent who does not care about Pokemon cards can nonetheless anticipate that their child, who cares very much about them, will be quite happy to find a special card inside a new pack.

The third-party appraisal framework can be extended such that observers can reason not just about the person experiencing an event but also about *onlookers* witnessing that experience. Given that an onlooker is not directly affected, observers could assume that the event is irrelevant to the onlooker's appraisal and thus will have little effect on their emotions. This changes, however, when considering the relationship between the onlooker and the target they are observing. Research in both economics and psychology finds that people place value on others' rewards and welfare, in addition to their own, and that this value is higher for closer affiliates (Charness & Rabin, 2002; Jones & Rachlin, 2006; Delton & Robertson, 2016). This interpersonal adoption of concern for others' welfare can make one person's outcome a relevant factor in the other person's emotional appraisal of that

outcome (Wondra & Ellsworth, 2015). Moreover, the importance of the outcome for the onlooker's appraisal should increase in proportion to strength of their relationship with the target. Mounting evidence suggests that people's representations of relationships encode this dimension of adopted concern for others' welfare (Quillien, Tooby, & Cosmides, 2023; Qi & Vul, 2022; Powell, 2022). If observers integrate these relationship representations with their process of emotion inference via third-party appraisal, then they should intuitively predict onlookers' vicarious emotions as a joint function of both the value of the situation for a target person and the strength of the relationship between the target and onlooker (Smith-Flores & Powell, 2023).

Although this hypothesis is intuitive, it is also largely untested, especially with adults. Recent research with children and infants finds that they use qualitative differences in relationship categories to guide expectations about vicarious emotions, predicting that friends will be happy for one another's success or good fortune, but that foes will not respond with similar positive empathy (Smith-Flores, Bonamy, & Powell, 2023; Smith-Flores, Herrera-Guevara, & Powell, 2024; Tompkins, Vasquez, Gerdin, Dunham, & Liberman, 2023). These results are consistent with the joint reasoning framework laid out above. It is also possible, however, that children employ category-based heuristics such as "friends cheer each other on" or "foes tend to be jealous of one another," rather than relying on third-party appraisal and graded relationship representations to guide reasoning about vicarious emotions. Testing if smaller parametric variations in onlooker-target relationship strength also impact observers' expectations of vicarious emotions will provide stronger evidence for this model of emotion inference.

There are also viable alternative hypotheses. In particular, observers may tend to think that onlookers simply feel some fraction of what the target feels. Some influential theories of empathy suggest that at the core of this phenomenon is a reflexive tendency to share others' emotions, which can also be referred to as emotional contagion (Hatfield, Rapson, & Le, 2011; Preston & De Waal, 2002; Dezechache, Jacob, & Grèzes, 2015). Whether or not this is the correct account of the processes that give rise to empathy, lay observers may also think that emotional contagion accounts for a large portion of vicarious emotion. If so, then observers may simply recycle the emotions they attribute to the target of an outcome when predicting the vicarious emotions of an onlooker, rather than considering the onlooker's own appraisal of the outcome given their concern for the target. We aim to test this alternative against our account.

The current research employs a paradigm previously used to investigate adults' emotion inferences in the context of directly experienced events (Ong et al., 2015). Each trial features a person playing a gambling game who begins with some expectations about what reward they will win and then experiences an actual reward. The previous research shows that observers' predictions about the player's feelings across a

number of specific emotions (e.g., happiness, sadness, disappointment, and surprise) incorporate trial-by-trial information about multiple appraisal-relevant features, including amount won and the prediction error separating that value from what they thought they would win. Here we extend this paradigm by adding an onlooker to each trial and asking participants to predict both the player's and the onlooker's emotions. Critically, we begin each trial by specifying the relationship between the player and onlooker, varying this value across five steps from somewhat negative to very positive. This design allows us to test the hypothesis that adults predict vicarious emotions by considering how an onlooker will appraise an outcome, given the valence and strength of their relationship to the target(s) directly experiencing the outcome and the value of the outcome for that target. Specifically, we expect participants' vicarious emotion predictions to be subject to a strong interaction effect between the amount the target wins in each trial and the closeness of the relationship between the target and the onlooker¹. We compare our model's ability to explain vicarious emotion predictions to that of a model based on the emotion contagion alternative.

Methods

The preregistered procedure and analysis plan for this study are available at <https://osf.io/52tgv>.

Participants

We recruited 127 participants through Prolific. Participants were required to be 18 years or older and fluent in English. All participants gave informed consent via protocols approved by the UC San Diego IRB and were paid \$4.00 as compensation for their time (approx. 20 minutes). We anticipated a final sample size of $N = 100$ after exclusions, which would provide $> 95\%$ power to detect a medium-sized interaction effect ($f = 0.15$). Power analyses were conducted using G*Power (Erdfelder, Faul, & Buchner, 1996).

17 participants were excluded for inattention or poor performance (see details below). The final sample thus consisted of $N = 110$ participants.

Procedure

The experiment consisted of 10 trials, each introducing two people with names and details about their relationship (e.g., "James and Olivia are coworkers who have finished several projects together. They like and respect one another, though they aren't friends outside of work"). A quantitative strength value for their relationship was also depicted using a "feelings" thermometer that ranged from -1 to 3 (see Figure 1). Each of these five relationships appeared in 2 of the 10 trials.

Each trial also featured a wheel with three sections, each

¹The one exception to this is the emotion of 'surprise.' Given that surprise in this context is driven most strongly by the absolute value of the target's prediction error rather than reward value (Ong et al., 2015), we do not expect predictions of vicarious surprise to be subject to an interaction between amount won and closeness.

James and Olivia are coworkers who have finished several projects together. They like and respect one another, though they are not friends outside of work. The feeling thermometer below shows how close they are.

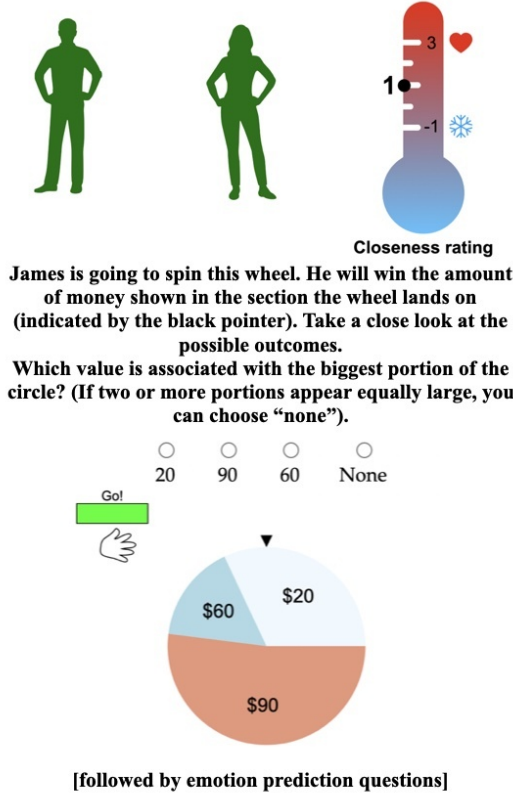


Figure 1: Condensed example of the text and images presented during one trial of the experiment.

labeled with a different reward value². Participants were told that one of the two people in the trial (the “player”) was going to spin the wheel and receive the amount of money indicated by a pointer once the wheel stopped. The other person (the “onlooker”) would observe the player but not receive any of the reward. We manipulated the size of the wheel sections, the associated values, and the value won across trials. To make sure participants encoded the possible outcomes and their likelihoods, they were asked to report the outcome associated with the largest area of the circle. Because some of the size differences between the areas were small, along with the three numerical values we also provided the option “none,” which participants were instructed to use if they thought two or more portions were equally large. We considered this a correct choice if the size of two largest portions were within 15% of one another. After answering this attention check, participants clicked a button to make the wheel spin and observed the reward obtained by the “player” character.

²We modified the experimental procedure from Ong et al. (2015) which only had one character playing the gamble.

After observing the outcome, participants were asked to predict the strength of four emotions felt by the player: *happiness*, *sadness*, *disappointment*, and *surprise*. Participants rated each of these emotions on a 9 point Likert scale ranging from “Not at all” to “Extremely”. Next, participants recalled the closeness between the player and the onlooker given at the beginning of the trial. We considered responses to be correct for the purposes of an attention check if they were within 1 point of the stated value (e.g., if the trial stated the relationship had a strength of 2, we accepted responses of 1, 2, or 3). Finally, the participant predicted how the onlooker felt following the outcome with respect to the same four emotions (*happiness*, *sadness*, *disappointment*, *surprise*) using the same Likert scales.

Across participants, the associations between relationship categories, descriptions, and numerical strength values were fixed (sibling - “3”, friend - “2”, coworker - “1”, stranger - “0”, neighbors - “-1”). The presentation order for the relationships was randomized. The set of possible rewards and the final outcome of the gambling game in each trial was chosen from a set of 50 unique outcomes, each defined by one of 17 wheel compositions and a specific spin outcome. For each participant, outcomes for the 10 trials were chosen randomly from this set without replacement.

Participant Exclusion We excluded participants if they were less than 70% correct when reporting either the value associated with the largest portion of the wheel or the relationship strength between the onlooker and recipient (see descriptions of tolerance for minor failures of perception or memory above). Sixteen participants failed the reward value check, and one participant failed both checks. For the remaining participants, we included all trials in our analyses, even those for which the participant made a mistake on an attention check. We also planned to exclude participants who gave the same value across all trials for either the happiness or surprise predictions for either target, but this did not occur.

Primary Data Analysis

To test our hypothesis that vicarious emotion predictions are based on both the reward experienced by the target and the social closeness of the onlooker to the target, we fit participants’ predictions for the onlookers’ emotions (separately for each emotion type) using the following *R* lmer model:

$$\text{onlookerEmo} \sim \text{win} + \text{PE} + \text{absPE} + \text{closeness} + \text{win:closeness} + (1|\text{SubID}) \quad (1)$$

where *onlookerEmo* refers to trialwise predictions for the onlooker’s emotion (e.g., happiness), *win* is amount won on that trial, and *PE* and *absPE* are the signed and absolute values of the prediction error for each trial, calculated as the expected amount won (the sum of the reward values each multiplied by the relevant wheel proportion) subtracted from the actual amount won. The formula specification for *win*, *PE*, *absPE* was taken from previous research (Ong et al., 2015). Participants’ recollection of the relationship strength for each trial

Table 1: Table of coefficients (with p-values in parentheses) for the full model.

	Intercept	Win	PE	PE	Closeness	Win:Closeness
Happiness	4.955 ($< 0.001^{***}$)	-0.013 (0.002**)	0.010 (0.024*)	-0.011 (0.005**)	-0.272 (0.002**)	0.024 ($< 0.001^{***}$)
Sad	1.235 ($< 0.001^{***}$)	0.017 ($< 0.001^{***}$)	-0.009 (0.032*)	0.023 ($< 0.001^{***}$)	0.956 ($< 0.001^{***}$)	-0.022 ($< 0.001^{***}$)
Disappointment	1.290 ($< 0.001^{***}$)	0.024 ($< 0.001^{***}$)	-0.011 (0.024*)	0.019 ($< 0.001^{***}$)	1.251 ($< 0.001^{***}$)	-0.028 ($< 0.001^{***}$)
Surprise	3.053 ($< 0.001^{***}$)	0.019 ($< 0.001^{***}$)	0.010 (0.029*)	0.018 ($< 0.001^{***}$)	0.486 ($< 0.001^{***}$)	-0.001 (0.731)

* $p < .05$. ** $p < .01$. *** $p < .001$.

was used for the `closeness` factor, and `win:closeness` represents the interaction between the `win` and `closeness` variables, while $(1|\text{SubID})$ adds a random intercept by subject ID.

We used a nested model comparison to test if emotion predictions were subject to a statistically significant interaction between the amount the player won and the closeness of the onlooker to the player (i.e., `win:closeness`). We repeated this analysis for each emotion.

We also compared the full model to an alternative model based on the competing hypothesis that people expect vicarious emotions to arise through emotional contagion. In this case, predictions about onlookers' vicarious emotions are a function only of predictions about the players' emotions:

$$\text{onlookerEmo} \sim \text{playerEmo} + (1|\text{SubID}) \quad (2)$$

where `playerEmo` are the trialwise predictions of the players' emotion, for the same emotion type as modeled for the onlooker. Although this model is very simple, predictions of the player's emotion already capture the influence of many of the factors shared with the primary model (e.g., `win` and `PE`; Ong et al., 2015), along with components of the emotion attribution process not successfully modeled there, so comparing our hypothesized model to this alternative represents a relatively stringent test. For each valenced emotion, we compare variance captured by each model, penalized for complexity, using the associated AIC values.

Exploratory Data Analysis

In addition to the primary analyses, we used preregistered exploratory analyses to further test the hypothesis that people use graded, rather than categorical, representations of relationship strength to inform vicarious emotion inference. If people incorporate graded representations of social ties into their predictions about vicarious emotions, then those predictions should be sensitive to the interaction of closeness and reward amount even when restricted to the space of positive relationships (i.e., relationships with a rating of 1, 2, or 3 on our feelings thermometer). Alternatively, if people only use relationship valence categories (i.e., positive, neutral, negative) to reason about vicarious emotions, then the interaction of closeness and reward should no longer be significant when

we restrict the data in this way. To test this, we repeated the primary nested model comparison, looking only at data from trials that featured positive relationships.

Results

Consistent with our hypothesis, not only did the players' reward experience (`win`, `PE`, $|PE|$) significantly influence participants' prediction about the onlookers' emotions, but the social relationship between the onlooker and the player also played a crucial role. We found statistically significant interactions between `win` and `closeness` for predictions about each of the three valenced vicarious emotions (happiness: $b = 0.024$, 95% CI [0.022, 0.027], $t(1062) = 17.278$, $p < 0.001$; sadness: $b = -0.022$, 95% CI [-0.025, -0.019], $t(1056) = -15.406$, $p < 0.001$ and disappointment: $b = -0.028$, 95% CI [-0.031, -0.025], $t(1075) = -17.954$, $p < 0.001$), but not for surprise ($b = -0.001$, 95% CI [-0.003, 0.002], $t(1025) = -0.343$, $p = 0.731$; Table 1, Figure 2).

To further understand the nature of observers' vicarious emotion predictions, we broke out participants' emotion predictions for the onlooker according to trialwise relationship strength. We used simple slopes analysis to estimate the effect of the amount the player won on onlooker emotion predictions, for each strength level and each emotion type (Table 2). While the previous linear mixed model treated closeness as a continuous variable, this follow-up analysis treated closeness as a categorical variable, allowing us to directly examine effects at specific, meaningful levels of relationship strength without imposing dependencies across levels. For a given relationship strength, a positive "win"-related slope for happiness and negative slope for sadness and/or disappointment would indicate that participants thought that onlooker would feel empathy for the player. The reverse pattern would reflect an expectation of counter-empathy. We found that for all three positive relationship strengths, participants expected the onlooker would empathize with the player, feeling happier and less sad or disappointed the more the player won. In contrast, when the player and onlooker were strangers, participants' vicarious emotion predictions were not affected by the amount the player won, suggesting no expectation of empathy for those outcomes. Finally, when the player and onlooker

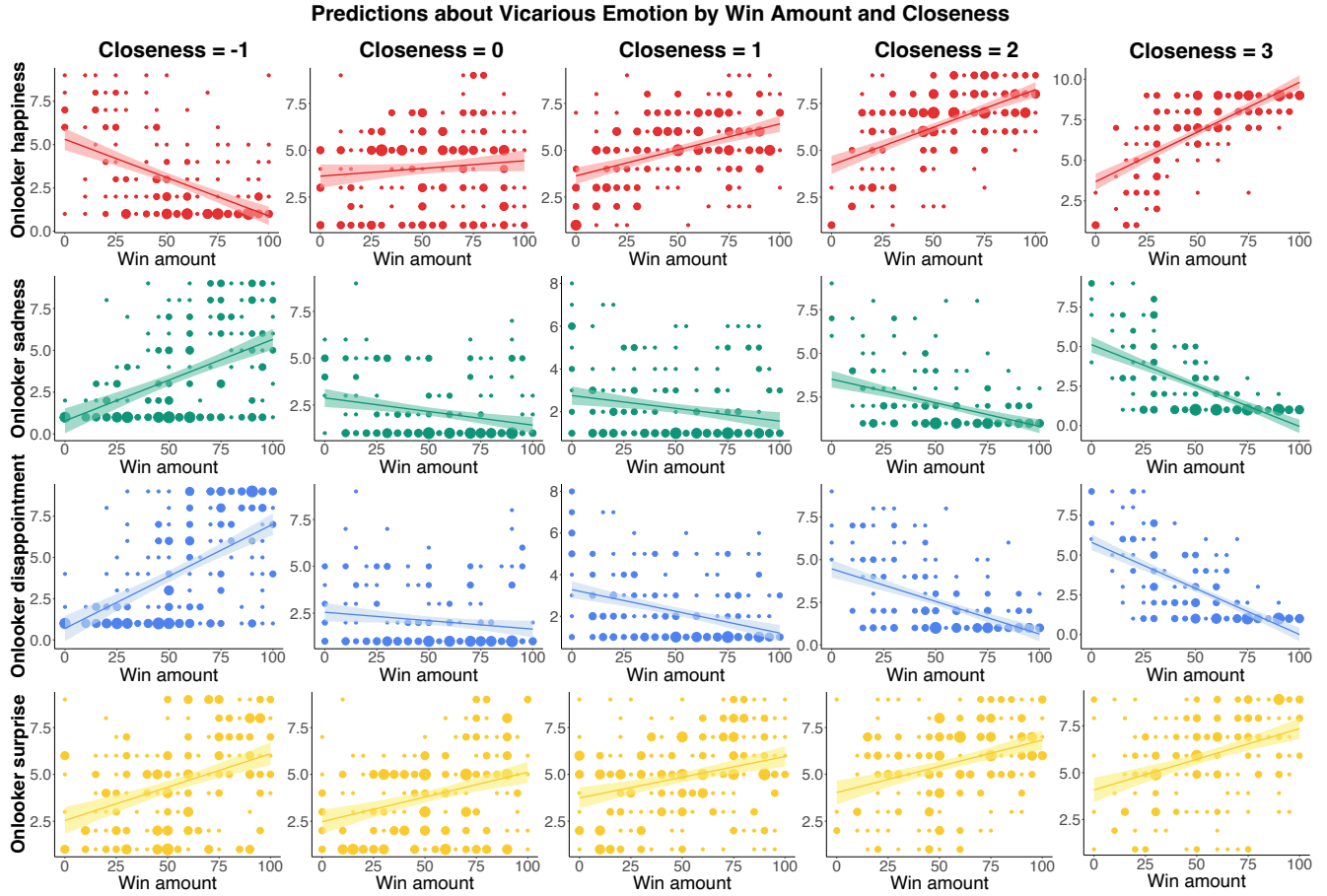


Figure 2: Participants' predictions about vicarious emotion by win amount and closeness. Rows correspond to four distinct emotions: happiness (red), sadness (green), disappointment (blue), and surprise (yellow). Columns represent varying levels of closeness between the onlooker and the player, ranging from -1 (negative) to 3 (most close). Each scatter plot visualizes the relationship between the win amount (x-axis) and the strength of the vicarious emotion participants predicted for the relevant onlooker (y-axis), with larger dots indicating a higher concentration of data points.

disliked one another, participants displayed expectations of counter-empathy: they predicted the onlooker would feel less happiness and more sadness or disappointment the more the player won.

Model comparisons also revealed that the full third-party appraisal models provided a better fit than the contagion models for all three valenced emotions (Happiness: full model AIC = 4472.63, contagion model AIC = 5154.73; Sadness: full model AIC = 4477.66, contagion model AIC = 4622.29; Disappointment: full model AIC = 4663.85, contagion model AIC = 4903.47). These results further support the hypothesis that people expect vicarious emotions to arise not through a simple process of emotional contagion, but rather through a joint reasoning process that integrates both the player's reward outcome and their social relationship with the onlooker.

Following our preregistered exploratory analyses, we tested the hypothesis that people use graded, rather than categorical, representations of relationship strength to inform vi-

carious emotion inference. Using the same set of nested linear regression models as in the primary analysis, we repeated the analysis while restricting the data to only positive relationships. Consistent with our hypothesis, we again found a significant interaction between win amount and closeness in predicting vicarious emotions except for surprise (happiness: $b = 0.016$, 95% CI [0.011, 0.021], $t(607) = 6.452$, $p < 0.001$; sadness: $b = -0.018$, 95% CI [-0.023, -0.013], $t(615) = -7.286$, $p < 0.001$; disappointment: $b = -0.019$, 95% CI [-0.024, -0.014], $t(624) = -7.314$, $p < 0.001$; surprise: $b = 0.001$, 95% CI [-0.004, 0.007], $t(586) = 0.466$, $p = 0.641$), supporting the idea that people incorporate continuous variations in relationship strength rather than relying solely on categorical valence.

Overall, these results suggest that people's expectations about vicarious emotions are modulated by the closeness between the target and the onlooker. Participants expected that onlookers would empathize with those they share posi-

Table 2: Simple slope results for the effect of win amount on onlooker emotion predictions for each level of social closeness.

Closeness	Happiness	Sadness	Disappointment	Surprise
-1	-0.054 [-0.065, -0.043] ($<0.001^{***}$)	0.054 [0.044, 0.065] ($<0.001^{***}$)	0.072 [0.060, 0.083] ($<0.001^{***}$)	0.019 [0.008, 0.031] (0.001^{**})
0	0.002 [-0.009, 0.013] (0.702)	-0.006 [-0.017, 0.004] (0.238)	-0.00 [-0.012, 0.010] (0.908)	0.022 [0.010, 0.033] ($<0.001^{***}$)
1	0.018 [0.008, 0.028] ($<0.001^{***}$)	-0.007 [-0.017, 0.003] (0.170)	-0.015 [-0.025, -0.004] (0.007^{**})	0.012 [0.001, 0.023] (0.028*)
2	0.032 [0.021, 0.044] ($<0.001^{***}$)	-0.024 [-0.035, -0.014] ($<0.001^{***}$)	-0.034 [-0.045, -0.023] ($<0.001^{***}$)	0.014 [0.002, 0.026] (0.018*)
3	0.053 [0.041, 0.064] ($<0.001^{***}$)	-0.045 [-0.055, -0.034] ($<0.001^{***}$)	-0.050 [-0.061, -0.038] ($<0.001^{***}$)	0.021 [0.009, 0.033] ($<0.001^{***}$)

* $p < .05$. ** $p < .01$. *** $p < .001$.

tive relationships with (i.e., feeling happy for their rewards), and they also expected counter-empathy in negative relationships (feeling unhappy when the player wins). However, they did not hold clear expectations about empathy for strangers, suggesting that, at least within this space of windfall gains, people may not have normative expectations about vicarious emotional responses to strangers.

Discussion

Using a computational cognitive modeling approach where we systematically varied both the situation a target experiences as well as the strength of the relationship that an onlooker has with the target, we were able to study how people make inferences about the vicarious emotions that they think the onlooker experiences. We found that our appraisal-based model (Equation 1) provided a good fit to participants' inferences, which varied by the perceived closeness between onlooker and player (Figure 2). Our results provide support for a third-person appraisal framework of emotion understanding (e.g., Ong et al., 2019; Doan et al., 2025; Saxe & Houlihan, 2017), but now augmented with insight into how relationships impact emotions and lead people to respond even when events do not affect them personally. That is, people understand onlookers' vicarious emotions by considering both how much the situation means to a target, and how much the target means to the onlooker.

These findings expand upon previous research which found that children also use relationships to guide predictions about vicarious emotions (Smith-Flores et al., 2023). That work employed categorical information about relationships (friends or foes) and outcomes (good or bad). Here we expanded the space of both variables, systematically varying both the strength of relationship between the onlooker and target and the value of the target's outcome, both in absolute terms and relative to their expected reward. The third-party appraisal model continued to provide a strong fit to the data within this graded structure. Even within the space of positive relationships, participants' expectations for empathic vicarious emotion increased with the strength of the onlooker and

player's relationship. And for a given level of closeness, participants expected empathic or counter-empathic responses to scale with the size of the target's rewards.

There were, however, important limits on the parameters of the current experiment. First, players do experience an arguably positive experience (winning money) in every trial, even when less than expected. Observers' expectations about vicarious emotions may begin to deviate from the current model when considering negative events. Children consider empathic concern for others' suffering to be normative and predict empathy for rivals' misfortunes (Paulus, Wörle, & Christner, 2020; Smith-Flores et al., 2023; Tompkins et al., 2023); adults may do the same. Second, participants here made emotion predictions only for unknown individuals. Outside of the lab, this reasoning is presumably most often applied to the emotions of people the observer knows. In such contexts, people accurately tailor their emotion predictions based on their knowledge about the individual under consideration (Zhao, Thornton, & Tamir, 2022). Future research should investigate how observers integrate their general understanding of emotions as appraisals, informed by social relationships, with their personalized knowledge about individuals' emotional characteristics. Finally, our strength scale included more gradations of positive than negative relationships. While this choice reflects everyday social experience (Hartup & Abecassis, 2002; Finch, Okun, Barrera, Zautra, & Reich, 1989), future research should better characterize how the intensity of negative relationships impacts expectations about counter-empathy.

Here we have focused on vicarious emotion predictions, but future research should also investigate how people use their understanding of these emotions to learn about and intervene on their social world. Knowing who is most likely to empathize can guide the search for emotional support, and people may also be able to use vicarious emotions to both assess and convey relationship strength. Overall, the understanding of vicarious emotions demonstrated here is likely to be an important tool in the maintenance of healthy social networks.

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